



INDIAN ACADEMY DEGREE COLLEGE

AUTONOMOUS



Department of Biochemistry

Proposed Syllabus

M. Sc. (Choice Based Credit System)

I - IV Semesters

(With effect from 2018)

April, 2018

Proceedings of the meeting of the Board of Studies in Biochemistry (PG)

The meeting of the Board of Studies in Biochemistry (PG) was held on Saturday, 21th April, 2018 at 10.30 am in the Department of Biochemistry to approve the M.Sc. CBCS Biochemistry syllabus.

The Chairman welcomed the members, the draft syllabus approved by the Departmental Council was placed before the board. After day-long scrutiny, the board approved the M.Sc. Biochemistry CBCS syllabus with incorporation of appropriate modifications.

The panel of examiners for PG Biochemistry (both external and internal) was modified and approved.

The Chairman thanked all the members for their active participation and valuable inputs.

Members present:

1. Dr. V. R. Devaraj,
Professor, Dept. of Biochemistry,
Bangalore University, Bengaluru.
2. Dr. V. Veeraraghavan,
Professor, Dept. of Biochemistry,
Reva University, Bengaluru.
3. Dr. Kavitha. G. Singh,
Associate Professor,
Dept. of Biochemistry,
Mount Carmel college, Bengaluru.
4. Dr. Shama Bhat,
Chairman and Managing director,
BHAT BIOTECH, Bengaluru.
5. Dr. Susanta Pahari
Chairman (BOS)
Department of Biochemistry
IADC, Bengaluru.
6. Mrs. Pushpa Reddy,
Professor, Dept. Of Biochemistry,
IADC, Bengaluru
IADC, Bengaluru.
7. Dr. Prashanthi, K.
Associate professor,
Dept. Of Biochemistry,
IADC, Bengaluru.
8. Mrs Ramya Kumari,B. S.
Associate professor,
Dept. Of Biochemistry,
IADC, Bengaluru.
9. Mrs Malathi R.
Associate professor,
Dept. Of Biochemistry,
IADC, Bengaluru.
10. Dr. Kokila S.
Associate professor,
Dept. Of Biochemistry,
IADC, Bengaluru.

**SCHEME OF STUDY AND EXAMINATION
I to IV SEMESTER M. Sc. BIOCHEMISTRY COURSE**

First Semester							
Paper Code	Title of the paper	Contact hours	Exam. hours	Marks			Credits
				IA	Exam	Total	
MBC – 101	Biophysical and Bio – organic chemistry	4	3	30	70	100	4
MBC – 102	Biomolecules	4	3	30	70	100	4
MBC – 103	Analytical Biochemistry – I	4	3	30	70	100	4
MBC – 104	General Physiology	4	3	30	70	100	4
MBC – 105	Microbiology	3	3	30	70	100	2
MBC – 106	Gen. Biochemistry – I	8	4*	30	70	100	4
MBC – 107	Clinical Biochemistry & Microbiology	8	4*	30	70	100	4
Total						700	26

Second Semester							
Paper Code	Title of the paper	Contact hours	Exam hours	Marks			Credits
				IA	Exam	Total	
MBC – 201	Enzymology	4	3	30	70	100	4
MBC – 202	Analytical Biochemistry – II	4	3	30	70	100	4
MBC – 203	Metabolism – I	4	3	30	70	100	4
MBC – 204	Membrane Biochemistry	4	3	30	70	100	4
MBC – 205	Bioinformatics & Toxicology	3	3	30	70	100	2
MBC – 206	Enzymology	8	4*	30	70	100	4
MBC – 207	Biochemical techniques	8	4*	30	70	100	4
Total						700	26

Third Semester							
Paper Code	Title of the paper	Contact hours	Exam hours	Marks			Credits
				IA	Exam	Total	
MBC – 301	Molecular Biology – I	4	3	30	70	100	4
MBC – 302	Molecular Physiology	4	3	30	70	100	4
MBC – 303	Metabolism – II	4	3	30	70	100	4
OET	Open Elective**	4	3	30	70	100	4
MBC – 304	Molecular Biology	8	4*	30	70	100	4
MBC – 305	Genetic Engineering and Bioinformatics	8	4*	30	70	100	4
Total						600	24

** Non- Biochemistry Paper

Fourth Semester							
Paper Code	Title of the paper	Contact hours	Exam. hours	Marks			Credits
				IA	Exam	Total	
MBC – 401	Molecular Biology – II	4	3	30	70	100	4
MBC – 402	Biochemical Genetics	4	3	30	70	100	4
MBC – 403	Biotechnology	4	3	30	70	100	4
MBC – 404	Immunology	4	3	30	70	100	4
MBC – 405	Immunology and Toxicology	8	4*	30	70	100	4
MBC – 406	Project work	8	Report	30	70	100	4
Total						600	24

Scheme of Continuous evaluation:

1. Continuous evaluation in theory papers: 5 marks for attendance and 25 marks for tests. Two tests will be conducted and average of marks from two tests will be computed for continuous evaluation
2. Practical IA: 5 marks for Record, 5 marks for attendance and 20 marks for tests. Two tests will be conducted and average of marks from two tests will be computed for continuous evaluation

PROJECT WORK

1. Proposed to carry out the project work individually or in group to a maximum of 3 or 4 students.
2. Project shall be allotted at the beginning of the III semester to facilitate students to carry out during semester break.
3. In house projects are encouraged.
4. Students in some cases may be allowed to carry out the project work in other research institutes, but faculty members of the Biochemistry department must serve as principal guide.
5. Evaluation of dissertation has to be done by two examiners (one internal and one external) appointed by the College for 70 marks (30 marks for the quality of accomplished work, 20 marks for the quality of presentation and 20 marks for viva voce).

FIRST SEMESTER M. Sc. BIOCHEMISTRY

MBC – 101: Biophysical and Bioorganic Chemistry

4 units (52 hrs)

Properties of water: Physical and chemical properties of water, ionization and ionic product of water, structure of liquid water and ice. Unusual properties of water. Hydrophilic, hydrophobic and amphipathic molecules in aqueous solution. Effect of solutes on colligative properties of water. Importance of water in biological systems with special reference to the maintenance of native structure of biological molecules. Biological relevance of pH and pKa, determination of pKa of weak acid. Buffers, buffer action, and buffer capacity. Henderson–Hasselbalch equation, preparation of buffers. Importance of buffers in biological systems (cytosol and blood).

6 hrs

Thermodynamics: First law of thermodynamics, basic concepts of entropy and second law of thermodynamics, free energy changes, standard free energy change and its relation to equilibrium constant. Oxidation – reduction reactions in biological systems.

5 hrs

Stereochemistry: Optical isomerism, chirality, symmetry elements, enantiomers, diastereomers, DL and RS notations, racemization, stereoisomerism and geometrical isomerism, cis – trans and E – Z conventions.

5 hrs

Mechanism of Bio-organic reactions: Introduction, meaning of the term, kinetic and non- kinetic. Fundamental aspects: Homo and heterolytic cleavage, structure and reactivity of carbocation (C^+), carbanion (C^-) and carbon free radical ($C^\cdot$) characteristic aspects of ionic, radical and concerted reactions, substitution, addition, elimination and rearrangements. Energy profiles of reactions, transition state theory, kinetically and thermodynamically controlled reactions. Reactions SN^1 , SN^2 , SN^1 neighbouring group participation. E_2 , E_i , Curtin-Hammett principle. Electrophilic addition to $C=O$, detailed discussion of all aspects of aldol condensation, related condensations, Michael addition. Esterification and hydrolysis.

12 hrs

Rearrangements: Migration to electron deficient C, N and O; Wagner-Meerwein, Pinacol, Beckmann, Hoffmann, Bayer-Villiger reactions, allylic rearrangements. Benzilic acid rearrangement, Cannizzaro and Manich reactions, oxidation-reduction.

6 hrs

Free radicals: Introduction, formation – photolysis, thermolysis, redox reactions, radical reactions with biomolecules.

4 hrs

Heterocyclic systems: Occurrence in biological systems, structure and properties of furon, pyrrole. Indole, thiazole, imidazole, pyridine, pyrimidine, purine, quinone, pteridine and isoalloxazine containing biomolecules.

8 hrs

Bioinorganic chemistry: Ligand field theory of complexes, stability of complex ions in solution, kinetics and mechanism of reactions of complexions. Ligand replacement reactions and

electron transfer reactions of organometallic moieties of biological macromolecules (cytochromes, chlorophyll and hemoglobin). **6 hrs**

References

1. Physical Biochemistry. Kansal Edward Van Halde. Prentice Hall.
2. Physical Biology of the Cell, 2nd Edn. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
3. Bioinorganic Chemistry; Ei-Ichiro Ochiai, Elsevier (2008).
4. Physical Biochemistry. David Frifielder. 2nd Edn. W.G.Freeman and Co ()
5. Organic Chemistry. Vol.I. Fundamental principles. I. L .Finar. 6th Edn. ELBS
6. Inorganic Biochemistry. G.L. Eicharn. Elsevier.
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
9. Introduction to Biophysical Chemistry, Bruce Martin
10. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Edn. Prentice Hall, India.
11. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
12. Principles and techniques of practical Biochemistry. K.Wilson and J. Walker. 4thEdn. Cambridge University press (2012).
13. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn. Karen C. Timberlake, Benjamin Cummings, (1999).
14. Physical Chemistry of Macromolecules, C. Tanford.
15. Molecular Cell Biology Baltimore et al., Scientific American Publication (1995).
16. Reaction Mechanisms at a glance, ed. M. Moloney, Blackwell Science (2000).

MBC– 102: Biomolecules

4 units (52 hrs)

Carbohydrates: Brief review of configurational and conformational aspects of carbohydrates. Structure, properties and importance of structural (cellulose and chitin) and storage polysaccharides (starch and glycogen), glycosaminoglycans, cardioglycosides and bacterial cell wall polysaccharides. Structure elucidation of polysaccharides (starch, glycogen and cellulose). Glycoproteins – structure and functions, blood group antigens, sequence analysis of oligosaccharides. Lectins – characteristics and functions in biological system.

10 hrs

Lipids: Lipid classification, brief account of the chemical properties and structure of lipids (without structure elucidation) & biological role of the following: fatty acids, acyl glycerols, phospholipids, plasmalogens, sphingolipids, glycolipids, steroids, eicosanoids – prostaglandins, thromboxanes, & leukotrienes, leptin and visfatin.

7 hrs

Amino acids and Proteins: Review of classification and structure of amino acids, acid – base properties of amino acids. Non – standard, non–protein and biologically active amino acids. UV-

light absorption property of amino acids. Ionic properties of peptides and proteins. Naturally occurring peptides. Peptide synthesis– reactive ester method and modified Merrifield solid phase synthesis.

Primary structure: Elucidation of primary structure of proteins – Determination of amino acid composition, end group analysis, cleavage by enzymes and chemicals, separation of fragments. Manual and modern methods of sequencing and reconstructing the protein sequence. Assignment of disulfide bonds.

Secondary structure: Peptide bond – structure and conformation, Ramachandran plot. Regular *secondary structure:* α – helix and other types of helices, β – pleated sheet, irregular, turns, loops and triple helical structures. Helix stabilizing and destabilizing amino acids. Structure of fibrous proteins: α -keratin, silk fibroin and collagen. Motifs (super secondary structure – triose phosphate isomerase, concanavalin-A and Rossmann fold) and domain structure (glyceraldehyde-3-phosphate dehydrogenase). Secondary structure of insulin, ribonuclease, lysozyme, myoglobin and chymotrypsin.

Tertiary structure: Forces stabilizing tertiary structure of proteins. Protein denaturation and renaturation.

Quaternary structure and symmetry: Structure and function of myoglobin and hemoglobin. Cooperative mechanism of oxygen binding to hemoglobin. Abnormal hemoglobin– sickle-cell hemoglobin.

20 hrs

Protein folding pathways: Protein dynamics – kinetics of protein folding and disulfide bond formation, molecular chaperones and protein disulfide isomerase. Prediction of secondary and tertiary protein structure. Disease related to protein folding – Alzheimer's and mad cow disease.

3 hrs

Nucleic Acids: Structure and properties of Nucleosides and Nucleotides. Structure of nucleic acids– primary, secondary and tertiary structure of DNA. Isolation, fractionation and characterization of nucleic acids. Properties of nucleic acids in solution. Secondary structure of tRNA and role of secondary structure in mRNA stability. Chemical synthesis of oligonucleotides (phosphate and phosphite method). Nucleic acid sequencing – Maxam and Gilbert and Sangers method. Rapid sequencing methods and new generation DNA sequencers.

12 hrs

References

1. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
2. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006).
3. Physical Biology of the Cell, 2nd Edn. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. Jhon Wiley and sons, (1999).
5. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
6. Complex Carbohydrates, Sharon, N. Addison Wisely, (1975).
7. Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).

8. Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., Blackwell Scientific (1982).
9. Principles of Biochemistry; Smith et al., McGraw Hill (1986).
10. Proteins Structures and Molecular Properties 2nd Edn. Thomas E. Creighton, W H Freeman and Co. (1993).
11. Principles of Protein Structure, Function, & evolution, Dickerson & Geis 2nd Ed. Benjamin-Cummings (1983).
12. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).
13. Practical Biostatistics; Mendel Suchmacher and Mauro Geller, Academic Press (2012).

MBC- 103: Analytical Biochemistry – I

4 Units (52 hrs)

Introduction to Biochemistry:

1 hr

Overview of Biochemical Investigations: Introduction to biochemistry, outline of strategies in biochemical investigations employing whole animal studies, isolated organs, tissues, and cell cultures. Specific investigations with isolated organelles; mitochondria and ER. Investigations with microorganisms and their mutants yeast, *Ceanorhabditis elegans*, *Arabidopsis thaliana* and *Drosophila melanogaster* as model specimen for biochemical investigations. Basic equipments and methods, and safety considerations in animal cell culture. Types of animal cells and their characteristics in culture, culture media and common animal cell lines for laboratory investigation. Plant cell culture, media for plant cell culture, potential of plant cell culture in biochemical investigations.

Extractions; Preparation of extracts for biochemical investigations, physicochemical properties of metabolites and drugs extracts from biological materials. Physico-chemical properties of solvents, solubility and miscibility, ionic bonds, and salting out. Partition, ionization, buffering and their effect on extraction. Choice of solvent for solvent extraction, mixed solvents, solid phase extraction.

9 hrs

Microscopic techniques: Review of light microscope, resolution of microscopes, Optical contrast, phase contrast, and dark field microscopy, preparation of specimen for biochemical investigations. Electron microscopy; Working principle and applications, specimens for electron microscopy, fixatives, immune-gold microscopy and its advantages. Metal shadowing, design and applications of scanning electron microscopy (SEM), Transmission electron microscopy (TEM), and cryo-electron microscopy. 3-D images, negative staining, single particle reconstruction.

5 hrs

Fluorescence Microscopy: Fluorophores, principle and applications of fluorescence microscopy, design and uses of Epifluorescence microscopy, and immuno-fluorescence microscopy. Imaging live cells and tissues; time lapse imaging, fluorescence stains of living cells, reporter molecules, multidimensional imaging. Measuring cellular dynamics; calcium imaging in live cells, fluorescence recovery after photo bleaching (FRAP), Fluorescence

resonance energy transfer (FRET). Use of ion-selective electrodes, light emitting indicators and optical tweezers in study of cellular dynamics.

5 hrs.

Centrifugation: Principle of centrifugation, the Swedberg equation, types of centrifuges and rotors. Density gradient centrifugation- Caesium chloride and sucrose density gradients; examples of separations, Sub-cellular fractionation. Design and working of analytical ultracentrifuges, sedimentation velocity and sedimentation equilibrium analyses.

Ultra-filtration; Principle, instrumentation and application. Dialysis, principle and uses of equilibrium dialysis,. Precipitation; methods and applications.

Flow Cytometry; Principle and design of flow cytometer, cell sorting. Detection strategies in flow cytometry and parameters measured by flow cytometry.

7 hrs

Biocalorimetry: Arrhenius equation, determination of energy of activation from Arrhenius plots. Main thermodynamic parameters; enthalpy, and entropy. Isothermal titration calorimetry, design of experiments, determination of change in heat capacity, eg., oligomerization of valinomycin, DNA duplex. Determination of specific heat from enthalpy. Differential scanning calorimetry; design of experiment, application of DSC, microcalorimetry. Determination of thermodynamic parameters by non-calorimetric data.

5 hrs

Radioisotopic methods of analysis: Atomic stability and radiation, types of decay, rate of radioactive decay, half life, units of radioactivity. Detection and measurement of radioactivity, Design and applications of Geiger-Muller Counter, and types of scintillation counters. Disadvantages of scintillation counters, quenching, Chemiluminescence and phospholuminescence counting efficiency, channel ratio, sample preparation, scintillation cocktails, Cerenkov counting. Autoradiography; types of emulsions and films for exposure to isotopes, suitable isotopes, times of exposure and processing films, direct autoradiography, fluorography, intensifying screens, quantification. Radio tracer techniques; Supply storage and purity of radio-labeled compounds, specific activity, radio-labeled nucleotides, metabolites. Pulse chase experiments.

8 hrs

Quantitative biochemical measurements: Analytical considerations and experimental errors, nature of experimental errors- random and systemic errors. Identification of systemic errors, SOPs. Performance of analytical methods, precision, accuracy, detection limit, analytical range, specificity, sensitivity, and robustness. Gaussian distribution (normal) of data, quantification of precision by standard deviation, coefficient of variation and variance, (data to be provided for calculation of each parameter). Assessment of accuracy; Population statistics- confidence limits and confidence intervals, student's t-test, standard error of mean, examples for calculation. Q-tests, examples and applications, Null hypothesis, use of t-test to validate analytical methods- unpaired, paired, one-sample, two-sample tests with examples. Calibration methods; Least mean square method of fitting straight line to data with example. Correlation and regression analyses. ANOVA, one way and two-way ANOVA.

8 hrs

References

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
4. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).
5. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
6. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
7. Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
8. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
9. Nucleic Acid Blotting; D C Darling, P M Bricknell; Garland Science; (1994)
10. Introduction to Proteomics; Daniel C. Liebler, Humana Press (2002),.
11. Introduction to Bioinformatics; T K Attwood & D J Parry-Smith, Pearson Education (2002).
12. Choosing and Using Statistics; A Biologist Guide, Clavin Dythan, Blackwell Scientific (1999).
13. Basic Mathematics for Biochemists; Cornish Bowden, Oxford University Press (1998),.
14. Biophysical Tools for Biologists *In Vivo* Techniques; John Correia H. Detrich, III Elsevier (2008).
15. Recent Advances in Electron Microscopy- Part-A; B.V. Venkartarmaprasad, and Steve Ludtke, Academic Press (2010).
16. Recent Advances in Electron Microscopy- Part-B; B.V. Venkartarmaprasad, and Steve Ludtke, Academic Press (2011).
17. Introduction to Electron Microscopy for Biologists; Terry Allen, Academic Press (2008).

MBC – 104: General Physiology

4 units (52 hrs)

Tissues: Formation of different kinds of tissues from primary germ layers. Types and functions of epithelial tissue, inter-cellular junctions. Connective tissue – extra cellular matrix, Collagens – types, composition, structure and synthesis, Elastin, fibronectins, and other proteins of the extra – cellular matrix. Basal lamina; laminins and associated proteins and their functions.

6 hrs

Cytoskeleton and Cellular dynamics: *Microfilaments*; Assembly and polymerization of G- actin, role of Thymosin-B4, Profilin and Cofilin in polymerization, structural and functional property of F-actin, Capping proteins and assembly of actin filaments, branched and unbranched

filament assemblies, Arp2/3, intracellular cellular movement and actin polymerization, use of toxins in study of actin dynamics. Role of cross-linking and adaptor proteins in actin bundling and membrane association.

Structure and organization of microtubules; dynamics of microtubules, assembly by MTOC, dynamic instability, tubulin polymerization as target of drugs. Side and end-binding proteins, capping and severing proteins. *Kinesins and dyneins*; vesicular transport along microtubule, role of kinesin-1 and dynein motors in organelle transport. Role of microfilaments and microtubules in cell migration.

Intermediate filaments; Assembly and tissue specific expression, dynamic nature of intermediate filaments, diseases associated with Lamins and Keratins defects.

7 hrs

Nervous System: Types and structure of neuron. Myelin sheath; composition and function.

Resting membrane and action potential. Nernst and Goldman equations. Mechanism of initiation and propagation of action potential – voltage gated ion channels, ionophores and toxins in study membrane transport. Design and use of Patch-Clamp in measuring membrane potential. Neurotransmitters and receptors; synaptic transmission, post-synaptic potentials. Outline and functions of autonomic and central nervous systems.

6 hrs

Muscular System: Ultra structure of smooth, skeletal and cardiac muscle fibers. Contractile and other proteins of muscle. Energy metabolism in muscle; Phosphagens, neuro-muscular junctions, excitation of striated muscles. Organization of sarcolemma, transverse-tubular system and sarcoplasmic reticulum, mechanism of muscle contraction. Regulation of contraction in striated and smooth muscle. Calmodulin and its regulatory role, muscular dystrophies.

6 hrs

Digestive System: Secretion, regulation of secretion, composition and functions of saliva, gastric, pancreatic and intestinal juices and bile. Gastro-intestinal hormones. Digestion, absorption and transport of carbohydrates, proteins, lipids, nucleic acids and vitamins. Liver – structure and functions. Detoxification mechanisms. [Liver function tests.](#)

5 hrs

Cardio – vascular System: Systemic and pulmonary circulation. Structure of blood vessels. Regulation of cardiac activity. Blood volume, blood pressure. Plasma composition and functions of plasma lipoproteins. Mechanism of blood clotting, role of vitamin K, clot dissolution, anti-clotting factors, Formation, counting and functions of erythrocytes, leukocytes and thrombocytes. [Lymph, Cerebro spinal fluid \(CSF\); composition and analysis in diagnosis.](#)

6 hrs

Respiratory System: Mechanics and regulation of respiration, pulmonary and alveolar ventilation and its control, transport of respiratory gases, respiratory mechanism of acid-base balance. **5 hrs**

Excretory System: Mechanism of urine formation and composition of urine. [Urine analysis for abnormal constituents, tubular function tests.](#) Nephritis and nephrosis. Kidney hormones. Regulation of acid-base electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis. **5 hrs**

Endocrine system: Hormones, feedback regulation, biosynthesis, storage, secretion, Circulation in blood. Degradation and peripheral transformation. Receptors and the mechanism of hormone action. Measurement of hormones, and receptors. Disorders of endocrine system.

7 hrs

References

1. The Cell, Copper, Geoffery, M., Oxford University Press, (2001)
2. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.](1997), Wiley – Liss.
3. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds], 6th Edn. Macmillan Publications (2012).
4. Principles of Human Physiology; 4th Edn. Cindy L. Stanfield Pearson, (2010).
5. Principles of Biochemistry: Smith et al., [Ed.] (1986) McGraw Hill.
6. Principles of Biochemistry: General Aspects, Smith et al., [Ed.] (1986) McGraw Hill.
7. Human Biochemistry, Orten and Neuhans , 10th Edn. Mosbey International, (1983).
8. Review of Medical Physiology, Gannong, W.F.15th Edn., Maruzen Asial, (1991).
9. Human Physiology: The mechanisms of Body functions. A.J. Vander, et. Al.,(1985) McGraw-Hill.
10. Molecular Cell Biology, Baltimore et. al. (1995) Scientific American Publication.
11. Cellular Physiology of Nerve and Muscle. Gary G Mathew (1998) Balckwell Scientific Inc.
12. Harper's Review of Biochemistry, Murray et. al., (1997) 24th Edn., Lange
13. Molecular Biology of Cell; Albertis et. al. (2002) Garland Science.
14. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
15. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill, (1986).

MBC – 105: Microbiology

39 hrs

Bacteriology: Classification of Bacteria – Conventional and molecular methods; Identification and classification of microorganisms; Eubacteria, Archaeobacteria, Cyanobacteria, Bergy's classification of bacteria. Brief study of important groups of bacteria: Coliform, spore formers, photosynthetic bacteria, lactic acid producing bacteria, actinomycetes, ricketisiae, mycoplasmas.

5 hrs

Eukaryotic Microorganisms: Fungi- classification, cultivation and morphology of yeasts and molds. Control of fungal growth. Mycotoxins and their actions. Brief study of algae and protozoa. Media for culture of algae and protozoa.

4 hrs

Staining techniques: Gram, Acid fast & flagellar. Detailed study of bacterial cell structures-genetic elements, ribosomes, membranes, cell envelope, capsule, flagella, pili and endospores. Mechanism of bacterial motility.

3 hrs

Pure culture techniques: Principles of microbial nutrition: Nutritional requirements, different kinds of media, factors affecting growth. Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. Modes of reproduction, Biosynthesis of cell wall components, enumeration, growth curve, generation time, synchronous growth, Chemostat. Adaptation to stationary phase, heat and cold shock, osmolarity and salinity, oxidative stress.

6 hrs

Food and Dairy Microbiology: Food spoilage, food preservation, fermented foods, Contamination of milk by micro-organisms and reactions, **Pasteurization and sterilization**, Fermented milk products, cheese.

4 hrs

Bacterial Pathogenesis and Interventions: Normal microbial flora of human body; role of the resident flora; Classic strategies used by bacteria to initiate and maintain infection: Microbial colonization and adherence strategies, Microbial invasion strategies.

Selected mechanisms of bacterial pathogenesis: Bacterial type 1-IV secretion systems, Bacterial surface structures, Antigenic variation, Biofilms and quorum sensing, modulation of cellular processes, toxins.

Quantitative measures of virulence: minimal lethal dose (MLD), LD 50, ID 50, TCID 50. Mechanisms of control of pathogens: Sterilization methods and sterility testing, Physical and chemical methods of controlling bacterial growth, Antiseptic and disinfectant action.

Mechanisms of action of antibiotics-targets, Emergence of drug resistance, Antibiotic assay; Determination of minimum inhibitory concentration (MIC).

9 hrs

Virology: Classification and General Properties and structure of plant, animal and bacterial viruses.

Bacteriophages; one step growth experiment, single burst and premature lysis experiments, productive cycles of λ and ϕ x-174 viruses, lysogeny – P1, P2, P22 and Mu1 phages, RNA phages, isolation and cultivation of bacterial viruses.

Plant viruses- transmission, effect on plants, common diseases, TMV. Slow viruses and DI viruses- discovery and importance.

Animal viruses- productive cycle of DNA viruses- parvo, adeno and SV40. RNA viruses- reo, rhabdo, picorna, polio, Influenza Retrovirus (RSV and HIV)

Cultivation and enumeration of viruses; cultivation in cell culture, chick embryo and animal inoculation. Persistent chronic and acute viral infections. Inhibition and inactivation of viruses by physical and chemical agents.

Interferon- types, nomenclature and classification, induction, antiviral effect, antiviral proteins-ds RNA dependent and independent pathways.

8 hrs

References:

1. Microbial physiology, 2 nd Edn. I.W. Dawes and I.W. Sutherland (1991) Blackwell Scientific.
2. Microbial physiology, 4 Edn. Albert G. Moat, John W. Foster and Michael P. Spector, Wiley-Liss (2002) .
3. Modern Food Microbiology; James M.Jay (1996) CBS Publishers.
4. A Modern Introduction to Food Microbiology; Board, R.G. (Ed.) (1983) Blackwell Scientific Publications.
5. Biology of Microorganisms, Brock Prentice Hall (1996).
6. Industrial Microbiology; Miller and Litsky (Eds.) (1976) McGraw Hill Publishers.
7. Microbiology; Lansing M. Prescott, Hartley and Klein, 5 th Edn. McGraw Hill (2002).
8. Microbiology; Essentials and Applications, Larry Mckane and J.Kandel (19) McGraw Hill publishers.
9. Applied Microbial Physiology: A practical approach Rhodes and Stanbury (1997) IRL Press.
10. Microbes in Action, A Laboratory Manual of Microbiology Seley et al., (19) W.H. Freeman.
11. Basic and Practical Microbiology, Ronald L. Atlas (1986) McMillan Publication Co.
12. General Microbiology, Stainer et al., 4 th Edn. McMillan (1975).
13. Microbiology, Pelczar, Reid and Kreig Tata McGraw Hill (1996).
14. Biology of Microorganisms, Brock Prentice Hall (1996).
15. Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society for Microbiology Press, Washington, DC USA. 2002.

MBC – 106: Gen. Biochemistry – I (4 Credits)

1. Preparation of buffers; Acetate, phosphate and tris buffer.
2. Determination of saponification number and acid value of oils and fats.
3. Determination of iodine number and peroxide value of oils and fats.
4. Determination of pKa of weak acids and amino acids by pH metric titration.
5. Isolation of potato starch / liver glycogen.
6. Hydrolysis of starch / glycogen and estimation of its purity by H.J. method.
7. Hydrolysis of starch / glycogen and estimation of its purity by Somogy's method.
8. Analysis of water: estimation of calcium and magnesium by EDTA method.
9. Determination of pI of casein from milk.
10. Determination of phytic acid.
11. Estimation of vitamin C by dichlorophenol indophenol method.

References

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
4. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
5. Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
6. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
7. Physical Biochemistry. Kansal Edward Van Halde. Prentice Hall.

MBC – 107: Clinical Biochemistry and Microbiology (4 Credits)

Clinical Biochemistry

1. Estimation of glucose by Folin Wu method.
2. Estimation of cholesterol by Zack's method.
3. Estimation of haemoglobin by Wong's method
4. Estimation of urea in blood by Diacetylmonoxime method.
5. Determination of A/G ratio by Biuret method.
6. Analysis of SGOT-SGPT (AST, ALT) / creatine kinase / acid or alkaline phosphatase.
7. Qualitative analysis of Urine sample for normal and abnormal constituents.
8. Estimation of uric acid in serum and urine by Caraway's method
9. Estimation of creatinine and creatine in serum and urine by Zaffe's method.
10. Estimation of urea in urine by Nesslerization method (Urease method).

Microbiology

1. Preparation and sterilization of culture media (Complete and Synthetic)- Broth and Plates
2. Propagation of bacteria (Gram Positive and Negative, each one)
3. Staining of bacteria – Simple staining, differential staining (Gram), staining of spores
4. Quantification of Bacteria (Serial Dilution and Plate count)
5. Determination of growth curve of bacteria and Calculation of Generation Time (one each in Complete and Synthetic medium)
6. Biochemical tests (2 each for Gram Positive and Negative) and motility for the identification of bacteria (1 each for Gram Positive and Negative)
7. Propagation and enumeration of Bacteriophage by plaque count

References

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (1988).
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (1996).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (1994).
4. Hawk's Physiological Chemistry, ed. Oser, 14th Edn.(1976), Tata-McGrawHill.
5. Biochemistry, ed. Plummer Tata-McGraw Hill, (1971).
6. Applied Microbial Physiology; A practical approach Rhodes and Stanbury (1997) IRL Press
7. Microbes in Action, A Laboratory Manual of Microbiology Seley et al., (19)W.H. Freeman.
8. Basic and Practical Microbiology, Ronald L. Atlas (1986) McMillan Publication Co.
9. General Microbiology, Stanier, et al., (1975) 4 th Edn. McMillan.
10. Microbiology, Pelczer, Reid and Krieg (1996) Tata-McGrawHill.
11. Biology of Microorganisms, Brock (1996) Prentice Hall.

Second Semester M. Sc. Biochemistry

MBC – 201: Enzymology

4 units (52hrs)

Introduction to Enzymes: Nomenclature and classification of enzymes. Specificity and active site. Fundamentals of enzyme assay – enzyme units, [coupled kinetic assay](#), [immobilized enzymes](#). Enzyme localization. Criteria of purity of enzymes.

Monomeric and oligomeric enzymes: Monomeric enzymes; serine proteases, zymogen activation, multifunctional enzymes, oligomeric enzymes and multi- enzyme complexes.

5 hrs

The investigation of active site structure: [The identification of binding sites and catalytic sites –trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains \(cys, met, his, ser, asp, glu, lys, and tyr\). Affinity labeling studies \(chymotrypsin triose phosphate isomerase\) an and super reactive amino acid chains \(chymotrypsin and glutamate dehydrogenase\). The 3-D structural features of active sites as revealed by X-ray crystallographic and chemical studies \(chymotrypsin trypsin, elastase and triose phosphate isomerase\). Site directed mutagenesis.](#)

7 hrs

Enzyme catalysis: Chemical nature of enzyme catalysis-General acid-base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Mechanisms of action of the following enzymes-lysozyme, ribonuclease, lactate dehydrogenase, serine proteases (chymotrypsin, trypsin, elastase), sulphydryl enzymes (papain and alcohol dehydrogenase), and multi-enzyme complexes (pyruvate dehydrogenase complex). Metal– activated and metallo-enzymes (mechanism of action of pyruvate kinase, creatine kinase, superoxide dismutase & carboxypeptidase – A).

7 hrs

Coenzymes: The mechanistic role of the following coenzymes in enzyme catalyzed reactions – nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B₁₂.

6 hrs

Kinetics of enzyme-catalyzed reactions: Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies, rapid reaction techniques and relaxation technique. Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Kinetic data evaluation-linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Integrated velocity

equation. Haldane equation. King-Altman procedure for deriving the rate equation. Effect of pH & temperature on enzymatic reactions, Arrhenius plot, determination of activation energy.

9 hrs

Enzyme Inhibition: Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial inhibition, substrate inhibition and allosteric inhibition. Irreversible inhibition.

6 hrs

Kinetics of bi- substrate reactions: Sequential mechanism, compulsory order and random order mechanism, non-sequential mechanism, ping pong mechanism, distinction between different kinetic pathways using primary and secondary plots. Inhibition studies in the characterisation of bisubstrate reactions. Investigations of reaction mechanisms using isotopic exchange at equilibrium.

5 hrs

Allostery of enzyme action: Binding of ligands to proteins, Co-operativity, the Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. *Sigmoidal kinetics*: MWC and KNF models. Significance of sigmoidal behavior. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation.

7 hrs

References

1. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).
2. Enzymes; Trevor Palmer, East – West Press Pvt. Ltd., Delhi (2004).
3. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
4. Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).
5. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
6. Methods in Enzymology; Colowick S.P. et al., Vol. 152, Academic Press, (1987).
7. Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).
8. Basic Biochemical Laboratory Procedures and Computing, R. Cecil Jack (1995) Oxford University.
9. Enzyme Kinetics; Roberts, D.V. (1977), Cambridge University Press.
10. The Enzymes; Boyer, Academic Press, (1982).
11. Enzyme Kinetics; Irwin H. Segel (1976) Interscience-Wiley.
12. Enzyme Kinetics; the Steady state approach; Engel, P.C. (1981) 2nd Edn. Chapman and Hall.
13. Nature of Enzymology; Foster, (1980), Croom Helm.
14. Principles of Enzymology for Food Sciences; Whitaker, Marcel Dekker (1972) Academic Press.
15. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry; Trevor Palmer (Edn) Horwood Chemical Science Series.
16. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, (2000), Blackwell Science.
17. An Introduction to Enzyme and Coenzyme Chemistry; Timothy B. Bugg, (1997) Jones

and Bartlett publishers.

18. Lehninger Principles of Biochemistry; D.L.Nelson and M.M. Cox, 6th Edn. MacMillan Publications (2012).
19. Principles of Biochemistry; Smith et al., Ed. McGraw Hill,(1986).

MBC – 202: Analytical Biochemistry – II

4 units (52hrs)

Chromatography: Introduction, partition coefficient phase systems, liquid and solid phases, principle procedure and application of paper chromatography, parameters employed in column chromatography, retention, resolution, physical basis of peak broadening, plate height equation, capacity factors, peak symmetry, standard systems of chromatography and its components, stationary phase, elution.

Modes of chromatography: Ion exchange, major ion exchange matrices, elution in ion exchange chromatography. Examples of cation and anion exchangers, chromate-focusing. Gel filtration: matrix used fractionation range and matrices, determination of native mass of protein by gel filtration. Reverse phase principle and procedure.

Hydrophobic interactions and affinity chromatography: Affinity ligands immobilization of ligands. Activation of matrices, coupling affinity ligands (example–GSH). Metal affinity chromatography, His tag, open column chromatography, hydroxyl apatite chromatography.

HPLC: Instrumentation, column, pumps, plumbing, injectors, mobile phases in HPLC, two dimensional HPLC, factors affecting resolution in HPLC chromatography, flow rate and linear velocity. Separate modes: normal and reverse, gradient reverse phase, ion suppression and ion pairing. Chiral-HPLC, chiral columns. Detectors: types, UV, visible fluorescence, electrochemical detectors. Fast protein liquid chromatography (FPLC).

15 hrs

Gas chromatography: Principle and design of instrument. Factors affecting GC, stationary phase, mobile phase, column length, diameter, film thickness, flow rate temperature, sample introduction. Detectors: flame ionization, thermal ionization, electron capture, mass selective detection. G.L.C; principle and application.

Thin layer chromatography: Introduction; phases used in TLC preparative TLC, metabolic profiling, solvent systems for TLC. Detection of compounds on TLC plates.

Capillary electrophoresis: Principle, instrumentation, electro-osmotic flow, free solution capillary electrophoresis. Choice of buffers and ionic strength. Organic modifiers electro chromatographic-electrically driven HPLC. Capillary sample introduction and detection in capillary electrophoresis.

Electrophoresis: Historical developments, principle, non-denaturing PAGE, activity staining for enzymes, zymogram, denaturing electrophoresis (PAGE), SDS-PAGE, SDS-PAGE in reducing conditions, chemical cross linking of proteins urea electrophoresis, isoelectrofocusing. Electrophoresis in DNA sequencing, Sanger- deoxynucleotide sequencing. Foot printing of DNA.

Immuno-electrophoresis: Dot blotting and immune-diffusion tests with antibodies, zone electrophoresis/immune-electrophoresis. Rocket electrophoresis, counter immune-electrophoresis, Agarose gel electrophoresis of nucleic acids, pulse field electrophoresis,

physical basis, equipment and applications. Electrophoresis: western, southern, northern equipments and application.

9 hrs

Spectroscopic techniques: Wave particle duality of light, electromagnetic spectrum, transition in spectroscopy. Principle, design and application of UV-Vis spectrophotometry. Principle, design and application of fluorescence spectroscopy. Measurement of fluorescence and chemiluminescence, use of fluorescence in binding studies. Spectroscopy techniques using plane polarized light, circular dichroism (CD), equipment for CD measurement, CD of biomolecules (proteins) and LD (linear dichroism) of biomolecules.

IR spectroscopy: Physical basis of IR spectroscopy. Instrumentation, use of IR in structure determination, Fourier transfer, IR spectroscopy, Raman IR spectroscopy.

NMR: Principle, effect of atomic, identity on NMR, chemical shift, spin coupling NMR, measurement of NMR spectra, biochemical application of NMR, P31 NMR to study transition in phases.

ESR: Principle, measurement of ESR spectra uses of ESR in chemistry.

Mass spectroscopy: Principle, overview of MS- experiment, ionization modes, equipments in MS analysis (Identification of metabolites) MS of protein/ peptides. Interfacing MS with other methods; MS/MS, LC/MS, GC/MS, electrophoresis/MS. Uses of MS in Biochemistry: MS and heterogeneity in proteins, peptide mapping, post translation modification analysis, determination of disulfide bridges, analysis of DNA compounds.

X ray diffraction – Braggs law, space group symmetry, non-crystallographic symmetry, impossible symmetry, growing crystal sample preparation, X-ray sources, data collection, electron density maps (Reciprocal and real space), the phase problem, Molecular replacement, MIR (multiple Isomorphous replacement) Anomalous scattering, Model building (simple molecule –Benzene, complex structure – peptide, as simple as possible).

22 hrs

Proteomics: Introduction, electrophoresis in proteomics, 2D SDS–PAGE, basic principle, instrumentation, analyses of cell proteins, free flow electrophoresis, blue native gel electrophoresis, Mass spectrometry in proteomics, tagging methods for MS proteomics, isotope coded affinity tagging, tagging for tandem MS. Microarrays, protein biochips. Post translational modifications in proteomics, proteolysis, glycosylation, oxidation, protein disulfides, phospho-proteins.

6 hrs

References

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
2. Principle and techniques in Biochemistry and Molecular biology; Keith Wilson and John Walker (2005).
3. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014)

4. Discovering Genomics, Proteomics and Bioinformatics, Campbell A M & Heyer L J, 2nd Edn. Benjamin Cummings, (2007).
5. Principle and Practice of Bioanalysis; Richard F. Venn (Ed.) Taylor and Francis (2000).
6. Hydrophobic interaction Chromatography, Principles and Methods, Stuart E. Builder, Amersham-Pharmacia Biotech.(1993).
7. Biochemical, Physiological, and Molecular Aspects of Human Nutrition, Stipanuk Elsevier (2012).
8. Protein Bioinformatics; M. Michael Gromiha, Academic Press (1983).
9. Immuno Assay Hand Book; David Wild, Elsevier (2013).
10. Isoelectric Focusing; Theory, Methodology and Applications; P.G. Righetti , Elsevier (2013).
11. Fluorescence Microscopy; Anda Carnea and P. Michael Conn; Academic Press (2014).
12. Fluorescence Spectroscopy; Ludwig Brand and Michael Johnson, Academic Press (2008).

MBC – 203: Metabolism – I

4 Units (52 hrs)

Carbohydrate metabolism; Introduction, glycolytic pathway and regulation. Gluconeogenesis. pathway and regulation. Role of LDH. The TCA cycle and its regulation. Alternate pathways: HMP pathway, Enter – Doudoroff, Glucuronate and Glyoxylate pathway, Cori's cycle, Futile cycles and anaplerotic reactions. **12 hrs**

Glycogen and starch metabolism: degradation, synthesis and regulation, glycogen storage disorders. Pasteur effect, fermentative pathways in microorganisms.

[Regulation of blood glucose level, hypoglycemia and hyperglycemia. Diabetes mellitus: introduction, biochemical and clinical changes associated with IDDM and NIDDM, control of hyper glycemia, diagnosis of Diabetes mellitus and GTT. Pentosuria, Hexose interconversion, fructose and lactose intolerance, fructosuria, galactosemia.](#) Glycosylation of proteins

18 hrs

Lipid metabolism: Oxidation of fatty acids: even and odd numbered, unsaturated and branched chain fatty acids. Alternate routes for fatty acid oxidation. Degradation of triacylglycerols and phospholipids. Energetic of β -oxidation. Metabolism of ketone bodies; their formation, oxidation and clinical significance. Biosynthesis of triacylglycerols, phospholipids and sphingolipids. Sphingolipidodystrophies. Biosynthesis of steroids, related biosynthesis from isoprenoid units. Metabolism of prostaglandins and related compounds. Cholesterol biosynthesis, catabolism and regulation. Transport of cholesterol -LDL receptor pathway. Lipoproteinemias, fatty liver, hypercholesterolemia.

Chemical composition, biological functions and metabolic fate of VLDL, LDL and HDL. Arachidonic acid metabolism-Leukotrienes

13 hrs

Photosynthesis: Introduction, chloroplast/thylakoid structure. Ultra structure and organization of chloroplast membranes, lipid composition of chloroplast membranes.

Photosynthetic reaction centre, photosynthetic apparatus, Hill reaction, light reaction, cyclic- and non-cyclic photophosphorylation. Dark reactions, CO₂ fixation into C₄-dicarboxylic acids. Bacterial photosynthesis, photorespiration, RUBISCO.

9 hrs

References

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3 Ed. John Wiley and sons.
2. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
3. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw Hill.
4. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
5. Photosynthesis, D.O. Hall and K. K. Rao, (1999), 6th Edn. Cambridge University Press.
6. Hawk's Physiological Chemistry, Oser (1976) 14th Edn Tata-McGrawHill.
7. Advances in Carbohydrate Chemistry and Biochemistry; Horton, Elsevier (1994).
8. Biochemistry of Foods, Eskin Elsevier (2012).
9. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin, Wiley-Liss (2012).
10. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
11. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
12. Biochemistry; David Rawn, Panima Publishers (2012).

MBC – 204: Membrane Biochemistry

4 units (52 hrs)

Introduction: Review of structure, nomenclature and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, hydrophobic and hydrophilic interactions, Polar lipids and their ability to form mono, bi-layers and micelles, Langmuir trough.

Cell and organelle membranes; Physical properties of bi-layers, Polymorphic phases and molecular shapes exhibited by lipids, [use of differential scanning calorimetry \(DSC\) and ³¹P NMR to study transition in phases](#). Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol, cardiolipin, engineering membrane lipid composition. Models of membranes; Metamorphic mosaic model, Singer-Nicolson fluid mosaic model, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; methods to determine membrane sidedness. Asymmetry of lipid distribution in bacterial, plant, and animal membranes, Lateral heterogeneity of membrane lipids; lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes.

Physical organization of bilayers; human erythrocyte membrane as a prototype plasma membrane, role of cytoskeleton in organization of bilayers. *Liposomes*; preparation, properties and application in membrane biochemistry.

13 hrs

Membrane proteins: Isolation and characterization of cell membranes. Detergent solubilization of membrane proteins. Purification and reconstitution of membrane proteins. Erythrocyte ghosts; proteins of RBC membrane and their interaction with cytoskeleton. Classification of membrane proteins based on membrane-protein interaction. Types of integral membrane protein, forces responsible for holding integral proteins in membranes, secondary structure of membrane spanning portions of integral membrane proteins; transmembrane α -helices and β -barrels, hydropathic plots. 3-D structures of typical integral membrane proteins: glycophorin, bacteriorhodopsin, photosynthetic reaction centre. Role of integral proteins in cell-cell interaction and adhesion; selectins, integrins, cadherins. Lipid-anchored membrane protein-acyl- prenyl- and GPI-anchors. [Techniques for determination of membrane protein topology: Freeze-fracture electron microscopy, Fluorescence photobleaching recovery \(FRAP\).](#)

8 hrs

Topology of membrane protein: Protein translocation, cotranslational, post translational translocation. Start transfer and stop transfer signals for single pass transmembrane protein and multipass transmembrane proteins. ER retention signals, Glycosylation in ER. N-linked oligosaccharide, Dolichol-linked oligosaccharides. Folding of proteins in ER, role of chaperons – Calnexin and Calreticulin. N-linked oligosaccharides as timers for protein turnover, ubiquitination and protein degradation (improperly folded proteins), GPI-anchored proteins.

6 hrs

Membrane transport: Relative permeability of pure phospholipid bilayer to various molecules. Diffusion across the plasma membrane. Partition coefficient and hydrophobicity. [Energetics of moving non polar and polar molecules across lipid bilayer \(PM\).](#) Experimental methods for study of membrane transport: Assay of membrane transport, use of liposomes to study single types of transporters. Mechanism for transport: Properties of passive diffusion, facilitated diffusion, active transport and co-transport. Electrically neutral and electrogenic transport, Kinetics and model of Glut-1 uniport ATP-driven pumps; classification, and working mechanism. ABC-transporters; MDR1, CFTR Channels and pores. Transport across organelle membranes. Ion channels; working and voltage gating, ionselectivity, electrochemical gradients, Nernst Equation, working of bacterial K-channels, aquaporins, ionophores.

Bacterial transport systems; Lactose permease, Phospho transferase and sugar binding proteins.

7 hrs

Intracellular compartments: Proteins sorting; Membrane enclosed organelles of eukaryotic cells, evolutionary origin and topological relationships. Protein trafficking: Sorting signals. Mechanisms: Gated transport, transmembrane transport, vesicular transport. Signal sequences: Experimental evidence, Genetic experiment to demonstrate protein translocation.

Transport of molecules between nucleus and cytosol. Nuclear pore, nuclear localization signals, nuclear transport receptors, nuclear export: Ras-GTPases- directionality. Regulation of nuclear import and export.

Transport of protein into mitochondria and chloroplast, signal sequence, experimental setup to study protein translocators, working of TOM & TIM complexes. Energy requirement in protein import. Signal sequence for thylakoid membranes, peroxisomes. Endoplasmic reticulum, structural and functional diversity of endoplasmic reticulum, isolation of rough ER and signal sequence for protein import.

Signal Hypothesis: Signal Sequence, SRP-receptors for protein import to ER. Organization of translocation pore, Sec61 complex.

9hr

Biogenesis of lipid bilayers: Intracellular vesicular trafficking: Maintenance of compartmental diversity, pathways of endocytosis and secretory. Vesicles: types, study of cell free system, genetic approach, use of GFP. Clathrin coated- Assembly and disassembly, Structure and function. significance. Coatamer coated-Assembly and disassembly, Structure and function. Retromer assembly on endosomal membrane. Coat assembly control by monomeric GTPases. Role of Rab proteins in vesicular targeting. SNARE proteins and their role in vesicular transport and membrane fusion. Experimental proof for SNARE requirement in vesicular fusion. Entry of enveloped viruses into cell. Coatamer coated vesicles: COP-II-coated transport vesicles, transport of cargo from ER to Golgi, homotypic membrane fusion. Retrieval pathway to ER. Compartments of Golgi: processing of oligosaccharide chain in Golgi, N-linked, proteoglycan assembly in Golgi. Transport through *trans* Golgi network to lysosomes. Mannose-6-phosphate receptors. Signal patch for mannose-6-phosphate lysosomal storage disease. Endocytosis: Phagocytosis, Pinocytosis- vesicles, receptor mediated endocytosis. Retrieval of proteins in endosomes, multivesicular bodies sequestration of endogenous proteins.

9 hrs

References

1. Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.
2. Harper's Illustrated Biochemistry; 27th Edn. Robert K. Murray, Daryl K. Granner, Victor W. Rodwell, The McGraw-Hill (2006).
3. Lipid Biochemistry; 5th Edn. Michael I. Gurr, John L. Harwood and Keith N. Frayn, Blackwell Science (2002).
4. Biochemistry of Lipids, Lipoproteins and Membranes; 5th Edn. Dennis E. Vance and Jean E. Vance, Elsevier (2008).
5. Membrane Protein Purification and Crystallization; Carola Hunte, Gebhard von Jagow and Hermann Schagger, Academic Press (2011).
6. Membrane Proteins; Douglas Rees, Academic Press (2003).
7. Introduction to Biological Membranes; William Stillwell, Elsevier (2013).
8. Molecular Biology of the Cell, Alberts et al., Garland Publications (2012).
9. Molecular Biology of the Cell; 6th Edn. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Garland Science (2014).
10. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).

MBC-205: Bioinformatics and Toxicology

(39 hrs)

Introduction to Computer: Computer softwares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS).

2 Hours

Computer Programming Languages: C Programming - Algorithm and flowchart, Structure of C program, Header file, Global declaration, Main function, variable declarations, Control statement- conditional and unconditional - sub functions. Introduction to PERL, Application of Bioperl.

4 Hours

Databases and Biological Databases: Introduction - Relational Databases Management (RDMS) - Oracle, SQL; Datamining and applications; accessing bibliographic databases-Pubmed; Nucleic acid sequence database – NCBI, EMBL, genome database- ENSEMBLE, EST tag databases and OMIM database. Protein sequence database - NBRF, PIR, SWISSPROT, Uniprot. Enzyme database – BRENDA, KEGG; Structural databases - protein data Bank (PDB), PROSITE, SCOP. Pathway and Interactome databases – KEGG, Reactome, INTACT, BIOGRID; Metabolome database – human metabolome database (HMD), PubChem; Cell line database (ATCC); Gene ontology database

7 Hours

Tools to analyse sequences: Pairwise sequence alignment - global and local alignment, scoring matrices. Restriction mapping - NEB CUTTER, Similarity searching (FASTA and BLAST), Multiple Sequence alignment, Phylogenetic analyses, Identification of genes in genomes, Identification of motifs.

8 Hours

Protein Structure and Molecular Interaction: Introduction to protein structure - secondary structure prediction , hydropathic plots, prediction of secondary structure and identification of protein families, Tertiary structure database; Cambridge database, PDB, specialist structural databases. Programs for analysis and visualization of tertiary structure-RasMol/Pymol, Swiss-prot Pdb viewer; tertiary structure prediction- principles of homology and comparative modelling. *ab initio* Modelling, structure evaluation and validation; Molecular docking – Autodoc and application in drug discovery etc.

11 Hours

Toxicology: Toxicological chemistry, factors influencing toxicity; Dose response relationship – LD50, ED50, NOEL. Reversibility and sensitivity. Xenobiotics and endogenous substances. Detoxification enzymes. Mutations-genotoxicity, Ames test. Carcinogenic toxins. Cytotoxicity, methods to test toxicogens. Diagnosis of toxic effects in liver and kidney. Metal toxicity–Arsenic and lead. Non metal–oxygen and ozone.

7 hrs

References:

1. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series
2. Jan (2001). Nucleic acid research, Genome Database issue
3. Higgins & Taylor (2000). Bioinformatics, OUP.
4. Baxavanis (1998). Bioinformatics.
5. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
6. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
7. Introduction to Exotoxicology, En. D.W. Connell, Blackwell Scientific (2000)
8. Molecular Cell Biology Baltimore et al., Scientifica Americal Publication (1995).
9. Molecular Pharmacology, ed. T. Kenakin, Blackwell Science Inc (1997).
10. Toxicological Chemistry and biochemistry; Manahan, Stanley E. CRC Press LLC (2003).

MBC – 206: Enzymology (4 Credits)

1. Fractionation of esterase by ammonium sulphate and dialysis.
2. Analysis of Purity by SDS-PAGE.
3. Determination of total activity of pea esterase.

4. Determination of Specific activity of pea esterase.
5. Determination of optimum pH of pea esterase.
6. Determination of optimum temperature and activation energy of pea esterase.
7. Determination of K_M and V_{max} of pea esterase.
8. Determination of type of inhibition (reversible or irreversible) of pea esterase.
9. Determination of I_{50} of pea esterase using organophosphate inhibitor.
10. Determination of total activity of salivary amylase.
11. Determination of Specific activity of salivary amylase.
12. Determination of optimum pH of salivary amylase.
13. Determination of optimum temperature of salivary amylase.
14. Determination of K_m and V_{max} of salivary amylase.
15. Determination of I_{50} of salivary amylase.

References

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry: Trevor Palmer, Horwood, (2001).
2. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis: Robert A. Copeland, by Wiley-VCH Inc. (2000).
3. *Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis*: Robert A. Copeland, John Wiley & Sons (2000).
4. Enzyme Kinetics: *A Modern Approach*: Alejandro G. Marangoni, John Wiley & Sons (2002)
5. Enzyme Kinetics: *Principles and Methods*: Hans Bisswanger, Wiley–VCH (2002).
6. Fundamentals of Enzyme Kinetics: 4th ed. Athel Cornish-Bowden, Wiley-Blackwell (2012).
7. *Fundamentals of Enzyme Kinetics*: Athel Cornish-Bowden, Portland Press (2004)
8. *Practical Enzymology*: Hans Bisswanger, Wiley–VCH (2004)
9. Practical Enzymology, Second Revised Edition [PDF] [StormRG]: Hans Bisswanger, Wiley – Blackwell; 2 edition (2011)

MBC – 207 Biochemical Techniques

1. Ascending descending and circular paper chromatography of amino acids / carbohydrates
2. Two-dimensional chromatography of amino acid / carbohydrates.
3. Thin layer chromatography of carbohydrates / amino acids.
4. Separation of proteins by non-denaturing PAGE.
5. Determination of molecular weight of Proteins by SDS–PAGE
6. Separation of isoenzymes by isoelectric focusing
7. Ion exchange chromatography of nucleic acids / proteins.
8. Purification of proteins by cation exchange chromatography.
9. Gel –permeation chromatography of pigments/proteins.
10. Separation of nucleic acid by Urea PAGE.
11. Absorption spectra of proteins and nucleic acids and determination of molar extinction coefficient.
12. Purification of proteins by affinity chromatography.

References

1. Basic Methods for the Biochemical Lab; Martin Holtz hauer, Springer, (2007).
2. Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
3. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
4. Principle and Techniques of Practical Biochemistry; Keith Wilson and John M. Walker, Cambridge University Press (2000).
5. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
6. Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
7. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).

Third Semester M. Sc. Biochemistry

MBC – 301: Molecular Biology – I

4 units (52 hrs)

Introduction: Historical account of DNA discovery. Relationship between genes and proteins, overview of flow of genetic information; central dogma of molecular biology. Nature of genetic material, experiments confirming DNA as genetic material. Review of physical chemistry of DNA. RNA as genetic material. Variation in size and shape of genomes; ultracentrifugaion and electron microscopic methods to study the shape and size of genomes. Relationship between size of genome and genetic capacity; C-value paradox. Organelle genomes, Genome sequence and gene numbers, measurement of expressed genes.

Clusters and repeats; tandem repeats, mini- micro- satellites and interspersed genome-wide repeats and their significance. Pseudo genes and transposable elements. Globin gene clusters, gene duplication and gene evolution, biases in mutations, gene conversion and codon usage.

Topological problems; Topo-isomerases, gyrases and helicases- mechanism and classification. Multi copy and single copy replicons, Linear and circular replicons, unidirectional and bi-directional replication of DNA. Experimental methods to map origin of replication. Semi-conservative and semi-discontinuous replication; experimental demonstration. **11 hrs**

Prokaryotic DNA Replication: Replicon, single and multi copy replicons, linear and circular replicons, unidirectional and bidirectional replication, experimental methods, mapping origin of replication, semi-conservative and semi-discontinuous replication; experimental demonstrations. Topological problems in DNA replication; topoisomerases, helicase and gyrase. Mechanism and classification of topoisomerases, assay of topoisomerases. Priming DNA synthesis in bacteria; experimental evidence, components of primosome,. Initiation at origin (*oriC*) of E. Coli. Creation of replication forks. Regulation of initiation at origins, sequestration of origins after replication, role of helicase, assay of helicase.

Enzymology of DNA replication; DNA polymerases, chemistry of nucleotide polymerization and in vitro assay. Use of conditional lethal mutants and in-vitro complementation methods for identification of replicative polymerase. Properties and functions of DNA polymerase-I, Korenberg enzyme. Subunit composition of polymerase –III holoenzyme, identification of functions of individual subunits by complementation and mutational studies. mechanism of

replication of *E. coli* DNA-trombone model, termination of replication. Hand-palm structure of DNA polymerases. Processivity and fidelity of replication. Bacterial replication and its connection to cell cycle

Eukaryotic DNA replication; Replicative and repair enzymes of eukaryotes. Initiation, elongation by eukaryotic DNA polymerases. Isolation of ARS of yeast, ORC, Licensing factors and control of eukaryotic DNA replication, role of MCM proteins. Replication of organelle genomes, maintenance of ends of linear DNAs; telomeric DNA and telomerase. Regulation of eukaryotic DNA replication and inhibitors of DNA replication. **12 hrs**

Extra chromosomal replication: Replication of phage DNA ϕ X174, T7, SV-40, rolling circle model of replication. Linear DNA-ends, terminal proteins, replication of plasmid DNA.

Replication of RNA viruses: ss +RNA viruses; Picorna (Polio) and corona viruse, ss-RNA viruses; rhabdo virus (VSV), orthomixovirus (influenza virus). dsRNA- reovirus (Rota virus), Structure and mechanism of RDR pol. Retroviruses; Structure and mechanism of reverse transcriptase and integrase (HIV), replication of tumor virus (RSV). Replication of Q β virus. **7 hrs**

DNA repair: experimental demonstration of repair in prokaryotes, damaging agents and damage recognition, direct repair, Miss-match repair assay for mismatch repair, Base excision repair (BER), Nucleotide excision repair (NER) systems; components and mechanism of repair, error prone repair, SOS and Rec-A. Eukaryotic BER and NER, controlling direction of mismatch repair, DNA damage in chromatin **4 hrs**

Transcription in prokaryotes: The transcriptome, prokaryotic RNA polymerase; molecular composition, and mechanism of transcription. Initiation of prokaryotic transcription; Structure of bacterial promoters. Effect of sigma factor on binding of RNA pol. to promoters. Structure and function of sigma factor, reuse of sigma factor (sigma cycle). Sigma movement relative to DNA: FRET assay. DNA melting at promoters, promoter clearance. Role of α -subunit in upstream element recognition. Foot-printing of upstream elements with α -subunit. *Elongation:* Role of β -subunit in phosphodiester bond formation. Structure of elongation complex and core polymerase. Termination of transcription: Rho- dependent and independent, termination, RNA product under Rho dependent termination. **5 hrs**

Transcription in eukaryotes: Separation of nuclear RNA polymerases- rat liver RNA pol. Roles of the RNA polymerases. Sensitivity to α -amanitin. Subunits of RNA pol-II (yeast pol- II). Heterogeneity of Rpb1 subunit. Formation and maintenance of transcription bubble. Eukaryotic promoters: Class-II core promoter, modular organization, SV40 early promoter. Linker-scanning mutagenesis, TATA Box, downstream promoter elements, proximal promoter elements, TATA-less promoters and initiators. Class-I and Class-III promoters, Enhancers and silencers.

Class-II pre-initiation complex, foot-printing DAB. Structure and function of TFIID, TBP and associated factors (TAFs). Phosphorylation of CTD of RNA pol-II, Mediator complex and RNA pol-II. Elongation factors: Effect of TFIIS, reversal of transcription arrest, proof reading of transcripts. Composition and working of transcription units at class-I and class-III promoters.

RNA processing: split genes, RNA splicing: R-looping experiments, splicing signals, effect of splicing on gene expression. Splicing of nuclear mRNA precursors. Branched intermediate, mechanism of RNase T₁ and T₂, direct evidence for a branched nucleotide. Signal at branch.

Spliceosomes: snRNPs, U1snRNP, detection of spliced product by RNase protection assay. U6snRNP, U2snRNP and U4snRNP. Spliceosome assembly and function. Alternative splicing, exon-intron definition. Commitment of precursor RNA to splicing, role of sr protein. Yeast two hybrid assay. Role of RNA pol-II in splicing, control of splicing. Self splicing RNase. Group-I introns, demonstration of exon ligation, Group-II introns.

Post transcriptional modification of mRNA: Structure of cap, purification of caps, capping substrate. Cap structure of Reovirus, functions of cap.

Polyadenylation: Function of poly A, mechanism and signals for polyadenylation. Cleavage and Polyadenylation for mRNA elongation of poly-A, poly-A binding protein (PABP), turnover of poly-A. Coordination of mRNA processing with Coupling termination and mRNA 3' end processing.

13 hrs

References

1. Biochemistry and Molecular Biology of Plant; Buchanan, Gruissum and Jones, (2000), ASPP, USA.
2. Biochemistry; David Rawn, Panima Publishers (2012).
3. The Bacteriophages; Richard Calendar, 2nd Edition, Oxford University Press (2005).
4. Basic Virology; Wagner and Hewlett; Blackwell Science, (2004)
5. LEWINS Gene XI; J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick, Jones and Bartlett Publishers (2012).
6. Molecular Biology of the Cell, Alberts et al., Garland Publications, (2012).
7. Molecular Biology, David Freifelder, Narosa Publishers, (1997).
8. Molecular Biology Robert F. Weaver, McGraw Hill (2012).
9. Microbial Genetics; Maloy et al., Jones and Bartlett Publishers, (1994).
10. Modern Microbial Genetics; Uldies N. Streips and Ronals E. Yasbin, Wiley Leis Inc. New York, (2002).
11. Principles of Developmental Genetics; S.A. Moody, Academic Press (2007).
12. Developmental Biology; S. P. Gilbert, 8th Edn, Sinauer Associates Inc.,(2006)
13. Molecular biology and Biotechnology; 4th Edn., J.M. Walker and R. Rapley, RSC (2000).
14. Molecular Biology of Gene; Watson, J.D. et al., 5th Edn. Pearson Education; (2004).
15. Principles of Virology; S.J. Flint et al., ASM Press (2000).
16. Biochemistry and Molecular Biology; 5th Edn. D.Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott Oxford University Press (2014)
17. Chromatin structure and Gene Expression; 2nd Edn. Sarah Elgin, Jerry Workman, Oxford University Press (2000)
18. Molecular Cell Biology; Harvey Lodish 5th Edn. (2010)
19. Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer (2011).
20. Genome Stability: DNA Repair and Recombination; James Haber, Garland Science (2013)
21. Retroviruses; Coffin JM, Hughes SH, Varmus HE, editors; CSH Press, (1997)
22. Viruses: Biology, Applications, and Control; David Harper, Garland Science (2011).

Nerve signaling: Acetylcholine receptor (AChR) channel, origin and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate, aspartate, GABA, and glycine) and neuropeptides (somatostatin/enkephalins).

Trafficking proteins of synaptic vesicles, vesicle cycle – exo – and endocytosis of synaptic vesicles.

Structure, subtypes and functions of receptors of ACh, GABA, Glycine, Serotonin and glutamate and peptide neurotransmitters, activation by ligands & interaction with effectors. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases. Natural, genetic and environmental factors affecting the development of CNS, Co – ordination between nervous and endocrine systems. **13 hrs**

Endocrine signaling: Signal transduction, extra – cellular signaling; hormones as signal molecules – peptide, amino acid derivatives, steroid, eicosanoids.

Signal transduction pathways of – 1) G – protein linked (epinephrine, serotonin, glucagons), 2) Ion-channel (ACh), 3) Tyrosine kinase {(RTK), [EGF, IGF, insulin]}, and 4) Intrinsic enzyme / cytokine, receptors.

Biochemistry of vision: Structure of an eye, lens and retina, perception of light, rods and cones, rhodopsin, primary events in visual excitation, cGMP and transduction in generation of nerve impulse, colour vision

Intracellular signaling proteins: {adaptors, activators, bifurcators, integrators, effectors, etc.}. Second messengers; and their regularization: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca^{2+} , and NO. Signal amplification cascades; Cascades downstream of RTK; Erk – fos – jun – cyclin – D, MAPK – Ras – Raf – Sos, specificity of protein kinases.

Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase, guanylate cyclase and their activation, negative modulation.

Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation. Transcriptional activation by phosphorylation cascade; CREB. **18 hrs**

Cell Cycle: Cell cycle (entry of cell from G_2 to M – phase) Role of M – Cdk, MPF. Promotion of G_1/S by growth factors, cell cycle arrest at G_1 , role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin.

Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation.

Cyclins and cyclin-dependent kinases.

Stem Cells: Embryonic and adult stem cells; unique properties, and potential applications.

Apoptosis: Discovery, morphological changes, mitochondrial regulation. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution and removal of dead cells). Distinguishing apoptotic cells from necrotic cells. Role of HeLa cells, Hyperactive apoptosis and treatments.

Cancer: Introduction, Signs and symptoms, causes pathophysiology, [diagnosis](#), [prevention and management](#). Signaling cascades in cancer (MAP kinases, Ras pathways, JAK-STAT and TGF- β pathways). Etiology of breast, colon and prostate cancer. **19 hrs**

Signaling in Plants: Outline of plant hormones and pheromones signaling. **2 hrs**

References

1. Signal transduction and human disease; Toren Finkel, and J. Silvio Gutkind, John Wiley & Sons, Inc. (2003)
2. Greenspan's Basic and Clinical Endocrinology; 9th Edn. David Gardner and Dolores Shoback Lange Clinical Medicine (2012).
3. Biochemistry of Signal Transduction and Regulation; Gerhard Krauss, Wiley-VCH (2003).
4. Elements of Molecular Neurobiology; 3rd Edn. C. U. M. Smith, John Wiley & Sons Ltd, (2002).
5. Basic Neurochemistry; George Siegel et al., (1999) Wippincott, Williams and Wilkins.
6. Neuroscience; 2nd edn. Purves, Dale; et al., Sinauer Associates, Inc. (2001).
7. G-Proteins coupled Receptors; P. Michael Conn Academic Press (2013).
8. Molecular Biology of the Cell; 6th Edn. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter; Garland Science (2014).
9. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).
10. Cell Signaling; Wendell Lim, Bruce Mayer, Tony Pawson; Garland Science (2014).
11. Cell Biology; A short course; Stephen R. Bolsover et al., John Wiley & Sons, Inc. (2004)
12. Electrochemical methods for neuroscience; Michael AC, Borland LM, editors. Boca Raton (FL): CRC Press (2007).
13. Signal Transduction; Lewis Cantley, CSHL Press (2014).
14. When Cells Die; A Comprehensive Evaluation of Apoptosis And Programmed Cell Death; Richard, A. Lockshin, and Zahra Zakeri, Wiley Liss (2004).
15. Neuroscience; 2nd edn. Purves, Dale; et al., Sinauer Associates, Inc.; (2001).
16. Biochemistry of Signal Transduction and Regulation; 3rd Edn. Gerhard Krauss, Wiley-VCH, (2003).
17. The Biology of Cancer; Robert A. Weinberg; Garland Science (2013).

MBC – 303: Metabolism – II

4 units (52 hrs)

Bioenergetics: Basic concepts of metabolic energy capture and transfer. Biochemical energetic-group transfer reactions of ATP, phosphate group transfer potential of ATP and other high energy phosphate donors. Stages in extraction of energy from fuel molecules. **2 hrs**

Biological oxidation: Biological redox couplers, participation in oxidative metabolism. Free energy changes in electron transfer reactions. Mitochondrial electron transfer system- Chemical nature, topology and thermodynamic design of electron carriers. Sequence of electron carriers- isolation of mitochondrial complexes, reconstitution experiments and study of specific inhibitors of Electron Transport Chain. **4 hrs**

Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1-ATPase- structure and mechanism, O¹⁸ exchange. Coupling of electron transfer to ATP synthesis. Uncouplers, inhibitors and ionophores, partial reactions of OP, P/O ratios and their use in localization of sites of ATP synthesis along the chain. Mechanism of oxidative phosphorylation, mitochondrial specific transport systems and energy charge. Microsomal electron transport. Proton motive force in Halobacteria, ATP synthesis in bacteria. H⁺ pumping by bacteriorhodopsin Photosynthetic electron transport. Structure and function of chloroplast ATP-synthase. **7 hrs**

Nitrogen Cycle: Introduction, biological and non-biological nitrogen fixation, *nif* genes, regulation and utilization of nitrate and nitrite, regulation of nitrate reductase. Assimilation of ammonia, formation of amino acid amides by glutamine synthetase and its regulation. **4 hrs**

Nucleotide Metabolism: Biosynthesis of purine and pyrimidine nucleotides and their inter conversion, regulation of biosynthesis. Other pathways of purine nucleotide formation. Biosynthesis of deoxyribonucleotides and coenzymes nucleotides. Chemical inhibition of the biosynthesis of nucleic acid precursors. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria. **7 hrs**

Amino acid Metabolism: General metabolic reaction of amino acids– transamination, pseudotransamination, glucose – alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – transdeamination, amino acid oxidase, and non – oxidative deamination (α -deaminase, dehydrase, asparaginase and glutaminase). Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines– putrescine, spermidine and spermine, glutathione (γ -glutamyl cycle), physiologically active amines (γ -amino butyric acid, serotonin, α – histamine and catecholamines – dopamine, epinephrine and epinephrine). **7 hrs**

Degradation of the individual amino acids: Pathways in animal, plant and microbial systems; Amino acids forming from pyruvate (alanine, glycine, threonine, serine, cystine and cysteine), oxaloacetate (aspartic acid and asparagine), α - ketoglutarate (glutamic acid, glutamine, arginine, histidine and proline), succinyl CoA (valine, isoleucine and methionine), acetoacetate and/or acetyl CoA (leucine and lysine), pyruvate, formaldehyde, acetoacetate and/or acetyl CoA (tryptophan), and fumarate, acetoacetate and/or acetyl CoA (phenylalanine and tyrosine). Inherited disorders associated with glycine, aromatic, branched chain, basic and sulfur containing amino acid metabolism. **9 hrs**

Biosynthesis of the individual amino acids: Pathways in animal, plant and microbial systems– biosynthesis of non – essential amino acids from pyruvate (alanine), intermediates of glycolysis (serine) and TCA cycle (aspartic acid, asparagine, glutamic acid and glutamine), essential amino acid (tyrosine), non – essential amino acid (glycine, proline and arginine), and essential & non – essential amino acid (cysteine). Biosynthesis of essential amino acids from aspartate family of amino acids (threonine, lysine and methionine), pyruvate family of amino acids (valine and leucine), pyruvate and α -ketobutyrate family of amino acid (isoleucine), aromatic family of amino acids (phenylalanine, tyrosine and tryptophan) and histidine. Regulation of amino acid biosynthesis by sequential & concerted feedback inhibition. **9 hrs**

Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies. **3 hrs**

References

1. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
2. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
3. Biochemistry; David Rawn, Panima Publishers, (1989).
4. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
5. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013).

MBC – 304: Molecular Biology (4 credits)

1. Isolation of genomic DNA from bacteria (E. Coli).
2. Quantification and characterization of isolated genomic DNA from bacteria (E. Coli) by agarose gel electrophoresis and spectrophotometer.
3. Isolation of genomic DNA from a plant source.
4. Quantification and characterization of isolated genomic DNA from a plant source by agarose gel electrophoresis and spectrophotometer.
5. Isolation of plasmid DNA from bacteria (E. Coli).
6. Quantification and characterization of isolated plasmid DNA from bacteria (E. Coli) by agarose gel electrophoresis and spectrophotometer.
7. Isolation of total RNA from yeast.
8. Quantification and characterization of isolated RNA from yeast by agarose gel electrophoresis and spectrophotometer.
8. Spectroscopic determination of melting temperature (T_m) of calf thymus DNA.
10. Rapid amplification of polymorphic DNA.
11. Southern Blotting
12. Northern Blotting

References

1. Molecular Biology Techniques; Sue Carson, Heather Miller and D. Scott Witherow, Academic Press (2011).
2. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).
3. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).
4. Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley-Blackwell (2006).
5. Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

6. Gene Cloning Laboratory Manual 4th Edn. Michael R. Green and Joseph Sambrook, CSHL Press (2014).
7. Current Protocols in Molecular Biology; S Gallagher, Wiley Interscience (2008).

MBC – 306: Genetic Engineering and Bioinformatics (4 Credits)

1. Preparation of Competent cells by Calcium chloride method.
2. Transformation of plasmid in competent cells.
3. Primer Design, DNA Amplification by (PCR) and Gel elution of the PCR fragment.
4. Ligation and screening.
5. Expression of GFP in E. coli
6. Restriction Mapping of Nucleotide Sequences using NEBCUTTER and Restriction digestion of isolated plasmid DNA.
7. Retrieval of Protein and Nucleotide Sequences from NCBI and UniProt and identification of ORFs using NCBI-ORF FINDER.
8. Pair wise Sequence Alignment, Multiple Sequence Alignment and Evolutionary studies / Phylogenetic analysis.
9. Retrieval of Protein Structure from PROTEIN DATA BANK, and Molecular Visualization of Protein Structure using RasMol.
10. Visualization of Secondary Structure of Protein in Ramachandran Plot and Protein Secondary Structure Prediction.
11. Introduction to Auto Doc.
12. Inferential statistics (t-test and ANOVA) and Correlation and regression analyses in MS-Excel.

References

1. Molecular Biology Techniques; Sue Carson, Heather Miller and D. Scott Witherow, Academic Press (2011).
2. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).
3. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).
4. Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley-Blackwell (2006).
5. Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).
6. Gene Cloning Laboratory Manual 4th Edn. Michael R. Green and Joseph Sambrook, CSHL Press (2014).
7. Current Protocols in Molecular Biology; S Gallagher, Wiley Interscience (2008).
8. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series
10. Jan (2001). Nucleic acid research, Genome Database issue
11. Higgins & Taylor (2000). Bioinformatics, OUP.
12. Practical Statistics for Experimental Biologists, Swardlaw, A.C. (1985).

Fourth Semester M. Sc. Biochemistry

MBC – 401: Molecular Biology – II

4 units (52 hrs)

Gene Expression in Prokaryotes: Definition of regulon, operon, cis and trans acting elements.

Bacterial transcription control; the lac operon, induction and diauxy. Discovery and structure of lac operon. Positive control of lac operon. Utility of merodiploids in understanding regulation of operon. Molecular basis of repression. Isolation of repressor, assay of binding of lac operator and repressor. Effect of repressor on dissociation of RNA pol. Positive control of lac operon; mechanism of action of CRP/CAP, transcription activation by recruitment, characterization of binding of cAMP-CAP-DNA. Activation of lac PL transcription by CAP-cAMP. Catabolite repression, inducer exclusion and prevention mechanism. Anatomy and regulation of arabinose and tryptophan operons. Riboswitches; discovery and models of riboswitch action. *Phage strategies*; Regulatory cascade controlling lytic development. Functional clustering of phage genomes. Antitermination in lambda phage, maintenance of lysogeny by lambda phage. Characterization of λ -repressor-DNA binding, molecular properties of λ -repressor, establishment of lysogeny. Sigma switching in phage infection. **14 hrs**

Gene Expression in Eukaryotes: Stages/levels of regulation of gene expression in eukaryotes; Chromatin structure and its effect on transcription. Organization of chromatin- 30 nm fiber, higher order chromatin folding. Effect of histones on transcription activation. Nucleosome positioning; SV 40 mini chromosome, experimental location of nucleosomal positions; DNase hypersensitive sites and mapping. Locus control regions.

Histone modifications; Acetylation of histone tails. Identification of histone acetyl transferases (HATs). Properties and roles of P₅₅ and Gcn-5 HATs. Histone deacetylases; experimental demonstration of HDACs in repressor complexes.

Chromatin remodeling; Major classes of remodeling complexes; assay of remodeling; ChIP. Composition of SWI2/SNF2 and ISWI complexes. Model of SWI2/SNF2 mechanism. Remodeling in yeast HO gene and human IFN- β promoter. Histone code. Heterochromatin silencing; chromo and bromo domains, histone methylation, HMTases, SFR and RAP-proteins. Transcription elongation through nucleosomes; FACT and PARP.

Mapping and quantifying transcripts; Northern blots; S1 mapping of 5' and 3' ends of transcripts. Primer extension, Runoff transcription and G-less cassette transcription, measuring in-vivo transcription rate- nuclear run on transcription. Quantification of gene expression by measuring protein product. **12 hrs**

Transcriptional activators; classification, structure and function, domains of activators. DNA binding motifs; Zn fingers- Gal 4 activator of yeast. Nuclear receptor- structure and function of glucocorticoid, thyroid and orphan receptors. Domains of nuclear receptors; homeo, bZIP and bHLH domains. Modularity of domains of activators; chimeric transcription factors- Gal4-LexA, two hybrid assay. Dimerization of activators, modular arrangement of enhanceosomes. Recruitment of TFIID and holoenzyme; evidence, role of enhancers, interaction between enhancer and promoter-control region of human metallothioneine gene. Insulators-working, insulator bodies, working of imprinting control region (ICR). Transcription factories, detection. Co-activators and mediators; discovery of mediators- mediators factors; activation of CRE- linked gene model for nuclear receptor activation. Regulation of transcription factors; modification of activation by ubiquitination, sumoylation and acetylation. Signal transduction pathways; Ras, Raf, JAK stat pathway.

Regulation of gene expression via stability of mRNA; Casein mRNA and transferring-receptor mRNA, gel mobility shift assay for IRE binding protein, model for TFR mRNA destabilization by iron. *RNA interference*; post transcriptional gene silencing (PTGS) and quelling. Definition, mechanism of RNAi. Classical experiments with petunia and *C. elegans*. Simplified model, composition and function of Dicer and RISC. Role of Argonaute. siRNAs, role of RNAi machinery in heterochromatin formation and gene silencing- EF1A gene. miRNAs; control of gene expression by miRNAs example and experimental proofs, pathways of gene silencing by miRNA. Stimulation

of translation by miRNAs. Translation repression; processing bodies.

13 hrs

Ribosomes: Prokaryotic ribosomes; molecular components, *in vivo* assembly, dissociation of subunits, and polysomes. Eukaryotic components and their assembly, organelle ribosomes.

3 hrs

Translation: Initiation of protein synthesis in prokaryotes, Shine-Dalgarno sequence, formation of 30 S and 70 S initiation complexes; effect of GTP hydrolysis by IF2. exchange of ribosomal subunits. Eukaryotic translation initiation-scanning model, eukaryotic initiation factors, role of eIF4E, F, and G. Formation of stable 48S initiation complex, role of eIF1 and eIF1A, toeprint assay, direction of polypeptide synthesis and mRNA translation. Control of translation in bacteria and eukaryotes. Amino acyl-tRNA synthetases, formation of ternary complex among amino-acyl tRNA, EF-T, and GTP, three site model of ribosome, peptide bond formation, G- protein and translation, stop codon suppression, release factors, aberrant termination, non-stop mRNAs, termination of transcription, termination codon, no-go-decay of mRNA. [Inhibitors of prokaryotic and eukaryotic translation](#). [Post-translational modifications of proteins](#). Mechanism of translational control.

Genetic code; breaking the code, experimental results leading to deciphering genetic code, coding properties of mRNA, Co-linearity of genes and proteins, Coding properties of tRNA, triplet binding assay, use of synthetic oligo nucleotides (works of Khorana and Neirenberg), base pairing between codon and anti-codon, Wobble base pairing. Properties of genetic code, deviation from universal genetic code.

10 hrs

References

1. Molecular biology and Biotechnology; 4th Edn., J.M. Walker and R. Rapley, RSC (2000).
2. Molecular Biology of Gene; Watson, J.D. et al., 5th Edn. Pearson Education; (2004).
3. LEWINS Gene XI; J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick, Jones and Barlett Publishers (2012).
4. Molecular Biology; Robert F. Weaver, Mc Graw-Hill (2012).
5. Epigenetics and Epigenomics; Christopher J. Payne, INTECH, (2014).
6. Gene Control; David Latchman, Garland Science (2010).
7. Molecular Cell Biology; Harvey Lodish, Arnold Berk, Chris A. Kaiser, 7th Edition, W. H. Freeman (2012).
8. Molecular Biology of the Cell; 7th Edn. Bruce Alberts et al., (2008), Garland Publications
9. Molecular Biology; David Freifelder, J. (1997) Narosa publishers.
10. Nuclear Organization; Chromatin Structure and Gene Expression, Roen Van Driel and Arie P. Otte (1997) Oxford University Press.
11. Genome 2; T.A. Brown, John Wiley & sons (2002).
12. Principles of Developmental Genetics; SA Moody, Academic Press (2007).
13. Developmental Biology; S. P. Gilbert, 8th Edn. Sinauer Associates Inc. (2006).
14. Principles of Biochemistry; Lehninger et al., [Eds.] 2nd Edn. Worth Publishers (1997).
15. Human Molecular Genetics; Peter Sudbery, (2002) Printice Hall.
16. The Cell- A Molecular Approach; Geoffery M. Cooper, Robert E. Hausman, 6th Edition, Sinauer Associates Inc. Publishers (2013).
17. Long Range Control of gene Expression; Veronica van Heyningen and Robert Hill, Academic Press (2008).

MBC – 402: Biochemical Genetics

4 units (55 hrs)

Introduction: Nature of genetic material. Chromosomes and genes. Mutation: types of mutation, mutagens, mechanism of mutation, induction and isolation of mutants and their role in genetic studies. **5 hrs**

Classical Genetics: Review of classical genetics; work on *Pisum sativum*, *Drosophila Melanogaster*, *Neurospora Crassa* etc. inheritance (sex-linked and others). **Population genetics, extranuclear inheritance.** Sex determination, Morgan's discovery of sex linked inheritance of sex linked genes, X;linked traits in humans. Identification of sex chromo;somes, XX,XY, mechanism of sex determination. **10 hrs**

Quantitative Genetics: Human quantitative traits, discontinuous traits and continuous traits, Breeding analysis, **genetics basis of quantitative variation**, Multiple factor hypothesis and analysis of polygenes. Genotype-Environment Interaction and models for their measurement, estimation of Heritability Index. **8 hrs**

Human Genetics: Biochemical events occurring during mitosis and meiosis. Structure of chromatin; nucleosomes and higher orders of organization. **Chromosome banding, Chromosome mapping based on recombination frequency data.** Transposons. Overview of human genome project, mapping of human genes; techniques used, assignment of important genes. Transposition in human chromosomes. Chromosomal abnormalities. **13 hrs**

Bacterial Genetics: Bacterial chromosomes, plasmids; fertility, resistance, colicinogenic and others. Recombination in bacteria. Mechanism of recombination, transposable genetic elements, **transformation and conjugation in bacteria.** Linkage map of bacterial chromosomes. **8 hrs**

Viral Genetics: Life cycles of bacteriophages, lytic cycle; replication of T-phages. Lysogeny and its regulation. **Transduction**; specialized, generalized and abortive. Fine structure analysis of T-phages; Benzer's work, concept of cistrons. **8 hrs**

References

1. Genetics, Strickberger, M.W. (1990) 3rd edn. McMillan.
2. Human Molecular Genetics; Peter Sudbery, (2002) Printice Hall.
3. Introduction to Modern Virology, Primrose and Dimmock (1988), Blackwell Sc.
4. Genetics and Molecular Biology; Robert Schleif, The Johns Hopkins University Press Baltimore, (1993).
5. Discovering Genomics, Proteomics and Bioinformatics, Campbell A M & Heyer L J, 2nd Edn. Benjamin Cummings, (2007).
6. Introduction to Genetics: A Molecular Approach; T A Brown, Garland Science (2011).
7. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).
8. Molecular Biology of the Cell; 7th Edn. Bruce Alberts et al., Garland Publications (2008).
9. Nuclear Organization; Chromatin Structure and Gene- Expression, Roen Van Driel and Arie P. Otte Oxford University Press (1997).
10. Principles of Developmental Genetics; S.A. Moody, Academic Press (2007).
11. The Cell; Geoffrey Cooper, and Robert E.; 5th edn. Hausman Sinauer Associates (2009).
12. The Science of Genetics, George W. Burns and Paul J. Bottino (1989), Maxwell-McMillan.
13. Human Genetics; Lewis, 7th Edn. WCB & McGraw Hill (2007).
14. Essential Genetics: A Genomics Perspective; Daniel L. Hartl, 6th Edition, Jones and Barlett

Learning (2012).

15. Bacterial and Bacteriophage Genetics; Edward A. Birge, 5th Edition, Springer (2006).
16. Nucleosome Histone, and Chromatin; Part-A; Carl Wu and C. Allis, Academic Press (2012).

MBC – 403: Biotechnology

4 credits (52 hrs)

Introduction; Introduction and overview of cloning procedures. Isolation of nucleic acids, characterization and purification of plasmid, bacteriophage genomic DNA for cloning purpose. **3 hrs**

Restriction endonucleases and DNA modifying enzymes: Restriction enzymes Discovery, classification, properties, and applications. Reactions, application of the following modifying enzymes employed in rDNA technology; DNA- and RNA ligase, Phosphatases and kinases DNase (DNase-I) and RNases (RNase A, H), S1- and Micrococcal nuclease, double and single stranded exonucleases. DNA and RNA polymerases (Klenow fragment), template independent RNA polymerases. Topoisomerase. Linkers and adapters, TA-cloning. **8 hrs**

Cloning Vectors: Basic properties of plasmids, desirable properties of vectors, plasmids as vectors. Directional cloning in plasmid vectors, blunt end cloning in to plasmids. Preparation and transformation of competent *E.coli*. electroporation, Screening colonies using X-gal and IPTG ($\square$ -complementation), screening by hybridization. Bacteriophage lambda vectors; Insertional and replacement lambda vectors, **transfection, *in vitro* packaging, screening recombinant phages.** Cloning in M13 vector and COSMID vectors and their applications. **Expression vectors:** Characteristics of expression vectors, expression vectors for cloning and expression in bacteria, yeast and mammalian cells. Super vectors; characteristic features and utility of BAC and YAC vectors. **9 hrs**

Genomic and cDNA libraries: Outline of methodology for genomic library construction, creation of genomic libraries using lambda and cosmid vectors. Growth, evaluation and storage of genomic libraries. cDNA libraries; methodology, random arrayed and ordered cDNA libraries, screening cDNA libraries; probe selection, hybridization. Screening with antibodies, rescreening and sub-cloning. Characterization of plasmid clones, restriction digestion, southern blot, PCR and sequence analysis. **10 hrs**

PCR: Discovery, principle and procedure, variants of PCR- RT-PCR, long PCR, differential PCR, and inverse PCR. Application of PCR; Rapid amplification of cDNA ends (5' and 3' RACE), Cloning PCR products, PCR in screening clones, colony PCR, Diagnostic application of PCR. **6 hrs**

Sequencing and mutagenesis: Principle of DNA sequencing, automated sequencing, extending the sequence, shot gun sequencing. Analysis of sequence data; annotation, ORF, exon-intron boundaries, identification of genes and their products. **4 hrs**

Gene transfer to animal cells: over view of strategies, transfection methods, phospholipids as delivery vehicles, electroporation and direct transfer, transient and stable transformation,

Cotransformation and selection of stable transformants, selectable markers for animal cells. Mammalian plasmid expression vectors, reporter genes. Gene transfer by viral vectors; adeno and baculo viruses, retroviral vectors. **6 hrs**

Gene transfer to plants: plant cell culture and protoplast, callus and their manipulations. *Agrobacterium* mediated transformation, Ti plasmid, mechanism of T-DNA transfer, Function of T-DNA genes, Ti-plasmid derivatives as plant vectors (disarmed T-DNA), cointegrate and binary vectors, high capacity binary vectors, selectable markers for plants, control of transgene expression in plants. Direct DNA transfer to plants; protoplast transformation, particle bombardment, *in-planta* and chloroplast transformation. Plant expression vectors; CaMV and TMV vectors. **6 hrs**

References

1. Molecular Cloning; A laboratory manual; Michael R. Green, CSHL Press (2012).
2. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co (2012).
3. Molecular Biology of the Cell; 7th Edn. Bruce Alberts et al., (2008), Garland Publications
4. Molecular Biology; Robert F. Weaver, McGraw Hill (2012).
5. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2010).
6. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).
7. Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley-Blackwell Publishing (2006).
8. Molecular biology and Biotechnology; 4th Edn., J.M. Walker and R. Rapley, RSC (2000).
9. Plant Biotechnology and Agriculture; Arie Altman and Paul Hasegawa Academic Press (2011).

MBC – 404: Immunology

(52 hrs)

Infection: Types of infection and nature of infective agents. Nonspecific host defense mechanisms. Anatomical barriers; lysozyme and other antimicrobial agents. **3 hrs**

Organs and Cells of the Immune System: lymphoid organs; Primary- bone marrow and thymus, Secondary – lymph nodes, spleen, MALT and skin; tertiary Lymphoid tissue; lymphatic system; Immune Cells- neutrophils, monocytes macrophages, basophils, natural killer cells, eosinophils, dendritic cells, phagocytosis, oxygen dependent and independent killing.

6 hrs
4hrs

Complement system: Introduction, alternate and classical pathway, regulation.

Immunity: States of immunity; innate and acquired immunity, naturally and artificial acquired passive and active immunity. Immunization practices, use of toxoids, killed and attenuated organisms. Surface components and newer vaccines, production of vaccines. **4 hrs**

Immunoglobulins: Structure and functions of immunoglobulins Types; isotypes and idiotypes, isoantibodies. Methods of raising antibodies. Monoclonal antibodies, production and purification. **6 hrs**

The Immune System: Recognition of self and non self, the major histocompatibility antigens, H-2 and HLA antigens, Antigenicity; humoral and cell mediated immunity. T and B lymphocytes; origin, differentiation, characteristics and functions, nature of surface receptors, antigen processing and

presentation. T cell and B cell interaction. Cytokines, monokines, lymphokines and their functions.

10 hrs

Molecular Immunology: Theories of antibody formation; clonal selection and network, Genetics of antibody diversity, germ line and somatic mutation theories, immunoglobulin, MHC a TCR gene organization and their recombination, class switch of Ig genes.

7 hrs

Clinical Immunology: Immune disorders; hyper sensitivity, autoimmune and immunodeficiency diseases. Tissue transplantation; auto – iso -, allo-, and xenografts, tissue matching, transplantations rejection, mechanism and control, tumor immunology, immunotherapy.

7 hrs

Immuno assay methods: Antigen – antigen interaction – affinity and avidity, determination of affinity and avidity constants. Principle, procedure and applications of Immunoprecipitation, neutralization, agglutination, complement fixation, immunodiffusion, immunofluorescence, RIA, ELISA – direct, indirect, sandwich, multiplex, micro ELISA Techniques.

5 hrs

References

1. Antibodies– A Laboratory Manual; E. D. Harlow, David Lane, 2nd Edn. CSHL Press (2014).
2. Basic and Clinical Immunology; Stites et al., [Ed] (1982) Lange.
3. Roitt's Essential Immunology; Ivan, M. Rohitt & Petrér J Delves (2001) Blackwell Science.
4. Immunology; Roitt et al., Mosby (2001),
5. Kuby Immunology; Owen, Punt, Stranford, 7th Edn. W. H. Freeman (2013).
6. Immune System; M. C. Connel et al., Eds. (1981) Blackwell Science.
7. Immunology at a Glance: J.H.L. Playfare [ed.] Blackwell Science, (1987).
8. Immunology; Jan Klein [Ed.], Blackwell Science (1990).
9. Introduction to Immunology; Kim Bell [Ed.,] 3rd Edn. McMillan (1990).
10. NMS for Immunology; Hyde and Patnide [Eds.] John Wiley (1990).
11. Microbiology; Prescott, Harley and Klein, McGraw-Hill (2003).
12. Molecular Toxicology; Nick Plant, Garland Science (2003).
13. Understanding Immunology (Cell and Molecular Biology in Action); Peterwood, Pearson Education Ltd. (2006).
14. Introduction to Exotoxicology, En. D.W. Connell, Blackwell Scientific (2000)
15. Molecular Cell Biology Baltimore et al., Scientifica Americal Publication (1995).

MBC – 405: Immunology and toxicology (4 Credits)

1. Qualitative analysis of antibodies
 - i) ODD
 - ii) RID
2. Determination of direct agglutination reaction using human blood group antigens
3. Rocket electrophoresis
4. Purification of antibodies using ammonium sulphate precipitation
5. Antibody titration – ELISA
 - i) Dot ELISA
 - ii) Sandwich ELISA
6. Western blotting of proteins and immunodetection.

7. Determination of antigen concentration using turbidometry
8. Estimation of heavy metals in contaminated water.
9. Estimation of pharmaceuticals in contaminated water.
10. Cytotoxicity assay in bacteria and estimation of LD50.

References

1. Methods in Immunology and Immunochemistry; Curtis Williams, Academic Press (1971).
2. Immuno Assay Hand Book; David Wild, Elsevier (2013)
3. Antibodies– A Laboratory Manual; E. D. Harlow, David Lane, 2nd Edn. CSHL Press (2014).
4. Molecular Toxicology; Nick Plant, Garland Science (2003).
5. Practical Clinical Biochemistry Methods And Interpretations. Ranjna Chawla (2014).
6. Practical Pharmaceutical Chemistry. A. H. Beckett and J. B. Stenlake. 1962.

MBC – 406: Project Work (4 Credits)

OET – 304 : Biochemistry in Daily Life

(52 hrs)

Definition of Biochemistry: Definition of life, The different forms of life, micro-organisms to human beings. Building blocks of life. Introduction to the common macro- and microconstituents of unicellular and multicellular organisms. Differences encountered in plant and animal kingdoms.

5 hrs

Food and Nutrition: Importance of food for existence of life. Modes of nutrition in life forms – Comparable and contrasting features.

3 hrs

Human Health and Disease: Nutrition (Health), definition, classification, food and non food sources. Nutraceuticals; use of nutraceuticals in traditional health sciences. Role of omega-3 fatty acids, carotenoids, dietary fiber, phytoestrogens; glucosinolates; organosulphur compounds in health and disease (prevention and control).

6 hrs

Prebiotics and probiotics: Mechanics and usefulness of probiotics and prebiotics in gastro intestinal health and other benefits. Beneficiary microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes.

Functional foods: Definition, development of functional foods, benefits and sources of functional foods in Indian diet. Effects of processing conditions and storage.

Development of nutraceutical and functional foods; Standards for health claims. Process of developing-preclinical & clinical studies.

10 hrs

Food additives: Definitions, functions and uses in processed food products. Chemical, technological and toxicological aspects of acid, base buffer systems, salts and chelating/sequestering agents, leavening agents, antioxidants, emulsifying and stabilizing agents, anti-caking agents, thickeners, firming agents, flour bleaching agents and bread improvers.

Sweetening agents: Artificial sweeteners, composition, uses. Natural and synthetic colors, food Flavors, Spices and flavoring constituents, flavors in food industries.

9 hrs

Enzymes: Introduction and essentiality to life forms. Use of enzyme in beverages- fruit juices, beer, wine, and distilleries; dairy, baking, oils and fats, plantation products, animal products.

Malting and germination of grains – process, characteristics, nutritional benefits and uses. Domestic use products like detergents. Textiles-Denim processing. Leather industry.

7 hrs

Food processing and fortification: Principles, objectives and rationale, selection and basis of fortificants. Technology of fortifying cereal products. Characteristics of nutrients used in cereal fortification. Fortification methods. Fortification premixes, Design and composition of premixes and quality control. Fortification of bread, pasta, noodles, biscuits, and breakfast cereals. Beverages; importance of beverage fortification, Health benefits of fortification, Selection of nutrients for fortification, Levels to be added, Characteristics of fortificants and method of fortification, Bioavailability, Organic Vs inorganic salts. Health foods; selection of nutrients, Technology of incorporation of fortificants, bioavailability.

12 hrs

References

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; D.L.Nelson and M.M. Cox, 6th Edn. MacMillan Publications (2012).
3. Nutrition: Science and Applications, 3rd Edn. Lori A. Smolin, Mary B. Grosvenor, Wiley (2013).
4. Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell (2009).
5. Nutrition: Everyday Choices, 1st Edition; Mary B. Grosvenor, Lori A. Smolin Wiley (2006).
6. Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease; Watson Elsevier (2012).
7. Food, Nutrition and Health. Tapsell L. Oxford University Press (2010).



INDIAN ACADEMY DEGREE COLLEGE

AUTONOMOUS



Department of Biochemistry

B. Sc. (Choice Based Credit System)

I - VI Semesters

(With effect from academic year April 2016)

FOREWARD

The syllabus is proposed to be introduced for B. Sc. (CBCS) Programme from the academic year 2016. A BOS committee was formed which included the university nominee from Department of Biochemistry, senior teachers from autonomous and affiliated colleges offering Biochemistry as cognate subject, industrial expert from reputed industry and members of the Department of Biochemistry, IADC. Meeting was held on 26th November 2016 and 11th March 2017 to prepare and finalize the theory and practical syllabus for I to VI semester of B. Sc. Biochemistry course. It was resolved to follow the BSc Biochemistry CBCS of the Bangalore University. The BOS approved syllabus is enclosed herewith. The Chairman records his thanks to the BOS members involved in the preparation of this syllabus.

Members of the Core Committee which prepared the B.Sc. Biochemistry syllabus

1. Dr. V. R. Devaraj, Professor, Dept. of Biochemistry, Bangalore University, Central College Campus, Bangalore -560 001.
2. Prof. V. Veeraraghavan, Prof. Dept. of Biochemistry, Reva Institute of Science & Management, Kattiganahalli, Yelahanka, Bangalore – 560 064.
3. Dr. Kavitha. G. Singh, Associate Professor, Dept. of Biochemistry, Mount Carmel College, Bengaluru.
4. Dr. Shama Bhat, Chairman and Managing Director, BHAT BIOTECH, Bengaluru.
5. Dr. Susanta Pahari, HOD- Biochemistry, Associate Professor, Dept. of Biochemistry, IADC, Bengaluru - 560043.
6. Mrs. Pushpa Reddy, Professor, Dept. of Biochemistry, IADC, Bengaluru - 560043.
7. Dr. Prashanthi, K. Associate professor, Dept. of Biochemistry, IADC, Bengaluru - 560043.
8. Mrs Ramya Kumari, B. S. Associate professor, Dept. of Biochemistry, IADC, Bengaluru - 560043.
9. Mrs Malathi R. Associate professor, Dept. of Biochemistry, IADC, Bengaluru - 560043.
10. Dr. Kokila, S. Assistant professor, Dept. of Biochemistry, IADC, Bengaluru - 560043.

SCHEME OF EXAMINATION

Title of the paper	Contact hrs/Wk	Exam. hours	I A	Marks	Total Marks	Credits
First Semester						
BIC 1.1: Biochemistry-I	4	3	30	70	100	2
BIC 1.2 : Biochemistry practical-I	3	3	15	35	50	1
Second Semester						
BIC 2.1 : Biochemistry-II	4	3	30	70	100	2
BIC 2.2: Biochemistry practical-II	3	3	15	35	50	1
Third Semester						
BIC 3.1 : Biochemistry-III	4	3	30	70	100	2
BIC 3.2 : Biochemistry practical-III	3	3	15	35	50	1
Fourth Semester						
BIC 4.1 : Biochemistry-IV	4	3	30	70	100	2
BIC 4.2: Biochemistry practical-IV	3	3	15	35	50	1
Fifth Semester						
BIC 5.1 : Biochemistry-V	3	3	30	70	100	2
BIC 6.1 : Biochemistry-VI	3	3	30	70	100	2
BIC 5.2 : Biochemistry practicals-V	3	3	15	35	50	1
BIC 6.2 : Biochemistry practicals-VI	3	3	15	35	50	1
Sixth Semester						
BIC 7.1 : Biochemistry-VII	3	3	30	70	100	2
BIC 8.1 : Biochemistry-VIII	3	3	30	70	100	2
BIC 7.2 : Biochemistry practical-VII	3	3	15	35	50	1
BIC 8.2 : Biochemistry practical-VIII	3	3	15	35	50	1

Pattern of Internal assessment of Practical and Practical Examination

1. Internal assessment Marks:

Attendance: 5 Marks

More than 91% attendance	:	5 Marks
86 – 90% attendance	:	4 Marks
81 – 85% attendance	:	3 Marks
75 – 80% attendance	:	2 Marks

Tests: 10 Marks (two internal tests to be conducted for)

2. Scheme of Practical Examination:

:	3 hours
:	35
:	5
:	5
:	5
:	20

:	5 Marks
:	4 Marks
:	3 Marks
:	2 Marks
:	0 Marks

: 5 Marks

Duration Total

Marks

Marks for practical record Marks for

procedure writing Marks for Viva –

Voce

Marks for performing experiment

Practical Record:

Recording 8 or more different experiments

Recording 6-7 different experiments

Recording 4-5 different experiments

Recording 3 different experiments

Recording Less than 3 experiments

II Procedure writing

B.Sc. Biochemistry First Semester

Biochemistry – I

52 hrs

Unit-I

13 hrs

1. Measurement

SI Units – International System of Units – Basic Units, Derived Units. Simple problems relating to derived units (conversions) – Prefixes, subsidiary units – Non SI units and their SI equivalents. Significant figures – and computation Dimensional analysis for volume, density pressure, surface tension and viscosity.

Exponential notation – expression of a large number in an exponential form; purposes, positive and negative powers of 10. Graphical representation of data – Types of graphs, Advantages of showing data in graphical forum.

Errors in quantitative analysis – types, sources minimization of errors.

Precision and accuracy.

Relationship between significant figures and precision

6 hrs

2. Atomic structure

Electromagnetic radiation – (wave length, frequency, velocity, wave number) electromagnetic spectrum, Nature of wave particle.

Quantum numbers & their significance (Principal quantum number, Azimuthal quantum number (l), Magnetic quantum number (m) and Spin quantum number [s])

Shapes of Atomic orbitals – s, p and d orbitals.

Pauli Exclusion Principle, Aufbau Principle, Hund's rule of maximum multiplicity-cause of stability of half filled and completely filled energy levels.

Electronic configuration of elements up to At No.54, (n+l rule, $2n^2$, order of energy levels to be followed)

Oxidation numbers – concept, difference between valency and oxidation number, and computation. calculation of equivalent weights of oxidising and reducing agents.

7 hrs

Unit-II

13 hrs

3. Chemical bonding

Ionic bond - factors favouring formation – lattice energy – energetics of Ionic bond formation (NaCl as example) Born – Haber cycle – for NaCl. Calculation of Lattice energy Characteristics of ionic compounds. Covalent bond- definition, pictorial representation of covalent bond formation in H_2 , HCl, NH_3 , CO_2 and N_2 . Valence bond theory – postulates, Sigma and pi bonds Hybridization of orbitals and directional characteristics – sp , sp^2 , sp^3 (egs- methane, ethene and acetylene) Resonance forms of H_2 and Benzene. VSEPR theory-Shapes of H_2O , NH_3 , H_3O^+ , SF_4 , ClF_3 and ICl_4^-

Molecular Orbital Theory – postulates, Atomic orbitals and molecular orbitals; conditions for the formation of molecular orbitals. LCAO – Bonding and antibonding molecular orbitals; comparison between bonding and antibonding molecular orbitals. Shapes of molecular orbitals (by s-s, s-p, p-p overlap) – pictures to be given. Molecular orbital diagrams for the formation of H_2 , He and O_2 . Polarisation concept, Fajan's rule, bond length, bond angle and bond energy, dipole moment. Coordinate bond – Donor, acceptor, representation of the formation of co-ordinate bond in H_3O^+ , NH_4^+ . Chelates – ligands, chelates in biological systems (mention chlorophyll, vitamin B_{12} , haeme, catalase as examples) Hydrogen bond – inter and intramolecular hydrogen bond- anomalous properties of HF, H_2O , NH_3 and nitro phenols Van- der Waals forces – definition.

8 hrs

4. Nuclear chemistry and Radioactivity

Characteristics of radioelements -Nucleus- – structure , nuclear forces - N/P ratio, mass defect, binding energy; packing fraction, instability of nuclei. Radioactivity –Types of radioactive decay, Properties of α , β , γ radiations. Group displacement law. Decay law - decay constant, Half life period and average life of a radioactive element. Detection of radioactivity – GM counter and scintillation counters. Tracer technique – applications of P^{32} , C^{14} , I^{131} & Co^{60} . Safety measures 7 hrs

5. Solutions and Colligative properties

Concentration units – molarity, molality, normality, mole fraction – simple problems. Types of solutions – homogenous and heterogeneous, factors influencing solubility– nature of solvent, solute, temperature, pressure and particle size. Solubility curves– plots showing solubility of sodium chloride, potassium nitrate, lead nitrate and sodium sulphate against temperature. Henry's law – statement, Applications. Colligative properties– Definition, Relative lowering of vapour pressure. Raoult's law of relative lowering of vapour pressure, Osmosis- preparation of copper ferrocyanide semi permeable membrane, Osmotic pressure – measurement by Berkely – Hartley method. Theory of dilute solutions – Laws of osmotic pressure - Van't Hoff Boyle's law, Van't Hoff Charles' law and Avogadro's law. Hypo-, hyper- and isotonic solutions. Donnan membrane equilibrium and its applications. Elevation in boiling point, ebullioscopic constant. Depression in freezing point, cryoscopic constant. Limitations of colligative properties. Abnormal molecular weights and the van't Hoff factor – degree of association, Degree of dissociation

6 hrs

5. Electrochemistry

Strong and weak electrolytes – definition and examples. Activity and activity coefficient – concepts. Activity and mean activity of the electrolyte. Mean ionic activity. Ionic strength- classification of electrolytes as 1:1, 2:2, 2:1 electrolytes with examples. Electrochemical cells: conventions of representing galvanic cells , half cell reactions and cell reaction

Reversible electrodes and cells – definition. Types-Cation reversible electrode, anion reversible electrode, redox electrode. (Examples and electrode reactions to be given) Single electrode potential – Nernst equation, Factors affecting single electrode potential.

Standard Electrode Potential (definition). Reference electrodes – primary reference (Standard hydrogen electrode), secondary reference electrodes (Calomel, quinhydrone and glass electrodes). Electrochemical series- to predict the ease of oxidation, displacement reaction to calculate standard emf of cell Ion selective electrodes- concept, types and applications

6. Acids, Bases and Buffers

Modern concepts of acids and bases-Arrhenius, Lowry- Bronsted and Lewis concepts. Limitations of each concept. Strong and weak acids -ionisation constant K_a and pK_a of weak acids, comparison of acid strength on this basis, Ionic product of water ,common ion effect, solubility product and ionic product of sparingly soluble salts and conditions for precipitation. and in qualitative analysis –in prediction of selective precipitation of second and forth group basic radicals, precipitation of third group basic radicals. Hydrolysis of salts –H+ salts

solutions. Hydrogen ion concentration- pH, pH of some biological fluids and its importance. Buffers-definition, types, buffer action and buffer capacity. pH of buffers-Henderson-Hasselbalch equation-derivation, preparation of buffers, problems.

7 hrs

7. Liquids

Properties of liquids –vapour pressure, viscosity and surface tension. Relationship between vapour pressure and boiling point, freezing point-heat of fusion. Viscosity-Definition, units, experimental determination using Ostwalds viscometer. Viscosity and shape/size of molecules. Surface tension:- Definition, units, experimental determination using stalagmometer. Surfactants – effect of surfactants on surface tension. Viscosity and Surface tension in everyday life.

4 hrs

standard oxalic acid

7. Estimation of chloride by Mohr's method
8. Estimation of Fe^{2+} using standard potassium dichromate and diphenyl amine indicator
9. Estimation of borax using standard sodium carbonate.
10. Estimation of carbonate and bicarbonate in a given mixture.

B.Sc. Biochemistry Second Semester

Biochemistry – II

52 hrs

Unit –I

13 hrs

1. Solids

Types-Crystalline and Amorphous. Size and Shapes. Definition of Space Lattice and Unit cell. Symmetry elements in crystals. Laws of Crystallography, Weiss and Miller Indices with simple numericals. Crystal systems with examples. Defects in crystalline solids – Schotky & Frenkel defects. X – ray diffraction of crystals-Bragg's equation. 5 hrs

2. Phase Rule

Definitions of Phase & Components, Criterion of phase equilibrium, Gibb's phase rule (no derivation). Application of phase rule to one component system – water system, Two component system-water-potassium iodide (freezing mixtures). Solutions of liquids in liquids– ideal solutions and Raoult's and Henry's law. Non-ideal solutions-vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions- azeotropes –HCl - H₂O and water-ethanol system.. Distillation of solutions-Lever rule. Partial miscibility of liquids (Water – Phenol). Critical Solution Temperature (lower and upper). Effect of impurity on CST. Immiscibility of liquids. Principle of steam distillation. Nernst distribution law- statement, deviations from distribution law due to association and dissociation of the solute in one of the solvents. Applications of distribution law– solvent extraction. 6 hrs

3. Chemical Equilibrium

Reversible reactions with examples. Law of mass action, Chemical equilibrium – definition and characteristics. Relationship between K_c , K_p Homogenous and heterogeneous systems with examples. Le Chatelier principle. Equilibrium constant and free energy change. Biological applications-ATP and its role in bio-energetics and binding of oxygen by myoglobin and haemoglobin. Redox equilibria with example Fe^{2+}/Fe^{3+} System. 3 hrs

Unit-II

13 hrs

4. Reaction Kinetics

Experimental methods of studying kinetics of reactions, rate of reactions, Factors influencing rate of reaction – temperature, pressure, concentration and catalyst, rate law or Rate equation, Molecularity and order of a reaction, velocity constant or rate constant and half life period expressions for zero, first and second order reactions ($a=b$ and $a \neq b$). Theories of reaction rates – Effect of temperature on rate of reaction, Arrhenius equation, elementary treatment of transition state theory. 5 hrs

5. Catalysis

Characteristics of catalysts, Types of catalysis – Homogeneous and heterogeneous with both biological and non-biological examples. Theories of catalysis – intermediate compound formation theory and adsorption theory (No mechanism required). 2 hrs

6. Introduction to organic chemistry

IUPAC nomenclature bi and poly functional compounds. Inductive effect, resonance and hyper conjugation. Reactive intermediates – free radicals, carbocations and carbanions. 5 hrs

Unit-III

13 hrs

7. Hydrocarbons

Mechanism of addition of HCl to propene, Markownikoff's rule. Peroxide effect, Alkenes – ozonolysis, oxidation. Alkynes – formation of acetylides and their importance. Dienes – types with examples. Conjugate dienes, 1,3-butadiene – stability, mechanism of addition of HBr. Conformational analysis of ethane and n – butane. 4 hrs

8. Cycloalkanes

Reactivity and relative stabilities. Baeyer strain theory, Sachse – Mohr theory, boat and chair forms of cyclohexane, axial and equatorial bonds. 2 hrs

9. Arenes

Modern concept of structure of benzene, mechanism of electrophilic substitution in benzene (nitration, Friedal– Craft's alkylation and acylation). Electronic interpretation of the orienting influence of substituents in the electrophilic substitution of toluene, chlorobenzene and nitrobenzene. Aromaticity– Huckel rule ($4n+2$ rule), structure of naphthalene, anthracene, phenanthrene and diphenyl. Oxidation reactions of naphthalene. 6 hrs

Unit – IV

13 hrs

10. Alkylhalides and organometallic reactions

SN^1 and SN^2 reaction mechanisms taking 1° , 2° & 3° alkylhalides as examples. Mechanistic concepts of elimination reactions involving tertiarybutylchloride and n– butylchloride. Organometallic compounds – examples, preparation and synthetic applications of Grignard reagents. 4 hrs

11. Alcohols

Classification, monohydric alcohols: examples, general and distinguishing reactions. Dihydric alcohols: glycols, Trihydric alcohols: glycerol – synthesis from propene, properties and uses. 3 hrs

12. Phenols

Classification, electronic interpretation of acidity of phenols, mechanism of Kolbe, Reimer– Tiemann and bromination reactions. 2 hrs

13. Carbonyl compounds

General properties, addition of alcohols to aldehydes and ketones. Keto-enol tautomerism. Mechanisms: addition of HCN to acetaldehyde, Claisen and aldol condensations. Quinones: o- and p-benzoquinones- structure and properties. 5 hrs

Biochemistry Practical- II

3 hrs / wk

List of experiments:

1. Determination of density and viscosity of the given organic liquid using Ostwald's viscometer
2. Determination of composition of a binary liquid mixture by viscosity method.
3. Determination of density and surface tension of the given liquid using Stalagmometer
4. Partition Coefficient of iodine between carbon tetrachloride and water
5. Partition Coefficient of benzoic acid between toluene and water.
6. Kinetics of iodination of acetone by colorimetric method
7. Reaction kinetics of acid catalysed hydrolysis of ethyl acetate
8. Determination of molar mass of a non-electrolyte by ebullioscopic method
9. Effect of surfactants on surface tension of water.
10. Adsorption of oxalic acid on activated charcoal.

B.Sc. Biochemistry – Third Semester Biochemistry –III
52 hrs

Unit – I

13 hrs

1. Bio-inorganic and Environmental Chemistry:

Metal ions in biological systems; Transition metal ions and oxidation states; Types of ligands; Role of iron in Myoglobin, Haemoglobin and cytochromes; Copper in Hemocyanin, Magnesium in chlorophyll, Cobalt in vitamin B-12 and Molybdenum in nitrogenase; Metalloenzymes; Geometrical and optical isomerism in coordination complexes.

7 hrs

2. Environmental Toxicology:

Biochemical toxicology- toxicity and detoxification of Pb, Hg, Cd. LD and ED values of major toxicants. Water pollution: Treatment of sewage and industrial effluents (tanning and electroplating); Pesticides hazards – DDT, Malathion, lindane and 2,4-D. Brief Introduction to Bioremediation and Phytoremediation with applications.

6 hrs

Unit -II

13 hrs

3. Carboxylic Acids :

Classification; hydroxy acids: preparation and properties of lactic acid; structures of tartaric, malic, citric and iso citric acids; dicarboxylic acids: saturated dicarboxylic acids- effect of heat on the first five members; ketoacids: structures , properties and reactions of pyruvic acid, α - ketoglutaric acid and oxaloacetic acid.

3 hrs

4. Amines:

Classification; isomerism; distinguishing reactions of 1°, 2° and 3° amines; some biologically important amines (DOPA, Histamine).

2 hrs

5. Alkaloids:

Introduction and general characteristics; general method of extraction; structure and medicinal uses of nicotine, atropine and LSD.

2 hrs

6. Terpenes: Structure and Biological roles of the following: menthol, santonin, juvenile hormone I, abscisin II, gibberilic acid and lanosterol. Steroids: basic ring system; structures of cholesterol, steroid hormones(testosterone and oestrogen); structures and biological importance of β -carotene.

2 hrs

7. Heterocyclic Compounds: Structural and nomenclature of furan, pyran, thiophene, thiazole, pyrrole, imidazole, pyridine, pyrimidine, purine, isoalloxazine and indole; biological compounds containing the above skeletons. reactions of imidazole and pyridine; Aromaticity of furan, thiophene, pyrrole and pyridine.

2 hrs

8. Drugs: Classification of drugs; synthesis and uses of sulphanilamide and pentothal. Antibiotics: Definition; types; sources; structures and antimicrobial spectrum of action of penicillin, chloroamphenicol, streptomycin and tetracyclines. 2 hrs

Unit - III

13 hrs

9. Colloids:

Types of colloidal systems, electrical properties of colloids. Emulsions and emulsifiers; Gels; Applications of emulsions in lipid chemistry. 2 hrs

10. Photochemistry:

Laws of Photochemistry; Chemiluminescence; Bioluminescence; Photocatalysis and photochemical reactions. 2 hrs

11. Stereochemistry:

Stereoisomerism: types, stereochemical terminology; optical isomerism: Molecular dissymmetry; chirality: glyceraldehyde, lactic acid, tartaric acid; Nomenclature of enantiomers – the RS system and DL notation; diastereoisom, epimers, mutarotation, racemization and resolution; Fischer's projection formulae; Geometrical isomerism: *cis-trans* isomerism in alkenes and ring compounds; structure and properties of maleic and fumaric acids; (E)-(Z) system of specifying geometrical isomers; significance of chirality in biological system.

9 hrs

Unit - IV

13 hrs

12. Introduction To Biochemistry:

Aim and scope, historical account of development of biochemistry, mention of the landmark developments, contributions of Paracelsus, van Helmholtz, Karl Sheele, Lavosier, Wohler, Emil Fisher, Louis Pasteur, Embden, Meyerhoff, Hans Krebs, Michaelis Menton, Watson & Crick, Chargaff and H. G. Khorana; biochemical composition of living organism: elemental and chemical compositions; properties of water which makes it as solvent of life. 5 hrs

13. Identification and Separation Techniques:

Spectroscopic methods- principle and applications of UV- Visible, IR, ESR and NMR spectroscopy. Separation techniques: principle, types and applications of centrifugation, chromatography and electrophoretic techniques. 8 hrs

Biochemistry Practical- III

3 hrs / wk

1. Systematic Qualitative Analysis of organic compound (8 practicals)

The following compounds may be given for systematic qualitative analysis

1. Resorcinol	2. Urea	3. Glucose	4. Aniline
5. Benzoic Acid	6. Salicylic acid	7. Phenol	8. m-Cresol
9. Benzyl alcohol	10. Benzaldehyde	11. Acetophenone	12. Ethyl benzoate
13. Toluene	14. Chlorobenzene	15. Benzamide	16. Nitrobenzene

2. Determination of BOD
3. Determination of COD
4. Separation of compounds by TLC
5. Determination of λ_{max}

B.Sc. Biochemistry – Fourth Semester

Biochemistry – IV

52 hrs

Unit – I

13 hrs

1. Tissues:

Classification, epithelial, connective tissues, role of collagen and elastin in bone composition, growth and remodeling, factors affecting growth. 3 hrs

2. Blood and Body fluids:

Composition of body fluids; blood; Properties, composition and functions; Erythropoiesis, blood coagulation - outline of extrinsic and intrinsic pathway; Composition and functions of CSF and Lymph. 5 hrs

3. Respiratory system:

Anatomy of Respiratory tract, Mechanism of respiration, Transport of gases and artificial respiration. Acid base balance by lungs and kidneys. Bohr's effect, transport of gases, chloride shift. 5 hrs

Unit – II

13 hrs

4. Digestive system:

Outline of digestive system ; composition and functions of major digestive secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids. 5 hrs

5. Excretory system:

Structure and functions of nephron; glomerular filtration, tubular absorption and secretion; Concentration of urine, GFR, kidney function tests, composition of urine, renal failure, nephritis. 4 hrs

6. Endocrinology:

Introduction - Endocrine glands - chemistry of hormones and hormonal action. Functions of the hormones of hypothalamus, pituitary glands, adrenal cortex, thyroid, parathyroid and pancreas (Insulin, Glucagon and Somatostatin) Diabetes mellitus & Hyperinsulinoma; Local hormones and its biological action (PGE_2 , PGI_2 , TXA_4 and LTA_4). 4 hrs

Unit – III

13 hrs

7. Cardiovascular system:

Blood vessels- anatomy and physiology; ECG, Blood pressure. Regulation of heart rate, hemorrhages. 3 hrs

8. Nervous system:

Structure and classification of neurons, membrane potential, resting membrane potential and action potential; Mechanism of synaptic transmission, EEG; Neurotransmitters– classification, neurotransmitters receptors. 5 hrs

9. Muscular system:

Muscle types; ultra structure of skeletal and cardiac muscle fibers; Muscle proteins – contractile and non contractile. Definition of sarcomeres and mechanism of contraction. Energetics of muscle contraction. Regulation of skeletal muscle contraction. Muscular dystrophies. 5 hrs

Unit – IV

13 hrs

11. Nutrition:

Energy content of foods, **Balanced diet**- Definition, characteristic feature of balanced diet, proximate analysis of foods for carbohydrate, proteins, fats, fiber material and water content. **Bomb calorimeter**- diagram and description, **Determination of calorific value of foods** (Carbohydrate, fat and protein); **respiratory quotient of food stuffs and significance of RQ**. **BMR determination by direct and indirect method**; BOD; SDA- definition; SDA for carbohydrate, fat and mixed diet and its significance. RDA for different physical activities: pregnant women, lactating woman, infants and children. 6 hrs

12. Macronutrients

Carbohydrate, proteins, lipid and fiber; Essential aminoacids, semi essential and non essential aminoacids; complete and incomplete proteins, protein efficiency ratio; Nitrogen balance- Positive and negative nitrogen balance.; Fortification - Definition and Biomedical importance; Protein Energy malnutrition: Marasmus & Kwashiorkor- causative factors , treatment and prevention. 4 hrs

13. Micronutrients:

Nutritional importance of vitamin, classification, source, daily requirements and functions; Deficiency symptoms- hypervitaminosis of fat soluble vitamins. Nutritional importance of Minerals- Definition, classification, source, daily requirement and deficiency symptoms. 3 hrs

Biochemistry Practical- IV

3 hrs / wk

List of experiments

1. **Paper chromatography of amino acid by circular method**
2. Preparation of m- dinitrobenzene from nitrobenzene
3. Preparation of p- nitroacetanilide from acetanilide
4. Preparation of p- bromoacetanilide from acetanilide
5. **Preparation of buffers (phosphate and citrate buffer)**
6. **Determination of titrable acidity of urine**
7. **Estimation of bilirubin by sulphanilic acid method**
8. **Estimation of haemoglobin by Wong's method**
9. Qualitative analysis of non protein nitrogenous substance in urine
10. **Determination of A/G ratio in serum by biuret method**

B.Sc. Biochemistry – Fifth Semester

Biochemistry - V 52hrs

Unit – I

13 hrs

1. Carbohydrates:

Biological importance ; Monosaccharides : Elucidation of structure of glucose (open chain and ring structure); Epimers and Anomers-definition and example ; Brief review on configurational and conformational aspects of carbohydrates; Derived monosaccharides: structures and biological importance of : Amino sugars: glucoseamine and galactosamine and their N- acetylated forms, Sugar phosphates: D-ribose-5-P, β -D-ribose-5-P, glucose-6-P and fructose -1,6- diphosphate, Sugar acids: types with examples; Disaccharides: Structure of isomaltose, cellobiose and trehalose; brief discussion on reducing property; Polysaccharides: classification with examples ;structure,properties and importance of homo and hetero polysaccharides-Blood group and bacterial polysaccharides; glycosaminoglycans, cardioglycosides, Glycoproteins- structure and functions, Lectins-characteristics and biological importance.

Unit – II

13 hrs

2. Lipids:

Biological importance; Classification. Fatty acids: definition,classification,examples and structures, **properties of fatty acids: melting point,solubility, cis-trans isomerism, reaction with NaOH, alcohol, catalytic hydrogenation**, Acylglycerols: mono, di, triacylglycerols (general,structure). Hydrolysis of acylglycerols:Saponification,saponification number; Acid hydrolysis of triglycerides, unsaturation in acyl glycerols and iodine number; Rancidity : definition,oxidative and hydrolytic rancidity; Phosphoglycerides:structure and biological roles of phosphatidylcholine, phosphatidyl ethanolamine, phosphatidylserine,phosphatidyl inositol;Sphingolipids:structure of 4- sphingenine, ceramids and sphingomyelin, biological importance to be mentioned.Glycosphingolipids: Biological importance and general structure of cerebroside and gangliosides; Prostaglandins: definition and example,structure of PGE₂ and PGF₂ and biological role ofprostaglandins in general; Thromboxanes and leukotrienes; Waxes: definition,types,biological importance; Lipoproteins: Types and functions, clinical significance; Membrane:common features of membranes ,behavior of amphipathic lipids in water; formation of micells, bilayers and vesicles; Biological membranes - fluid mosaic model, functions and composition; Steroids: definition, functions of cholic acid.

Unit – III

13 hrs

3. Proteins:

Structure and classification of α -amino acids based on the polarity of R group; amino acids as ampholytes – zwitterion structure of amino acids, Isoelectric pH, titration curve of alanine; reactions of amino acids with ninhydrin ,FDNB, Edman's reagent and decarboxylation of amino acids; peptides: structure and conformation, biological importance of peptides; Proteins: classification based on composition shape and function with examples; color reactions:ninhydrin, xanthoproteic, Lowry, Sakaguchi's and Biuret reaction; Overview of structural organization of proteins: Primary structure-importance of restoration of primary structure by taking sickle cell anemia as example, Secondary structure-Types – α -helix, β -pleated structure, triple helix – example and characteristic features of each type; Tertiary structure and Quaternary structure- factors stabilizing both; Denaturation-Denaturing agents and mechanism of operation, renaturation of ribonuclease-Anfinsen's experiment.

4. Bioenergetics and Biological Oxidation:

Laws of thermodynamics ; Definition of bioenergetics, stages of energy transformation– photosynthesis, respiration and utilization of energy; free energy concepts: free energy change: exergonic and endergonic reactions, meaning of ΔG , ΔG° , $\Delta G^\circ'$; Biochemical standard state and $\Delta G^\circ'$, ΔG and K_{eq} (relationship). High energy compound: Definition and examples; energy coupling–explain the concept by taking suitable example; Biological oxidation: Comparison of biological oxidation with combustion using glucose as an example; Calculation of thermodynamic efficiency of biological oxidation for a mole of glucose; Redox potential of some biologically important half reactions(Ex: components of electron transport system); Calculation of energy yields from biological Red–ox reaction(problems to be solved); Electron transport chain: components sequence and their arrangement, 4 complexes and their functions to be mentioned; Structure and reaction associated with ubiquinone, coenzyme Q, NAD, FMN and FAD. Scheme and sites of energy conservation; Cytochromes and NHI proteins; Oxidative phosphorylation: definition, salient features of chemiosmotic theory, P:O ratio.

**Biochemistry Practical-
V****3 hrs / wk****List of experiments:**

1. Qualitative analysis of carbohydrates.
2. Qualitative analysis of amino acids and proteins.
3. Qualitative analysis of lipids.
4. Preparation of solid derivatives of monosaccharide – osazones.
5. Determination of total Carbohydrate content in cereal by anthrone method.
6. Estimation of amino acids by formal titration.
7. Estimation of ascorbic acid from biological samples by titrimetric method.
8. Determination of iodine value of a lipid.
9. Determination of saponification value of a lipid.
10. Estimation of Calcium from milk.

B.Sc. Biochemistry – Fifth Semester

Biochemistry - VI

52hrs

Unit - I

13 hrs

1. Enzymes:

Nomenclature (E.C. No. upto 2nd digit) and **classification of enzymes**, Holoenzyme, apoenzyme, prosthetic group. Substrate enzyme interaction – lock and key model, induced fit model. Active site and its characteristics. Enzyme specificity and theories. Enzyme assay– methods, enzyme units. **Chemical nature of enzymes, catalysis and energy of activation. Enzyme kinetics of single substrate reactions-** Michaelis theory, steady state theory. Michaelis-Menten equation (No derivation), Significance of K_m and V_{max} and their determination using Line Weaver– Burk plots. **Effect of pH and temperature.** Monomeric and oligomeric enzymes; cooperativity in catalysis, sigmoidal kinetics, allosteric effectors. **Enzyme Inhibition:** Types - reversible, irreversible, competitive, non-competitive, uncompetitive and mixed inhibitors. Partial inhibition, substrate inhibition and allosteric inhibition. Cofactors- metal cofactors, coenzymes (definition and role of NAD, TPP and PLP).

Unit - II

13 hrs

2. Nucleic acids:

Nucleosides and nucleotides, configuration and conformation, Composition of RNA and DNA, **Physico- chemical properties of nucleic acids** - effect of alkali, acid and heat (denaturation and renaturation), features of phosphodiester bond, endonucleases. Complementary base pairing, secondary structure of RNA, features of DNA double helix (Watson-Crick model), Nucleoproteins – histone and nonhistone. **Isolation of nucleic acids and sequencing.**

Unit – III

13 hrs

3. Genetic material:

Experimental proofs; Genome organization- from nucleotide to chromatin; the versatility of RNA. Basic features of DNA replication in vivo: semi - conservative replication, bidirectional **replication-visualization of replication forks by autoradiography**, unique origins of replication, DNA polymerases and DNA synthesis in vitro: Discovery of DNA polymerases, multiple DNA polymerases; the complex replication apparatus: semi- discontinuous synthesis, replication initiation, elongation and termination- Enzymology, outline of DNA replication in eukaryotes.

9 hrs

4. Mutation:

Mutagens – chemical and physical, Molecular basis of mutation: spontaneous and induced mutations. Types of mutation, reversion and suppression, DNA repair mechanisms- repair systems, direct (photoactivation), excision repair – base excision and nucleotide excision repair.

4 hrs

Unit - IV

13 hrs

5. Transcription:

Transfer of genetic information: the central dogma, RNA polymerases, different types of RNA polymerases, promoters, regulatory elements, constitutive and inducible promoter, operators. Initiation (role sigma factor), elongation and termination (rho dependent and independent); **regulation of gene expression** in prokaryotes: positive and negative control using lac operon as an example, attenuation: trp operon. Overview of eukaryotic transcription, post transcriptional processing: capping, splicing and polyadenylation.

8 hrs

6. Translation:

Genetic code– features; Translation machinery– ribosomes, composition and assembly. Translation - overview, mechanism, isoaccepting tRNA, wobble hypothesis, outline of translation in eukaryotes. Inhibitors of translation. 5 hrs

Biochemistry Practical-VI

3 hrs / wk

List of experiments:

1. Determination of total activity of α/β amylase
 - a) Standard curve for maltose
 - b) Determination of rate of amylase activity
2. Determination of optimum temperature for α/β amylase
3. Determination of optimum pH for α/β amylase
4. Determination of total activity of acid phosphatase
 - a) Standard curve for p-nitro phenol
 - b) Determination of rate of acid phosphatase activity
5. Determination of optimum temperature for acid phosphatase
6. Determination of optimum pH acid phosphatase
7. Determination of total activity Urease
 - a) Standard curve for ammonium sulfate
 - b) Determination of rate of Urease activity
8. Determination of optimum temperature for Urease
9. Determination of optimum pH Urease
10. Estimation of DNA by Diphenylamine method

B.Sc. Biochemistry – Sixth Semester

Biochemistry-VII

52hrs

Unit – I

13 hrs

1. Introduction to metabolism and Carbohydrate metabolism:

Definition, phases of metabolism, Anabolism and Catabolism- definition, schematic representation of metabolism. Glycolysis; definition, individual reactions with energetic. Irreversible reactions/ATP dependent reactions. Substrate level phosphorylation reactions of glycolysis. Net reaction of glycolysis. Entry of lactose, sucrose and glycogen into glycolysis. Fate of pyruvate-formation of Acetyl-CoA, Ethanol and Lactate. Stoichiometry and energetics of Glycolysis. Regulation of Glycolysis. TCA cycle- Individual reactions. Net reaction of TCA cycle. Number of ATP molecules production. Functions of TCA cycle- Amphibolic roles (Anapleorosis). Regulation of TCA cycle, energetics of TCA cycle. Pentose phosphate pathways (PPP/ HMP)- Significance , reactions. Gluconeogenesis- Definition and significance, flow chart for gluconeogenesis. CORI cycle-explanation, diagram, purpose. Substrate level phosphorylation (SLP) from TCA cycle. Glycogen metabolism- Glycogenolysis- definition, reactions. Glycogenesis- definition, reaction, Cori-diseases. Regulation of blood glucose level; role of Insulin and Glucagon.

Unit - II

13 hrs

2. Lipid metabolism:

β -oxidation of saturated fatty acids; individual reactions, enzymes, coenzymes. Energetics of β -oxidation of palmitic acid and stearic acid (one to be worked in the class room and remaining two may be given as home assignment), role of carnitine, Oxidation fatty acids-with odd number of carbon atoms, fate of propionyl coA, oxidation of unsaturated fatty acids. Fatty acid synthetases; structure and functions. Biosynthesis of fatty acids-general flow chart, fatty acid oxidation v/s fatty acid synthesis. [Cholesterol- structure and functions. cholesterol biosynthesis- \(chemical reactions up to the formation of mevalonate, remaining reactions may be given as flow scheme\). Regulation of cholesterol biosynthesis. Atherosclerosis-cause, blood cholesterol levels \(mentioning\). Ketone bodies-cause for the production. Ketogenesis-reactions, utilization, over production \(ketosis\).](#)

Unit – III

13 hrs

3. Amino acid metabolism:

General reactions- transamination- definition, reactions catalyzed by SGOT and SGPT, importance of transamination; Deamination - definition, oxidative and non-oxidative, examples for oxidative deamination- L-glutamate and non-oxidative- serine, aspartic acid and glutamine. Decarboxylation - definition, decarboxylation of glutamic acid, Histidine. Urea cycle- individual reactions, importance of urea cycle, hyperammonemia, regulation of urea cycle. Interrelationship between urea cycle and TCA cycle. Biosynthesis of glycine from serine and choline. Biosynthesis of alanine from transamination reaction. Biosynthesis of cysteine from L- serine. Epinephrine and Nor-epinephrine- importance and biosynthesis from tyrosine. Histamine; biological importance and synthesis. PKU and AKU characteristic features, metabolic reasons.

8 hrs

[4. Nucleic acid metabolism: Biosynthesis of purine and pyrimidine nucleotides- sources of nitrogen and carbon atoms of purine and pyrimidine ring. Precursors of purine and pyrimidine](#)

biosynthesis. Reactions involved in the biosynthesis. Conversion of nucleotides to deoxynucleotides. Orotic aciduria- general features. Gout; general features. 5 hrs

Unit - IV

13 hrs

5. Photosynthesis:

Photosynthetic pigments and Photosynthetic unit. Light reactions – photosystem- I and II and their interactions. Synthesis of NADPH, photolysis of water, synthesis of ATP in cyclic and non-cyclic photophosphorylation. Dark reactions - chemical reactions upto the synthesis of fructose-6-phosphate. Trans- ketolation and aldolation reactions (shall be given in the form of flow chart). Interdependence of light and dark reactions. C₃ and C₄ plants- definition and C₄ pathway (HSK pathway). Bacterial photosynthesis. 10 hrs

6. Biological Nitrogen Fixation:

Nitrogen cycle, components of nitrogenase complex, stoichiometry of nitrogen fixation, nif genes. 3 hrs

Biochemistry Practical- VII

3 hrs / wk

List of experiments:

1. Estimation of protein by FC method
2. Estimation of Iron using ammonium thiocyanate by Colorimetric method
3. Colorimetric Estimation of Inorganic Phosphate by Fiske Subbarow method
4. Colorimetric Estimation of Creatine and Creatinine by Jaffe's method
5. Colorimetric Estimation of Lactose in milk by D.N.S method
6. Estimation of amino acid (alanine/glycine) using ninhydrin by colorimetric method
7. Estimation of serum cholesterol by Zak's method
8. Extraction of DNA from onions
9. Conductometric titration of amino acid against NaOH.
10. Conductometric titration of amino acid against HCl

**B.Sc. Biochemistry – Sixth Semester
Biochemistry -VIII**

52 hrs

Unit - I

13 hrs

1. Industrial Microbiology:

Principles and methods of sterilization; physical chemical, filtration, UV- radiation, ultrasonic methods with example. Isolation of pure cultures; enrichment, dilution-plating, streak- and spread-plate and micromanipulations. Preservation of microorganism, sub-culturing, lyophilization.

Microbial growth kinetics; growth curve, kinetics in batch, continuous and fed-batch culture. Measurement of growth (cell count), immobilization of microbes.

Use of microorganisms in fermentation, strain improvement strategies. Fermentation Technology; design of fermentors, types, media inoculation. Fermentation types; single, batch, submerged and solid state. Production of ethanol, Glycerol, Citric acid, Penicillin and biofuels by microbial fermentation. Single cell proteins (SCP) definition and production.

Unit - II

13 hrs

2. Molecular and Immunological techniques:

Blotting techniques: principle and applications of Western, Southern and Northern blotting; Molecular biology techniques: PCR- types, principle, applications; Hybridization techniques- types and applications. Fluorescent In situ Hybridisation (FISH), microarrays, Immunochemical techniques: principle and applications of Precipitation, agglutination, Immunodiffusion; Immunoelectrophoresis, RIA and ELISA. Autoradiography; principle and applications.

Unit - III

13 hrs

3. Immunology:

Organs and cells of Immune system - Primary and secondary Lymphoid organs, Characteristic and features of monocytes, granulocytes, mast cells and dendrite cells. Immunity– Definition, Types, Innate immunity – Mechanism of immune response anatomic, physiological, phagocytic and inflammatory barriers. Adaptive immunity cell mediated and humoral immunity –Mechanism of immune response. Complement system – Definition, functions, classical, alternate and lectin pathways. Antigens - Chemical nature of antigens, hapten, antigenicity, immunogenicity, epitope.

Immunoglobulins -History, Isotypes, structures and functions IgG, IgM, IgE. Methods of raising antibodies –adjuvants, immune sera, IgG fraction. Monoclonal antibodies – definition and production. Major histocompatibility complex proteins (MHC): Definition. Types, physiological role, Antigen processing and presentation. Vaccines- classification, methods of production of live, attenuated and toxoids, modern vaccines – recombinant and peptide vaccines Hypersensitivity reactions- definition, types and examples, Type-I HS reaction and its mechanism.

4. Recombinant DNA Technology and Genetic Engineering:

Tools of Recombinant Technology – Genetic engineering; definition, gene cloning-definition, use of DNA polymerase, restriction endonuclease, ligase and other DNA modifying enzymes in cloning. Cloning vectors- definition, characteristic features of plasmid vectors (pUC18, pBR322), features and advantages of cosmids, phage and yeast artificial chromosome. [Outline of the methods of producing recombinant DNA](#). Cloning hosts - features of an ideal host (*E.coli*). Transformation - types, selection of transformants by colony hybridization, insertional inactivation and blotting. Gene libraries and cDNA libraries- outline of their construction and uses.

**Biochemistry
Practical-VIII****3 hrs / wk****List of experiments:**

1. Determination of energy of activation for hydrolysis of Methyl acetate.
2. Determination of pKa value of acetic acid by pH metric titration.
3. Determination of pKa value of amino acid (glycine) by pH metric titration.
4. [Preparation of microbial culture media and sterilization.](#)
5. [Gram staining and endospore staining.](#)
6. [Isolation of microorganisms from fermented foods \(Demonstration\)](#)
7. [Alcoholic fermentation of fruit juice. \(Demonstration\)](#)
8. [Identification of antigen by Ouchterlony Immunodiffusion technique.](#)
9. [Immunoelectrophoresis of serum or any biological sample.](#)
10. [Restriction digestion of DNA and separation by agar-gel-electrophoresis.](#)

List of References for all the Semesters**A. For Theory component:**

1. Chemistry- An Introduction to General, Organic and Biological Chemistry, VII Ed., (1999), Karen C. Timberlake, Benjamin/Cummings
2. Introduction to Biophysical Chemistry, Bruce Martin.
3. Physical Chemistry of Macromolecules, C. Tanford.
4. Stereochemistry of Carbon Compounds, Eliel(1977) Tata-McGrawHill.
5. Organic Mechanisms, Peter Sykes (1977), Longman
6. Inorganic Biochemistry, G.L. Eichhorn (1973) Elsevier.
7. Guide Book to Mechanisms in Organic Chemistry, Peter Sykes, 6th Ed., (1986), Longman
8. Introduction to Ecotoxicology, Ed. D.W. Connell, (2000) Blackwell Scientific
9. Molecular Pharmacology, ed. T. Kenakin, (1997), Blackwell Science Inc.
10. Molecular Cell Biology Baltimore et al., (1995) Scientific American Publication.
11. Analytical Biochemistry; D.J.Holme and H. Pick,(1983) Longman.
12. Instrumental Analysis in the Biological Sciences, M.H.Goxdon, R. Macrae (1987), Blackie & Sons.

13. Molecular Biology; Current Innovations and Future Trends; Griffin and Griffin, (1995), Horizon Scientific Press.
14. Molecular Biology and Biotechnology; Walker J.M. and Gingold E.B. [Eds.] (1992) Royal Society of Chemistry, London.
15. Practical Biochemistry; Principles and Techniques; K. Wilson and J. Walker (1995), Cambridge University
16. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
17. Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3 Ed. John Wiley and sons.
18. Molecular Biology of the Cell, Alberts et al., (1989) 2nd Edn. Garland Publications
19. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
20. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw Hill.
21. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley-Liss.
22. Principles of Enzymology for Food Sciences; Whitaker, Marcel Dekker (1972) Academic Press.
23. Basic and Clinical Immunology; Stites et al., [Ed.] (1982) Lange.
24. Roitt's Essential Immunology; Ivan, M. Roitt & Peter J Delves (2001) Blackwell Science
25. Principles of Nutrition by M.S Swaminathan
26. Principles of Nutrition by Dr.C. Gopalan.
27. Human Nutrition and Dietetics by Davidson and Passmore; 8th edition (1986)
28. Modern Nutrition and Health disease by M.E. Skillis and V.R. Young
29. Human Physiology by CC. Chatterjee, 11th edition (1985)
30. Essentials of Medical physiology by K Sambulingam, 3rd edition, 2005

B. For practicals:

1. Text book of Clinical Chemistry- Teitz
2. Clinical chemistry in Diagnosis and Treatment by P.D Mayne/ Arnold. New Delhi
3. Medical Laboratory technology- Kanai L. Mukherjee, Tata Mc Graw Hill Publication and Co. Ltd; Vol I, II, III
4. Practical Clinical Biochemistry- Harold Varley CBS, New Delhi
5. Medical Laboratory Science, theory and practice. J. Ochei & A. Kolhakar, Tata Mc Graw Hill.
6. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
7. Lab manual of Biochemistry, Immunology and BioTechnology, Artinagam and Archana Ayyagiri -- Tata Mc Graw Hill.

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SCHEME AND SYLLABUS

For the course

BSC BIOCHEMISTRY (HONOURS)

NEP 2021 Scheme

Revised w.e.f.

Academic Year 2021-22 and onwards

DEPARTMENT OF BIOCHEMISTRY

INDIAN ACADEMY DEGREE COLLEGE AUTONOMOUS (IADCA)

BANGALORE -560043

FOREWARD

The syllabus is proposed to be introduced for B.Sc Biochemistry (Honours) Programme from the academic year 2021-22 under NEP 2021 scheme. The enclosed syllabus has been prepared based on the scheme and syllabus received from Department of Biochemistry, Bangalore University, Bengaluru. A BOS committee was formed which included the university nominee from Department of Biochemistry - Bangalore University, senior teachers from other private universities / autonomous and affiliated colleges offering Biochemistry as cognate subject. Industry expert from reputed industry and members of the Department of Biochemistry, IADCA were also in the BOS panel. BOS meeting was held on 07.10.2021 to finalize the theory and practical syllabus for I and II semesters of B.Sc. Biochemistry Honours course. The final BOS approved syllabus is enclosed herewith. The Chairman records his thanks to the BOS members involved in the preparation of this syllabus.

Proceedings of the meeting of Board of studies (BoS) in Biochemistry (UG) held on 7th October 2021 at 11.00 AM in the Board Room, IADCA campus, IADCA, Bengaluru - 560043

1. Dr. H. Ananda Vardhan, Professor, Professor & Head, Dept. of Biochemistry, Indian Academy Degree College Autonomous (IADCA), Bengaluru-560 043
2. Prof. C.S. Karigar, Professor, Dept. of Biochemistry Department of Biochemistry, Bangalore University Jnanabharathi Campus, Bengaluru-560 056.
3. Dr. Damodara Reddy.V, Associate Professor, Department of Biochemistry, Reva Institute of Science & Management, Kattiganahalli, Yelahanka, Bangalore – 560 064.
4. Dr. Kamala.A, Associate Professor, Department of Biochemistry, Maharani Lakshmi Ammani College for Women – Autonomous, Bengaluru
5. Dr.Padmavati.P, Scientist, DR Biosciences, Bengaluru.
6. Mr.Kiran.K.S. Executive Quality Control Officer, Himalaya Drugs Company, Bengaluru
7. Dr. Pushpa Reddy, Professor, Dept. of Biochemistry, IADCA, Bengaluru – 560 043.
8. Dr. Suma.T.K, Assistant Professor, Dept. of Biochemistry, IADCA, Bengaluru – 560 043.
9. Dr.C.Naveenkumar, Assistant professor, Dept. of Biochemistry, IADCA, Bengaluru – 560 043.
10. Mrs.Dilshad Begum, Assistant professor, Dept. of Biochemistry, IADCA, Bengaluru – 560 043.

B.Sc. BIOCHEMISTRY (Honors)

Preamble

The learning outcomes are designed to help learners understand the objectives of studying B.Sc (Honors) Biochemistry that is, to analyze, appreciate, understand the basic concepts of biomolecular processes and chemical reactions occurring in the living system. This course is fundamental to tackle many of the health – related challenges facing society. Considering the rapid and far-reaching advances in biological sciences in 21st century, it is imperative to have curriculum incorporating these updated emerging concepts of biochemistry. The current pattern is designed to impart concept based learning with emphasis on hands-on training, skill development and research. Aimed at multi-faceted development of a student, the curriculum includes courses encompassing core courses, intra and inter discipline specific courses, skill and ability enhancement courses to impart in-depth knowledge in biochemistry complemented with varied subjects and skills. The course seeks to discover and nurture typical attributes of a competent science graduate such as; spirit of inquiry, critical thinking, problem solving, analytical reasoning, aptitude to research/industry and entrepreneurial instincts.

Programme Learning Outcome

The learning outcome-based curriculum is specific in terms of changes in cognitive and psychomotor behavior of students. Biochemistry Honors course is intended to provide a broad framework enabling students to acquire a skill set that helps them understand and appreciate the field of biochemistry. The structure or design of this framework shall ensure a high standard of the Honors degree in Biochemistry at national level. The programme specifications are intended as a reference point for prospective students, current students, academic in delivering the programme and realizing its objectives.

Keeping in pace with the developmental trends in Biochemistry and allied areas, it is expected that the students undertaking Biochemistry (Honours) course become conversant with the essence of Biochemistry and exhibit certain levels of learning outcomes as proposed below;

PROGRAMME OUTCOME (PO)

PO1- To create interest in Biochemistry and appreciation for chemical basis of biological processes.

PO2- To inculcate the spirit of inquiry and value of systematic study of a discipline. Provide a general understanding of the related disciplines with a holistic knowledge generation in biological sciences.

PO3- To provide an in-depth understanding of chemical reaction mechanisms in biological processes.

PO4- To provide a flavor of historical developments of enzymes and their applications in research, diagnostics and various industries.

PO5- Gain proficiency in basic laboratory techniques and be able to apply the scientific method to the processes of experimentation, hypothesis testing, data interpretation and logical conclusions.

PO6- Develop problem solving and analytical skills through case studies, research papers and hands-on-experience

PO7- To appreciate biochemical mechanistic basis of physiological processes, metabolism under normal and pathological conditions importance and levels of metabolic regulations. **PO8-** to apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well-designed posters and slides in talks aimed at scientific audiences as well as the general public.

PO9- To bridge the knowledge and skill gap between academic and industry requirements.

PO10- To give students experience in conducting independent, hypothesis-driven, biological research, project planning and management

PO11- To provide skills to publish research findings, and awareness of IP rights, and scientific publication ethics and problems of plagiarism.

PO12- To prepare competent human resource with better knowledge, hands-on-experience and scientific attitude, at national and global levels for careers in research and development, academia and Pharma-, biotech- and agro-, and food processing industries.

Graduate Attributes B.Sc. BIOCHEMISTRY (Honours):

Graduates with strong academic knowledge, discipline-specific and generic skills complemented with social responsibility are greatest asset of the country. The curriculum frame work under NEP for Biochemistry graduates aims to build the following attributes;

Disciplinary Knowledge:

- a) Ability to comprehend fundamental concepts of biology, chemistry and apply basic principles of chemistry to biological systems.
- b) Ability to relate various interrelated physiological and metabolic events.
- c) Ability to critically evaluate a problem and resolve to challenge blindly accepted concepts
- d) Ability to think laterally and in an integrating manner and develop interdisciplinary
- e) Good experimental and quantitative skills and awareness of laboratory safety
- f) A general awareness of current developments at the forefront in biochemistry and allied subjects.
- g) Awareness of resources, and their conservation.

Communication Skills:

- a) Ability to speak and write clearly in English and local language
- b) Ability to listen to and follow scientific viewpoints and engage with them.
- c) Ability to understand and articulate with clarity and critical thinking one's position.

Critical Thinking:

- a) Ability to conceptualize critical readings of scientific texts in order to comprehend.
- b) Ability to place scientific statements and themes in contexts and also evaluate those in terms of generic conventions.

Problem Solving:

Ability makes careful observation of the situation, and applies lateral thinking and analytical skills.

Analytical Reasoning:

- a) Ability to evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments.
- b) Ability to use scientific evidences and experimental approach to substantiate one's argument in one's reading of scientific texts.

Research Skills:

- a) Ability to formulate hypothesis and research questions and to identify and consult relevant sources to find answers.
- b) Ability to plan and write a research paper.

Teamwork and Time Management:

a) Willingness to participate constructively in class room discussions and contribute to groupwork.

b) Ability to meet a deadline.

Scientific Reasoning:

a) Ability to analyze theories and beliefs, evaluate ideas and scientific strategies.

b) Ability to formulate logical and convincing arguments.

Reflective Thinking:

Ability to locate oneself and see the influence of location - regional, national, global on critical thinking.

Self-Directing Learning:

a) Ability to work independently in terms of organizing laboratory, and critically analyzing scientific literature.

b) Ability to postulate hypothesis, questions and search for answers.

Digital Literacy:

Ability to use digital resources, and apply various platforms to convey and explain concepts of biochemistry.

Multicultural Competence:

Ability to engage with and understand cultures of various nations and respect and transcend differences.

Moral and Ethical Values:

a) Ability to interrogate one's own ethical values, and to be aware of ethical and environmental issues.

b) Ability to read values inherited in society and criticism vis-a-vis, the environment, religion, spirituality, and structures of power.

Leadership qualities:

Ability to lead group discussions, to formulate questions related to scientific and social issues.

Life-long Learning:

Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day business.

Job opportunities in Biochemistry Core Course

Exit After ONE Year: CERTIFICATE COURSE

Knowledge	Skill Acquired	Employability
Fundamental properties of elements, atoms, acids and bases, metals, non-metals, alloys and composites. Biological significance of elements. Understanding of chemical bonding, Physical properties of molecules, chemistry of toxic chemicals. Colligative properties, Properties of matter and electro chemistry, fundamentals and applications of nuclear and radio chemistry. Classification, structure, reactivity and biological significance of major organic compounds. A general scientific spirit of inquiry	Numerical calculations, data generation and analysis, including the application of data transformations. Laboratory, safety and precautions, proficiency in preparation of laboratory reagents, use of glassware, Demonstration of basic oxidation and reduction reactions, primary and secondary standards. Handling basic instruments. Communication interpersonal and leadership skills, and ability enhancements complementing the core biochemistry, Entrepreneurship	Small and medium size chemistry/pharma based laboratories; as Jr. laboratory assistant assisting chemists/scientists. QC assistants in Laboratories dealing with QC service. Toiletries, chemicals, perfumery, oil industries, distilleries/textiles/ pollution control units Entrepreneurship

Exit After two Years: Diploma COURSE

Knowledge	Skill Acquired	Employability
Basic chemistry of natural compounds, alkaloids, terpenes, heterocyclic compounds, drugs, stereochemistry, biological relevance of these compounds, outlines of Photochemistry and environmental chemistry. History of Biochemistry, Comprehensive knowledge and hand-on training in laboratory techniques of biochemistry. Analytical instrumentation and methodology	Acquaintance with analytical techniques that will permit them to study the biological system. Demonstrating skills of fractionating organic compounds. Hands on experience of handling instruments and analysis of data. Improving personality traits, team work, organizing abilities. Communication skills	Assistants in Health care/paramedical laboratories. Supervision and maintenance of laboratories QC assistants in analytical laboratories dealing with biochemical/clinical/Food processing/pharma industrial settings. Marketing Entrepreneurial opportunities, Material safety data sheet maintenance, curation of chemical/drug stores, chemical storekeeping

Exit After three Years: B.Sc. degree

Knowledge	Skill Acquired	Employability
Comprehensive knowledge of biomolecules: higher order structures of proteins, nucleic acids and their functions. Bioenergetics, metabolism, enzyme kinetics, basic molecular biology, industrial microbiology, Immunology recombinant DNA technology. Understanding interrelated physiological and metabolic events. Overall knowledge of the avenues for research and higher academic achievements in the field of biochemistry and allied subjects.	Basic skills in clinical laboratory techniques, Immunology and molecular biological experimental skills. Demonstrate the overall ability to independently design experiment and analyse data. Basic statistical handling of data. Oral and written skills to convey scientific experimental results. Ability to understand research findings and disseminate to common public. Teaching skills	Scientific assistants in biotech based industries. Chemical /pharma/animal feeds/ scientific data mining, / Forensic science labs. Blood Banks, Public health support staff, Clinical research, Drug discovery R&D, Medical coding, medical transcription, Medical content writing Teaching at secondary school level

B.Sc. (Hons.) After four Years: B.Sc. degree

Knowledge	Skill Acquired	Employability
Introduction to advanced concepts in Biochemistry; Molecular Biology, Recombinant DNA technology, Clinical Biochemistry/ Plant Biochemistry, Immunology, Nutrition and Dietetics, Biochemical Pharmacology, Research methodology, Intellectual property rights, Bioinformatics skills, data analysis, Pharmacogenomics, Introduction to Intellectual property rights. A strong theoretical and practical knowledge of clinical and molecular setting, core research exposure.	Skills to isolate identify and assay the biomolecules. Conducting independent research as part of project work. Hand on training in modern techniques in molecular biology. R-DNA techniques Computation skills, Prism, graph pad, Excel, Scientific writing skills: general articles, research reviews, Debating on scientific inventions and social implications.	Research staff, Clinical Biochemist, Forensic science technician, Biomedical scientist, Nutrition Dept. Pharma industry, Clinical research industries, R&D divisions of Pharma industries, Vaccine industry. Medical coding, Bioinformatics, Medical content writing, Patent examiner, Toxicological asst. Medical Science Liaison officer, Environmental science

CURRICULUM STRUCTURE FOR UNDERGRADUATE DEGREE PROGRAM
(Inputs to this document: Program Outcomes of a program, List core courses of the same program)

A) Name of the Degree: B.Sc.

B) Specialization: Biochemistry

C) Program Articulation Matrix:

This matrix lists only the core courses. Core courses list the courses that are essential for every student to earn his degree.

It includes all types of courses (theory, lab, tutorial, Project, Internships ... that every student of the course). Electives are not part of this list.

Semester	Name of the Core course	What all program outcomes the course addresses (not exceeding three per course)	Pre-requisite course(s)	Concurrent course#	Pedagogy##	Assessment\$	
1	BIO A1	PO1 AND PO2	CHEMISTRY/BIOLOGY	CORE COURSE PRACTICALS	MOOC, Desk work,	Class work Seminar Assignment Class Tests Open discussion	
	BIO B1						
2	BIO A2	PO2 AND PO3					
	BIO B2						
3	BIO A3	PO3 AND PO4					
	BIO B3						
4	BIO A4	PO5 AND PO6	BIOA1 , BIOA2			Problem solving, Book Chapter Seminar, Project based	
	BIO B4						
5	BIO A5	PO6 AND PO7					
	BIO A6	PO4 AND PO5					
	BIO B5						
6	BIO A7	PO8 AND PO9					
	BIO A8	PO4 AND PO8,PO9					
	BIO B6						
7	BIO A9	PO7 AND PO8		CORE COURSE PRACTICALS	learning, Term paper Assignment, Group Discussion	Articles writing, Interpretation of results Articles writing, Project proposal writing	
	BIO A10	PO10 AND PO9					
	BIO A11	PO9 AND PO10					
8	BIO A12	PO9 AND PO10					
	BIO A13	PO10,PO11 AND PO12			Research Project Instrumentation		
	BIO A14	PO11 AND PO12					
#Concurrent course is a core (lab / tutorial / project/ ...) course that a student has to take along with this course in the same semester for effective learning. Course design of concurrent courses is preferred to be done by the same team.							
##Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. This list includes active learning / course projects / Problem Based or Project Based Learning / Case studies /Self-study like seminar, term paper or MOOC)							
\$Every course needs to include assessment for higher order thinking skills (Applying / Analyzing / Evaluating / Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for learning)							

IIA Model Program Structures for the Under-Graduate Programs in Universities and Colleges in Karnataka
Example: Bachelor of Science (Basic/ Hons.) etc. (with Botany & Zoology as subjects with practical) with one major and one minor

Sem	Discipline Core (DSC) (Credits) (L+T+P)	Discipline Elective(DSE) / Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Courses (AECC), Languages (Credits) (L+T+P)		Skill Enhancement Courses (SEC)			Total Credits
					Skill based (Credits) (L+T+P)	Value based (Credits) (L+T+P)		
I	Botany A1(4+2) Zoology B1(4+2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs. each)		SEC-1: Digital Fluency (2) (1+0+2)	Physical Education for fitness(1)(0+0+2)	Health &Wellness (1) (0+0+2)	25
II	Botany A2(4+2) Zoology B2(4+2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs. each)	Environmental Studies (2)		Physical Education - Yoga(1) (0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1)(0+0+2)	25
Exit option with Certificate (50 credits)								
III	Botany A3(4+2) Zoology B3(4+2)	OE-3 (3)	L1-3(3), L2-3(3) (4 hrs. each)		SEC-2: Artificial Intelligence (2)(1+0+2)	Physical Education- Sports (1) (0+0+2)	NCC/NSS/R&R(S&G)/Cultural (1)(0+0+2)	25
IV	Botany A4(4+2) Zoology B4(4+2)	OE-4 (3)	L1-4(3), L2-4(3) (4 hrs. each)	Constitution of India (2)		Physical Education -Games (1) (0+0+2)	NCC/NSS/R&R(S&G)/Cultural (1)(0+0+2)	25
Exit option with Diploma in Science (100 credits) OR Choose any one of the core subjects as Major and the other as Minor								
V	Botany A5(3+2) Botany A6(3+2) Zoology B5(3+2)	Vocational-1 (3)			SEC-3: SEC Cyber Security (2) (1+0+2)			20
VI	Botany A7(3+2) Botany A8(3+2) Zoology B6(3+2)	Vocational-2 (3) Internship (2)			SEC-4: Professional Communication (2)			22
Exit option with Bachelor of Science Degree, B. Sc. Degree in Biological science (142 credits) or continue studies with the Major in the third year								
VII	Botany e A9(3+2) Botany A10(3+2) Botany e A11(3)	Botany E-1 (3) Botany E-2 (3) Res. Methodology (3)						22
VIII	Botany e A12(3+2) Botany A13(3) Botany A14(3)	Botany E-3 (3) Research Project (6)*						20
Award of Bachelor of Science Honours Degree, B.Sc.(Hons.) Degree in Botany (184 credits)								

**II A model programme structure for the under-graduate programs in universities and colleges [subjects with practicals]
[with Major Biochemistry and one minor]**

Sem	Discipline Core (DSC) (Credits) (L+T+P)	Discipline Elective(DSE) / Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Courses (AECC), Languages (Credits) (L+T+P)		Skill Enhancement Courses (SEC)			Total Credits
					Skill based (Credits) (L+T+P)	Value based (Credits) (L+T+P)		
I	Biochem A1(4+2) Minor B1(4+2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs. each)		SEC-1: Digital Fluency (2) (1+0+2)	Physical Education for fitness(1)(0+0+2)	Health &Wellness (1) (0+0+2)	25
II	Biochem A2(4+2) Minor B2(4+2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs. each)	Environmental Studies (2)		Physical Education - Yoga(1) (0+0+2)	NCC/NSS/R&R(S&G)/Cultural (1)(0+0+2)	25
Exit option with Certificate (50 credits)								
III	Biochem A3(4+2) Minor B3(4+2)	OE-3 (3)	L1-3(3), L2-3(3) (4 hrs. each)		SEC-2: Artificial Intelligence (2)(1+0+2)	Physical Education-Sports (1) (0+0+2)	NCC/NSS/R&R(S&G)/C ultural (1)(0+0+2)	25
IV	Biochem A4(4+2) Minor B4(4+2)	OE-4 (3)	L1-4(3), L2-4(3) (4 hrs. each)	Constitution of India (2)		Physical Education - Games (1) (0+0+2)	NCC/NSS/R&R(S&G)/C ultural (1)(0+0+2)	25
Exit option with Diploma in Science (100 credits) OR Choose any one of the core subjects as Major and the other as Minor								
V	Biochem A5(3+2) Biochem A6(3+2) Minor B5(3+2)	Vocational-1 (3)			SEC-3: SEC Cyber Security (2) (1+0+2)			20
VI	Biochem A7(3+2) Biochem A8(3+2) Minor B6(3+2)	Vocational-2 (3) Internship (2)			SEC-4: Professional Communication (2)			22
Exit option with Bachelor of Science Degree, B. Sc. Degree in Biological science (142 credits) or continue studies with the Major in the third year								
VII	Biochem e 9(3+2) BiochemA10(3+2) Biochem e 11(3)	Biochem E-1 3) Biochem E-2 3) Res. Methodology(3)						22
VIII	Biochem e12(3+2) Biochem A13(3) Biochem A14(3)	Biochem E-33) Research Project (6)*						20
Award of Bachelor of Science Honours Degree, B.Sc.(Hons.) Degree in Botany (184 credits)								

*In lieu of the research Project, two additional elective papers/ Internship may be offer

Programme structure for the under-graduate programs in universities and colleges [subjects with practical] [with Major Biochemistry]

Sem.	Discipline Core (DSC) (L+T+P)	Discipline Elective(DSE) / Open Elective (OE)	Ability Enhancement Compulsory Courses (AECC), Languages (L+T+P)		Skill Enhancement Courses (SEC)			Total Credits
					Skill based (L+T+P)	Value based (L+T+P)		
I	BIOCHEM A1 (4 + 2) CHEMICAL FOUNDATIONOF BIOCHEMISTRY -1 DISCIPLINE B1 CHEMICAL FOUNDATIONOF BIOCHEMISTRY -1 PRACTICALS – 1	OE – 1 (3) BIOCHEMISTRY IN HEALTH AND DISEASES	L1-1 (3), L2-1 (3)		SEC-1: Digital Fluency (2)	Physical Education for fitness(1)(0+0+2)	Health &Wellness (1)(0+0+2)	25
II	DISCIPLINE A2(4 + 2) CHEMICAL FOUNDATIONOF BIOCHEMISTRY -2 DISCIPLINE B2 CHEMICAL FOUNDATIONOF BIOCHEMISTRY -2 PRACTICALS – 2	OE – 2 (3) NUTRITION AND DIETETICS	L1-2(3), L2-2 (3) (3+1+0 each)	Environme ntal Studies (2)		Physical Education – Yoga (1) (0+0+2)	NCC/NSS/R&R(S&G) / Cultural (1)(0+0+2)	25
Exit option with Certificate (50 credits)								
III	DISCILINE A3(4 + 2) BIOORGANIC CHEMISTRY DISCIPLINE B3 BIOORGANIC CHEMISTRY	OE – 3 (3) BIOCHEMICAL TECHNIQUES	L1-3 (3), L2-3(3) (3+1+0 each)		SEC-2: Artificial Intelligence (2)(1+0+2)	Physical Education- Sports (1) (0+0+2)	NCC/NSS/R&R(S&G) /Cultural (1)(0+0+2)	25
	PRACTICALS – 3							
IV	DISCIPLINE A4(4 + 2) ANALYTICAL BIOCHEMISTRY DISCIPLINE B4 ANALYTICAL BIOCHEMISTRY	OE – 4 (3) BIOCHEMICAL TOXICOLOGY	L1-4 (3), L2-4(3) (3+1+0 each)	Constitu tion of India (2)		Physical Education - Games (1) (0+0+2)	NCC/NSS/R&R(S&G) /Cultural (1)(0+0+2)	25
Exit option with Diploma (100 credits)								
Choose any one Discipline as Major, the other as the Minor								
V	DISCIPLINE A6 (3 + 2) HUMAN PHYSIOLOGY ANDCELL BIOLOGY DISCIPLINE B5 (3 + 2) BIOCHEMISTRY OF	Vocational 1 (3) BASIC MOLECULAR BIOLOGY			SEC-3: Cyber Security (2) (1+0+2)	Ethics & Self Awareness (2) (1+0+2)		20

	MACROMOLECULES PRACTICALS – 5 & 6							
VI	DISCIPLINE A7 (3 + 2) ENZYMOLOGY DISCIPLINE A8 (3 + 2) INTERMEDIARY METABOLISM DISCIPLINE B6 (3 + 2) BIOENERGETICS AND METABOLISM PRACTICALS – 7 & 8	Vocational-2 (3) Internship (2)			SEC-4: Professional/ Societal Communication(2)			22
Exit option with Bachelor of Arts, B.A. / Bachelor of Science, B. Sc. Basic Degree (142 credits)								
VII	DISCIPLINE A9 (3 + 2) MOLECULAR BIOLOGY DISCIPLINE A10 (3 + 2) BIOCHEMISTRY OF HARMONES PRACTICALS – 9 & 10 DISCIPLINE A11 (4) MEMBRANE BIOCHEMISTRY	DSE A3 (3) BASIC IMMUNOLOGY RESEARCH METHODOLOGY (3)						
VIII	DISCIPLINE A12 (4) MOLECULAR IMMUNOLOGYDISCIPLINE A13 (4) GENETIC ENGINEERING DISCIPLINE A14 (3) PLANT BIOCHEMISTRY	DSE A4 (3) BIOSTATISTICS AND BIOINFORMATI CS RESEARCH PROJECT(6)						
Award of Bachelor of Science/ B.Sc. BIOCHEMISTRY (Hons) degree in a discipline (176 credits)								

*In lieu of the research Project, two additional elective papers/ Internship may be offer

Scheme for Theory and Practicals

Biochemistry as Major

Sem	Code	Title of the paper	Lecture/ practical per week	Duration of exam	IA marks	Max Marks	Total	Credits
I	BC101	Biochemistry-I	04	02	40	60	100	4
	BC102	Practical-I	04	03	25	25	50	2
II	BC201	Biochemistry -II	04	02	40	60	100	4
	BC202	Practical -II	04	03	25	25	50	2
III	BC301	Biochemistry -III	04	02	40	60	100	4
	BC302	Practical -III	04	03	25	25	50	2
IV	BC401	Biochemistry -IV	04	02	40	60	100	4
	BC402	Practical -IV	04	03	25	25	50	2
V	BC501	Biochemistry -V	03	02	40	60	100	3
	BC502	Biochemistry -VI	03	02	40	60	100	3
	BC503	Practical -V	04	03	25	25	50	2
	BC504	Practical -VI	04	03	25	25	50	2
	BC505	VOC-1	03	03	40	60	100	3
VI	BC601	Biochemistry -VII	04	02	40	60	100	3
	BC602	Biochemistry -VIII	04	02	40	60	100	3
	BC603	Practical -VII	04	03	25	25	50	2
	BC604	Practical -VIII	04	03	25	25	50	2
	BC605	VOC-2	03	03	40	60	100	3
	BC606	Internship	02	-	25	25	50	2
VII	BC701	Biochemistry -IX	04	02	40	60	100	3
	BC702	Biochemistry -X	04	02	40	60	100	3
	BC703	Practical -IX	04	03	25	25	50	2
	BC704	Practical -X	04	03	25	25	50	2
	BC705	Biochemistry -XI	03	02	40	60	100	3
	BC706	Biochemistry -E1	03	02	40	60	100	3
	BC707	Biochemistry E2	03	02	40	60	100	3
	BC708	Res Methodology	03	02	40	60	100	3
VIII	BC801	Biochemistry -XII	04	02	40	60	100	3
	BC802	Practical -XI	04	02	25	25	50	2
	BC803	Biochemistry -XIII	03	02	40	60	100	3
	BC804	Biochemistry -XIV	03	02	40	60	100	3
	BC805	Biochem-E3	03	02	40	60	100	3
	BC806	Research Project	06					6

Scheme for Theory and Practicals

Biochemistry as Minor

Sem	Code	Title of the paper	Lecture/ practical per week	Duration of exam	IA marks	Max Marks	Total	Credits
I	BC101	Biochemistry -I	04	03	40	60	100	4
	BC102	Practical-I	04	03	25	25	50	2
II	BC201	Biochemistry -II	04	03	40	60	100	4
	BC202	Practical -II	04	03	25	25	50	2
III	BC301	Biochemistry -III	04	03	40	60	100	4
	BC302	Practical -III	04	03	25	25	50	2
IV	BC401	Biochemistry -IV	04	03	40	60	100	4
	BC402	Practical -IV	04	03	25	25	50	2
V	BC501	Biochemistry -V	03	03	40	60	100	3
	BC503	Practical -V	04	03	25	25	50	2
VI	BC601	Biochemistry -VII	04	03	40	60	100	3
	BC602	Practical -VII	04	03	25	25	50	2

SEMESTER -1

COURSE TITLE : CHEMICAL FOUNDATION OF BIOCHEMISTRY -1	COURSE CREDITS: 4
TOTAL CONTACT HOURS: 56	DURATION OF ESA : 02
FORMATIVE ASSESSMENT MARKS : 40	SUMMATIVE ASSESSMENT MARKS : 60

Course Outcome:

This will inculcate confidence and clarity of mind in students to understand the chemistry of Biomolecules, and Biological reactions.

UNIT -1: Scope of Biochemistry and units of measurement

Origin of life, types of organisms, prokaryotes, eukaryotes, unicellular, multicellular, compartmentation of functions in lower and higher organisms, and common physiological events of organisms, chemical composition of living organisms, subcellular organelles, SI units, mass, volume, temperature, amount, length and time. An overview on the metric system, atomic weight, molecular weight, equivalent weight, basicity of acids, acidity of bases, Avogadro's number, molarity, normality, molality, Dalton concept, mole concept, concentration, mole to molar conversion, oxidation number and its significance, density and specific gravity, their significances. 14hrs

UNIT -2: Atomic structure and chemical bonds

Structure of an atom, , electrons and Quantum numbers, orbitals, shapes of orbitals, s, p, d, and f subshells, K, L, M, N, O, P, and Q shells. Illustration of Pauli's exclusion principle, Aufbau principle, and Hund's rule, electron configuration, octet rule. Formation and properties of non- covalent and covalent bonds, hydrogen bonds, ionic bonds, van der Waals interactions, London forces, dipole-dipole interactions, electrostatic interactions, and hydrophobic interactions. Sigma, pi and co-ordinate bonds, back bonding. Corresponding energy associated, outline of theories of bonding. 14 hrs

UNIT-3: Buffers and Colligative properties

Acids, bases, Arrhenius concept, proton transfer theory, Lewis concept, Lowry and Bronsted concepts. Buffers, composition, pH, pH scale, Henderson-Hasselbalch equation, titration curve of H_3PO_4 , pK value, isoelectric pH, ionization of HCl , HNO_3 , H_2SO_4 . Colligative properties and anomalous colligative properties of solutions, structure of water, phase diagram of pure water, ionic product of water, special properties of water, buffers in animal system. Solutions and types, ionizable solutes, non-ionizable solutes, vapor pressure and its application in distillation, Vant Hoff law, Roul't's law, boiling point, freezing point, de-icing, osmosis and osmotic pressure determination, reverse osmosis, surface tension. 14 hrs

UNIT – 4 : Electrochemistry and redox reactions

Scope of electrochemistry, electrochemical cells, Daniel cell, galvanic cell, electrode potential and its measurement, electrolysis, types of electrolytes, primary and secondary batteries, electrodes, half cell reaction, standard electrodes. Laws of thermodynamics, entropy and enthalpy, their relation, Gibb's energy, free energy change, Lewis concept, ions, redox reactions, redox potential, application of redox potential, energy linked to redox reactions, reduction of oxygen, oxidation and reduction of iron in hemoglobin, biological active forms of zinc, calcium, nickel, molybdenum, selenium, and cobalt, NAD^+/NADH , $\text{NADP}^+/\text{NADPH}$, FAD/FADH_2 , FMN/FMNH_2 . Molecularity and order of a reaction. 14 hrs

REFERENCES:

1. Advanced Inorganic Chemistry: A comprehensive Text, 1999, Cotton A and Geoffrey Wilkinson, 6th edition , Wiley publication
2. Inorganic Chemistry, 2014, Miessler GL , Paul Fischer PJ, and Tarr DA, 5th edition, Pearson Publication
3. Inorganic Chemistry, 2004, Catherine E and Sharpe AG, ACS publication
4. Inorganic Chemistry , 2015, Overton, Rourke , Weller , Armstrong and Hagerman, Oxford Press
5. Physical Chemistry: A molecular approach , 2019, Donald A, McQuarrie and Simon JD, VivaBooks Publication
6. Physical chemistry 2019, Atkins P, Paula JD, Keeler J , 11th edition , Oxford press

PEDAGOGY : MOOK/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	WEIGHTAGE IN MARKS
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER -1 PRACTICALS - 1

COURSE TITLE : VOLUMETRIC ANALYSIS – PRACTICALS-1	COURSE CREDITS: 2
TOTAL CONTACT HOURS: 4 Hours/ Week	DURATION OF ESA : 03
FORMATIVE ASSESSMENT MARKS : 25	SUMMATIVE ASSESSMENT MARKS : 25

Course Outcome:

This course aims to familiarize students with the principles of analytical chemistry and basic analytical techniques such as volumetric analysis. Course Objective is to provide experimental practice of quantitative volumetric analysis. Upon successful completion students should be able to make solutions of various molar, normal concentrations and determine the amount of a substance in a given sample.

Experiments:

1. Concept of molarity, molality and normality. Calculation and preparation of molar solutions. (Problems to be given in exams). Calculation and preparation of normal solutions and percent solutions and dilute solutions.
2. Calibration of volumetric glassware's (Burette, pipette).
3. Preparation of standard Sodium carbonate solution, standardization of HCl (Methyl orange) and estimation of NaOH in the given solution. (methyl orange or phenolphthalein).
4. Preparation of standard Oxalic acid. Standardization of NaOH and estimation of H₂SO₄ in the given solution (phenolphthalein).
5. Preparation of standard Oxalic acid. Standardization of KMnO₄ and estimation of H₂O₂ in the given solution.

6. Preparation of standard $K_2Cr_2O_7$. Standardization of $Na_2S_2O_3$ and estimation of $CuSO_4$ in the given solution.
7. Preparation of $ZnSO_4$. Standardization of EDTA and estimation of total hardness of water using Eriochrome black-T indicator.
8. Preparation of standard potassium biphthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
9. Estimation of sulphuric acid and oxalic acid in a mixture using standard sodium hydroxide solution and standard potassium permanganate solution.
10. Preparation of standard Potassium dichromate and estimation of ferrous/ferric mixture using diphenylamine indicator (Demonstration).
11. Preparation of standard oxalic acid solution. Standardization of NaOH solution and estimation of acidity in vinegar.
12. Preparation of standard potassium biphthalate solution, standardization of sodium hydroxide solution and estimation of alkalinity of antacids.
13. Preparation of standard Oxalic acid solution. Standardization of $KMnO_4$ solution and estimation of calcium in milk.

REFERENCES:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,
4. Principles of Practical Chemistry- M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.
6. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
7. Advanced Practical Physical Chemistry J.B. Yadav, Goel Publishing House
8. Advanced Experimental Chemistry. Vol-I J.N. Gurtu and R Kapoor, S.Chand and Co.
9. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
10. General Chemistry experiment – Anil J Elias (University press).
11. Vogel textbook of quantitative chemical analysis G.H. Jeffery, J. Basset.
12. Quantitative chemical analysis S. Sahay (S. Chand & Co.).
13. Practical Chemistry Dr O P Pandey, D N Bajpai, Dr S Giri. S. Chand Publication
14. College Practical Chemistry. V K Ahluwalia, Sunitha Dingra, Adarsh Gulati
15. Practical Physical Chemistry- B. Viswanathan, P S Raghavan. MV Learning Publication

PEDAGOGY : PADAGOGY : MOOK/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	WEIGHTAGE IN MARKS
CONTINUOUS EVALUATION AND CLASS TEST	15
RECORD / VIVA VOCE	5+5
TOTAL	25

SEMESTER - II

COURSE TITLE : CHEMICAL FOUNDATION OF BIOCHEMISTRY -2	COURSE CREDITS: 4
TOTAL CONTACT HOURS: 56	DURATION OF ESA : 02
FORMATIVE ASSESSMENT MARKS : 40	SUMMATIVE ASSESSMENT MARKS : 60

Course Outcome: These topics will enable students to understand the fundamentals of chemical processes in biological systems

UNIT 1. Chemical Kinetics and Colloids: Introduction, Rate of reactions, rate law or Rate equation, Molecularity and order of a reaction with examples, velocity constant or rate constant and half-life period expressions for zero, first and second order reactions with derivations ($a=b$ and $a \neq b$), Numerical problems. Effect of temperature, Pressure and catalyst on rate of reaction, Arrhenius equation and Arrhenius interpretation of energy of activation, Transition state theory with brief explanation. Colloids: True solutions, classification, Brownian movements, electric properties, coagulation, mutual lyophilic sols, peptisation, purification, ultrafiltration, dialysis, electro and persistent dialysis, addition of electrolytes, colloids in daily life and applications. Emulsion, types, micelles with biomolecules and its Biological applications. 14 Hours

UNIT 2. Nomenclature of Organic Compounds: Classification, naming, IUPAC nomenclature, compounds containing one, two functional groups with chains, homologous series. Stereochemistry, geometrical and structural Isomerism, conformation and free rotation. Optical isomerism, symmetry of elements, plane polarized light and optical purity. Nomenclature of enantiomers, epimers, racemic mixture, resolution. Fischer and Newmann projection formulae, molecule with one and two chiral and achiral centers. Priority rules; E and Z (CIP rules), R and S, D and L notations, absolute (r and s) and relative (d and l) configuration. Role of stereochemistry in biological systems. 14 Hours

UNIT 3. Organometallic Compounds: Metal atom linked organic compounds. Preparation of Grignard reagents and structure, limitations, protonolysis and reactions. Organolithium compounds, preparation and reactions. Organozinc compounds. Organoboranes its mechanisms. Ferrocenes. Introduction to mineral and ores, classification, concentration, extraction, refining, uses of minerals and metals and its importance.

Porphyrins and Metal ions: Role of metal ions in biological systems, Fe, Cu, Zn, structure and functions of porphyrins, metalloporphyrins and iron-sulphur clusters with suitable examples and their role in biological systems. 14 Hours

UNIT 4. Inorganic Chemistry: Nomenclature of inorganic molecules and coordination compounds, formula. IUPAC nomenclature. Central metal ion, ligand, coordination number, sphere, complex ion, oxidation number of central atom, homoleptic and heteroleptic complexes. Isomerism in complexes, structural, ionisation, solvate, linkage and coordination Stereoisomerism, geometrical, optical isomerism with simple inorganic complexes. Applications of qualitative, quantitative analysis, photographic, metallurgy, medicine, catalysis and biosystems.

Heavy Metal Poisons: Introduction, poisons, lead, mercury, aluminium, arsenic, corrosives, cyanide, irritants, phosphorus, CO_2 , SO_2 , SO_3 , NO_2 , halides and acid fumes, poisoning, sources, signs and symptoms. Free radicals: introduction, definition, generation and scavenger systems. Redox reactions, types, stock notations, change in oxidation number and combination. Endergonic and exergonic reactions with examples. The Importance in biological systems. 14 Hours

REFERENCES

1. Physical Chemistry 2006, Peter Atkins. 8th edition, W.H. Freeman and Company
2. Inorganic Chemistry: Principles of structure and Reactivity, 2006, Huheey JE, Keiter EA, Keiter RL, Pearson Education India
3. Stereochemistry: Conformation and Mechanism, 2009, Kalsi PS, New Age International Publications
4. Introduction to Stereochemistry 2012, Kurt Mislow, Dover Publications
5. A text book of Organic Chemistry 2016, Raj K Bansal, 6th edition, New Age International Publications
6. Advanced Inorganic Chemistry 1999, Cotton et al, 6th edition, A Wiley - International

TEXT BOOKS

1. Principles of physical Chemistry by Puri, Sharma and Pathania.
2. Physical Chemistry by R. L. Madan, G. D. Tuli. S. Chand and Co.
3. A Text Book of Physical Chemistry by K. L. Kapoor. Vol. 2. Mc. Millan Publisher, India Ltd.
4. Advanced Organic Chemistry by Bahl and Bahl.

PEDAGOGY : MOOK/DESK WORK/BOOK CHAPTER/PROBLEMSOLVING/
ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	WEIGHTAGE IN MARKS
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER - II PRACTICALS - 2

COURSE TITLE: QUALITATIVE AND QUANTITATIVE ANALYSIS – PRACTICALS – 2	COURSE CREDITS: 2
TOTAL CONTACT HOURS: 4 Hours/ Week	DURATION OF ESA : 03
FORMATIVE ASSESSMENT MARKS : 25	SUMMATIVE ASSESSMENT MARKS : 25

Course Outcome: The Course Objective is to provide experimental practice of quantitative and qualitative analysis. Also it provides training in physical chemistry laboratory techniques. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

Experiments:

1. Semi micro Qualitative Analysis of Inorganic salt Mixtures
Systematic semi micro qualitative analysis of two acid and two basic radicals in the given inorganicsalt mixture. The constituent ions in the mixture to be restricted to the following. (Any four binary mixtures shall be given)

Anions: HCO_3^- , CO_3^{2-} , Cl^- , Br^- , NO_3^- , BO_3^{3-} , SO_4^{2-} and PO_4^{3-} .

Cations: Pb^{2+} , Al^{3+} , Fe^{2+} , Fe^{3+} , Mn^{2+} , Zn^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Mg^{2+} , K^+ , Na^+ and NH_4^+ .

- Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.
- Determination of density and surface tension of the given liquid using specific gravity bottle and stalagmometer.
- Determination of molecular weight of non-volatile solute by Walker-Lumsden method.
- Determination of rate constant of decomposition of H_2O_2 using KMnO_4 by volumetric analysis method using ferric chloride as catalyst.
- Determination of distribution coefficient of benzoic acid between water and benzene or iodine between water and carbon tetrachloride.
- Separation of Two Components from given Binary Mixture of Organic Compounds Qualitatively. (Types of binary mixtures- Solid – Solid, Solid – Liquid, Liquid – Liquid)
- Verification of Beer's Law. Estimation of unknown concentration of a biomolecule by using colorimeter
- Calibration of pH meter and determination of pH of aerated soft drinks.

REFERENCES:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
- Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,
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- Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
- Advanced Practical Physical Chemistry J.B. Yadav, Goel Publishing House
- Advanced Experimental Chemistry. Vol-I J.N. Gurtu and R Kapoor, S.Chand and Co.
- Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
- General Chemistry experiment – Anil J Elias (University press)
- Vogel textbook of quantitative chemical analysis G.H. Jeffery, J. Basset.
- Quantitative chemical analysis S. Sahay (S. Chand & Co.)
- Practical Chemistry Dr O P Pandey, D N Bajpai, Dr S Giri. S. Chand Publication
- College Practical Chemistry. V K Ahluwalia, Sunitha Dingra, Adarsh Gulati
- Practical Physical Chemistry- B. Viswanathan, P S Raghavan. MV Learning Publication

PEDAGOGY : MOOK/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	WEIGHTAGE IN MARKS
CONTINUOUS EVALUATION AND CLASS TEST	15
RECORD / VIVA VOCE	5+5
TOTAL	25

SEMESTER - III

COURSE TITLE : Bioorganic chemistry	COURSE CREDITS: 4
TOTAL CONTACT HOURS: 56	DURATION OF ESA : 02
FORMATIVE ASSESSMENT MARKS : 40	SUMMATIVE ASSESSMENT MARKS : 60

Course Outcome:

To appreciate the concepts of reaction mechanisms of hydrocarbons.

To understand the properties and importance of allides, alcohols and carbonyl compounds.

To know the significance of primary metabolites in living organisms such as carboxylic acids, amines and heterocyclic compounds.

To understand the significance of secondary metabolites in living organisms, such as terpenes and alkaloids.

UNIT – 1 Reaction mechanisms

Reaction mechanisms: Concept of inductive effect, resonance and hyperconjugation. Classification of organic reactions (substitution, addition, elimination and rearrangement), with two examples for each. Concepts of the following – carbanions, carbocations, carbenes, nucleophiles and electrophiles (Formation and Stability). Hydrocarbons - Mechanism of addition of HCl to propene, Markovnikov's rule. Peroxide effect, Alkenes – ozonolysis, oxidation. Alkynes – formation of acetylides and their importance. Dienes – types with examples. Conjugate dienes, 1,3-butadiene – stability, mechanism of addition of HBr. Arenes - Modern concept of structure of benzene by Resonance and molecular orbital theories, mechanism of electrophilic substitution in benzene (nitration, Friedel– Craft's alkylation and acylation). Electronic interpretation of the orienting influence of substituents in the electrophilic substitution of toluene, chlorobenzene and nitrobenzene. Aromaticity– Huckel rule ($4n+2$ rule), structure of naphthalene, anthracene.

UNIT – 2 Organic compounds

Cycloalkanes - Reactivity and relative stabilities. Baeyer strain theory, Sachse – Mohr theory, boat and chair forms of cyclohexane, axial and equatorial bonds.

Alkylhalides - SN^1 and SN^2 reaction mechanisms taking 1° , 2° & 3° alkylhalides as examples. Mechanistic concepts of elimination reactions involving tertiary butyl chloride and *n*-butyl chloride.

Alcohols and phenols - Classification, monohydric alcohols: examples, general and distinguishing reactions. Dihydric alcohols: glycols, Trihydric alcohols: glycerol – synthesis from propene, properties and uses. Classification of phenols, electronic interpretation of acidity of phenols, mechanism of Kolbe, Reimer–Tiemann and bromination reactions.

Carbonyl compounds - General properties, addition of alcohols to aldehydes and ketones. Keto-enol tautomerism. Mechanisms: addition of HCN to acetaldehyde, Claisen and aldol condensations. Quinones: *o*- and *p*-benzoquinones- structure and properties.

UNIT – 3 Primary and secondary metabolites

Introduction, types. Carboxylic Acids : Classification; hydroxy acids: preparation and properties of lactic acid; structures of tartaric, malic, citric and iso citric acids; dicarboxylic acids: saturated dicarboxylic acids- effect of heat on the first five members; ketoacids: structures, properties and reactions of pyruvic acid, α -ketoglutaric acid and oxaloacetic acid.

Amines: Classification; properties, Basicity of amines acylation isomerism; React with HNO_2 & Schiff's base formation distinguishing reactions of 1° , 2° and 3° amines; some biologically important amines (DOPA, Histamine).

Heterocyclic Compounds: Structural and nomenclature of furan, pyran, thiophene, thiazole, pyrrole, imidazole, pyridine, pyrimidine, purine, isoalloxazine and indole; biological compounds containing the

above skeletons. reactions of imidazole and pyridine; Aromaticity of furan, thiophene, pyrrole and pyridine. Steroids: Basic ring structure in steroids. Structure and biological importance of cholesterol, steroid hormones (testosterone and oestrogen), phytosterols and ergosterol. Bile acids [Mono, Di & Tri cholic acids].

Alkaloids: Introduction and general characteristics; classification based on their structure and biological functions, general method of extraction; structure and medicinal uses of nicotine, atropine, morphine and LSD.

Terpenes: Definition, isoprene rule, classification, Structure and Biological roles of menthol, camphor, farnesol, phytol, lycopene and dolichols, santonin, juvenile hormone I, abscisin II, gibberilic acid and lanosterol.

UNIT – 4 Bioorganic chemistry

Nutrients – Introduction: Concept of nutrition, calorific value of foods, different components of energy expenditure, respiratory quotient, basal metabolic rate (BMR), determination of BMR, factors affecting BMR. Carbohydrates: Dietary Sources, dietary fibers, its importance.

Proteins: Dietary sources, nutritional classification, nutritional value of proteins – PER, NPU and biological value of proteins (BV). Essential amino acids, nitrogen balance, Malnutrition- Kwashiorkor and Marasmus. Fats: Dietary sources of fats, invisible fat, essential fatty acids and their biological importance.

Minerals: Ca, P, Fe, Zn, Cu, Iodine, Fluoride, Mg, Se, Manganese, Molybdenum.

Vitamins: Classification- Water soluble & fat soluble. Structural formulae and co-enzyme forms of B1, B2, B6 and niacin. Vitamin C as red-ox reagent, Chemical synthesis of vitamin C. Structural formula of vitamin A, D, E and K.

Drugs: Classification of drugs; synthesis and uses of sulphanilamide and penicillin. Antibiotics: Definition; types; sources; structures and antimicrobial spectrum of action of penicillin, chloroamphenicol, streptomycin and tetracyclines.

Books for Reference:

1. Carey, Francis A. Organic Chemistry. VIIth Edition, Tata McGraw Hill, 2009.
2. Page, M.I. and Andrew Williams Organic and Bio-organic Mechanisms. Pearson, 2010.
3. Dugas, Hermann Bioorganic Chemistry: A Chemical Approach to Enzyme Action 3rd Edition, Springer, 2003.
4. Organic Chemistry. Vol.I. Fundamental principles. I. L .Finar. 6th Edn. ELBS
5. Organic Mechanisms, Peter Sykes, Longman, (1977).
6. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
7. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Edn. Prentice Hall, India.
8. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds], 6th Edn. Macmillan Publications (2012).
9. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn. Karen C. Timberlake, Benjamin Cummings, (1999).
10. Reaction Mechanisms at a glance, ed. M. Moloney, Blackwell Science (2000).

SEMESTER -3 PRACTICALS - 3

COURSE TITLE :	COURSE CREDITS: 2
TOTAL CONTACT HOURS: 4 Hours/ Week	DURATION OF ESA : 03
FORMATIVE ASSESSMENT MARKS : 25	SUMMATIVE ASSESSMENT MARKS : 25

Course Outcome:

Understanding good laboratory practices in a chemistry/biochemistry laboratory.

Develop skill and proficiency in preparation of laboratory reagents.

Perform systematic qualitative analysis of organic compounds.

Synthesize and evaluate biologically useful organic compounds like aspirin.

Develop skills to isolate, characterize and analyze biomolecules like cholesterol, starch and nucleic acids.

Experiments:

1. Systematic qualitative analysis of the organic compounds: glucose, Urea, aniline, phenol, nitrobenzene, naphthalene, p-toluidine, benzoic acid, salicylic acid, resorcinol and p-dichloro benzene
2. Organic preparations: Aspirin from salicylic acid, benzoic acid from benzaldehyde, p-bromoacetanilide from acetanilide and meta-dinitrobenzene from nitrobenzene
3. Isolation of cholesterol from egg yolk
4. Isolation of starch from potatoes.
5. Qualitative Identification of DNA, RNA and Nitrogen Bases

REFERENCES:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Principles and Techniques of Biochemistry and Molecular Biology
7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
4. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).
5. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
6. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood, Blackwell Science, (1993),
7. Advanced Practical Organic Chemistry, John Leonard, 2017, CRC press
8. Biochemistry: An Organic Chemistry Approach 1st Edition, by Michael B. Smith, CRC Press, 2020.

SEMESTER - IV

COURSE TITLE : Analytical Biochemistry	COURSE CREDITS: 4
TOTAL CONTACT HOURS: 56	DURATION OF ESA : 02
FORMATIVE ASSESSMENT MARKS : 40	SUMMATIVE ASSESSMENT MARKS : 60

Course Outcome:

To understand the principles of biochemical analysis employing various bioanalytical techniques.

To comprehend about general principles of various chromatographic techniques useful for bioanalysis.

To analyze biomolecules using electrophoretic methods.

To appreciate the importance of spectroscopic techniques in molecular analysis.

UNIT – 1 Biochemical investigations

Outline of strategies in biochemical investigations, models for biochemical investigations, introduction to animal cell culture and plant tissue culture, applications. Preparation of extracts for biochemical investigations. Methods of tissue homogenization: (Potter-Elvehjem, mechanical blender, sonicator and enzymatic). Centrifugation techniques, principles and applications- differential, density gradient. Ultra-centrifugation- preparative and analytical. Tracer techniques: Radio isotopes, units of radio activity, half life,

β and γ - emitters, use of radioactive isotopes in biology, ELISA, RIA.

UNIT – 2 Chromatography

General Principles of chromatography – adsorption and partition, partition coefficient, R_f values Types of chromatographic techniques,

Principle and applications – Paper chromatography- solvents, R_f value, applications; Thin layer chromatography- principle, choice of adsorbent and solvent, R_f value, applications; Gel filtration, Ion-exchange- principle, resins, action of resins, experimental techniques, applications, Affinity chromatography. HPLC: Instrumentation, mobile phases in HPLC, factors affecting resolution in HPLC chromatography. Normal and reverse, Fast protein liquid chromatography (FPLC). Gas chromatography: Principle and design of instrument. Factors affecting GC, stationary phase, mobile phase.

UNIT –3 Electrophoresis and spectroscopy.

Electrophoresis: principle, non-denaturing PAGE, denaturing electrophoresis (PAGE), SDS-PAGE, SDS-PAGE in reducing conditions, isoelectrofocusing. 2D electrophoresis, Immuno-electrophoresis: Dot blotting and immune-diffusion tests with antibodies, zone electrophoresis/immune-electrophoresis. Rocket electrophoresis, counter immune-electrophoresis, Agarose gel electrophoresis of nucleic acids.

Spectroscopic techniques: Beer and Lamberts law, Principles of colorimeter, spectrophotometer, circular dichroism (CD), CD of biomolecules (proteins) and LD (linear dichroism) of biomolecules. IR spectroscopy, NMR: Principle, biochemical application of NMR. Mass spectroscopy: Principle, experiment, ionization modes, equipments in MS analysis Uses of MS in Biochemistry.

UNIT –4 Microbiological techniques

Microscopy: Basic principles of light microscopy, phase contrast, electron microscope and fluorescent microscope and their applications. Preparation of different growth media, isolation and culturing and preservation of microbes, Gram staining- Gram positive and Gram negative bacteria, motility, and sporulation, Sterilization techniques-Physical methods, chemical methods.

Books for Reference:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Principles and Techniques of Biochemistry and Molecular Biology
4. 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
5. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old, Blackwell Science (2012).
6. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
7. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
8. Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
9. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
10. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
11. Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
12. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969)

SEMESTER -4 PRACTICALS - 4

COURSE TITLE : BIOCHEMICAL TECHNIQUES	COURSE CREDITS: 2
TOTAL CONTACT HOURS: 4 Hours/ Week	DURATION OF ESA : 03
FORMATIVE ASSESSMENT MARKS : 25	SUMMATIVE ASSESSMENT MARKS : 25

Course outcomes:

Learn various techniques useful for separation of biomolecules
Perform chromatography methods for separation of amino acids and carbohydrates
Separate and purify proteins by various chromatographic methods
Analyze proteins and nucleic acids by electrophoresis and spectrophotometry
Isolate, culture and study microorganisms in laboratory.

Experiments:

1. Separation of amino acids by paper chromatography
2. Separation of serum proteins by paper electrophoresis
3. Absorption maxima of coloured substances (p-Nitrophenol and Methyl Orange)
4. Absorption maxima of proteins (BSA) and nucleic acids
5. Separation of plant pigments using paper chromatography
6. Separation of plant pigments by column chromatography using silica gel-G
7. Demonstration of separation of lipids by TLC
8. Sterilization techniques.
9. Identification of Bacterial cells
10. Pure culture technique- Streak, Pour Plate and Serial dilution
11. Simple Staining and Gram Staining.

REFERENCES:

1. Basic Methods for the Biochemical Lab; Martin Holtz hauer, Springer, (2007).
2. Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
3. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
4. Principle and Techniques of Practical Biochemistry; Keith Wilson and John M. Walker, Cambridge University Press (2000).
5. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993).
6. Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990) .
7. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).

SEMESTER -V

COURSE TITLE : BIOCHEMISTRY OF MACROMOLECULES COURSE CODE: S21 BC 5.1	COURSE CREDITS: 4
TOTAL CONTACT HOURS: 60 hrs	DURATION OF ESA : 02
FORMATIVE ASSESSMENT MARKS : 40	SUMMATIVE ASSESSMENT MARKS : 60

CO_{Obj}_ID Course Objectives

- CO_{Obj}_1 To understand chemical basis of biological process.
CO_{Obj}_2 To revisit the fundamental concepts of correlation of macromolecules and its chemical reactions.
CO_{Obj}_3 To familiarize with understanding of significance of macromolecular structures in understanding the life process.

CO_ID Course Outcomes

- CO_1 To appreciate Biochemistry as a discipline by understanding the chemical basis of biological systems.
CO_2 To understand the basic concepts of carbohydrates structures and biological roles relevant to living cell growth and division.
CO_3 To know the significance of coordination of lipids molecules and its properties in a living cell structure.
CO_4 To understand the structural and chemical properties of amino acids and proteins in living systems.
CO_5 To understand the composition and structure of RNA and DNA that regulate the biological process.

Course Content

Carbohydrates

Biological importance ; Monosaccharides : **Elucidation of structure of glucose (open chain and ring structure);** Epimers and Anomers-definition and example ; Brief review on **configurational and conformational aspects of carbohydrates; Derived monosaccharides:** structures and biological importance of : Amino sugars: glucose amine and galactosamine and their N-acetylated forms, Sugar phosphates: Dribose-5-P,β-D-ribose-5-P,glucose-6-P and fructose -,6-diphosphate, Sugar acids: types with examples; Disaccharides: Structure of isomaltose, cellobiose and trehalose; brief discussion on reducing property; Polysaccharides: classification

with examples ; structure, properties and importance of homo and hetero polysaccharides, Structure, properties and importance of structural (cellulose and chitin) and storage polysaccharides (starch and glycogen), [Blood group and bacterial polysaccharides](#); [glycosaminoglycans](#), [cardioglycosides](#), Glycoproteins-structure and functions.

Lipids

Biological importance; Classification. Fatty acids: definition, classification, examples and structures, [properties of fatty acids: melting point, solubility, cis-trans isomerism, reaction with NaOH, alcohol, catalytic hydrogenation](#), Acylglycerols: mono, di, triacylglycerols (general, structure). Hydrolysis of acylglycerols: Saponification, saponification number; Acid hydrolysis of triglycerides, unsaturation in acyl glycerols and iodine number; [Rancidity : definition, oxidative and hydrolytic rancidity](#); Phosphoglycerides: structure and biological roles of phosphatidylcholine, phosphatidyl ethanolamine, phosphatidyl serine, phosphatidyl inositol. Sphingolipids: structure of 4- sphingenine, ceramides and sphingomyelin, biological importance. Glycosphingolipids: Biological importance and general structure of cerebrosides and gangliosides; Prostaglandins: definition and example, structure of PGE2 and PGF2 and biological role of prostaglandins in general; Thromboxanes and leukotrienes; Waxes: definition, types, biological importance; Lipoproteins: Types and functions, clinical significance; behaviour of amphipathic lipids in water; formation of micelles, bilayers and vesicles; Membrane: common features of membranes. [Steroids: definition, functions of cholic acid](#).

Amino acids and Proteins

Structure and classification of α -amino acids based on the polarity of R group; acid – base properties of amino acids. Non – standard, non–protein and biologically active amino acids. UV-light absorption property of amino acids, amino acids as ampholytes – zwitterion structure of amino acids, Isoelectric pH, titration curve of alanine; [reactions of amino acids with ninhydrin , FDNB, Edman's reagent and decarboxylation of amino acids](#); peptides: structure and conformation, biological importance of peptides.

Proteins: classification based on composition shape and function with examples; [color reactions: ninhydrin, xanthoproteic, Lowry, Sakaguchi's and Biuret reaction](#); Overview of structural organization of proteins: Primary structure- importance of restoration of primary structure by taking sickle cell anemia as example, Secondary structure-Types – α -helix, β -pleated structure, triple helix – example and characteristic features of each type; Structure of fibrous proteins: α -keratin, silk fibroin and collagen. Tertiary structure and Quaternary structure-factors stabilizing both; Structure and function of myoglobin and hemoglobin. [Denaturation-Denaturing agents and mechanism of operation, renaturation of ribonuclease-Anfinsen's experiment](#).

Nucleic acids

Structure and properties of Nucleosides and Nucleotides, configuration and conformation. Composition of RNA and DNA, Physico- chemical properties of nucleic acids - effect of alkali, acid and heat (denaturation and renaturation), features of phosphodiester bond, endonucleases. Properties of nucleic acids in solution. Structure of nucleic acids– primary, secondary and tertiary structure of DNA, Complementary base pairing, features of DNA double helix (Watson-Crick model), Secondary structure of RNA, Secondary structure of tRNA and role of secondary structure in mRNA stability. Nucleoproteins – histone and non histone. Isolation of nucleic acids and sequencing.

References:

1. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
2. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (2010), Wiley and sons.
4. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006).
5. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
6. Complex Carbohydrates, Sharon, N. Addison Wisely, (1975).
7. Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., Blackwell Scientific (1982).
8. Principles of Biochemistry; Smith et al., McGarw Hill (1986).

Formative Assessment	
ASSESSMENT OCCASION	WEIGHTAGE IN MARKS
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

PRACTICALS – V

Total Teaching Hours: 60

No. of Hours / Week: 4

COURSE TITLE : MACROMOLECULES PRACTICALS	COURSE CREDITS: 2
COURSE CODE : S21 BC 5.2	
TOTAL CONTACT HOURS: 4 Hours/ Week	DURATION OF ESA : 03
FORMATIVE ASSESSMENT MARKS : 25	SUMMATIVE ASSESSMENT MARKS : 25

CObj_ID

Course Objectives

CObj_1

Familiarize students with the principles of basic macromolecular analysis.

CObj_2

Provide experimental practice of quantitative identification of various biomolecules.

CObj_3

Enable students to prepare the biological samples for analysis.

CO_ID Course Outcomes

CO_1 Exposed to do hands experience in learning how to analyze a give biomolecule

CO_2 Qualitative analysis of some carbohydrates, amino acids and lipids.

CO_3 To learn the preparation of solid derivatives of carbohydrates.

CO_4 To analyze the content of ascorbic acid from any biological samples.

Course Content

Qualitative analysis of carbohydrates.

Qualitative analysis of amino acids and proteins.

Qualitative analysis of lipids.

Extraction and determination of reducing carbohydrate content in fruit samples by DNS method.

Estimation of amino acids by formal titration.

Extraction and estimation of ascorbic acid from biological samples (chilli /citrus fruits) by titrimetric method.

Determination of iodine value of a oils/ fats samples.

Demonstration: Determination of pI value of amino acids(glycine/alanine).

References:

1. Practical Biochemistry; Principles and Techniques; K. Wilson and J. Walker (1995), Cambridge University.
2. Practical Clinical Biochemistry- Harold Varley CBS, New Delhi
3. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

S21 BC 6.1: Human Physiology and Cell Biology
Total Teaching Hours: 60
No. of Hours per Week: 4
(4 credits)

CObj Course Objectives

- CObj_1 To understand the structures and purposes of basic components of cells, especially membranes and organelles
- CObj_2 To revisit the fundamentals concepts of cells and tissues, organ systems and their working
- CObj_3 To familiarize with physiology and biochemistry of processes and organization of various organ systems

CO Course Outcomes

- CO1 To appreciate the concepts of cell biology, tissue organization, organ systems and physiological processes
- CO2 To comprehend the structural organization, functioning and important cellular events of cells and cell organelles
- CO3 To understand importance of tissues, and organization, dynamics and role of organs in circulatory and skeletal systems
- CO4 To understand the biochemistry and physiology of digestive, excretory and respiratory systems
- CO5 To recognize the fundamentals of biochemistry and physiology of muscular, nervous and endocrine systems

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	X	-	-	-	-
CO2	X	X	-	-	-
CO3	X	-	-	-	-
CO4	X	-	-	-	-
CO5	X	-	-	-	-

Course Content

Cell biology

Fundamentals of cell structure, discovery of cells, basic properties of cells, different classes of cells. Cells as experimental models,

Microscopy (light, phase contrast, fluorescence microscopy, electron microscopy) and its applications.

Organelles – structure and function of mitochondria, chloroplast, ER, Golgi apparatus, ribosomes, morphology and functions of peroxisomes and glyoxysomes, cytoskeleton, plant cell vacuoles. Centrifugation for subcellular fractionation .

Cellular membranes – chemical composition, fluidity, fluid mosaic model, dynamic nature of membranes, transport across cell membranes, membrane potentials. Passive and active transports, permeases, pumps, co-transport, symport, antiport, endocytosis, exocytosis.

Cell cycle, restriction point, and checkpoints. Cell division, mitosis, meiosis. Apoptosis and necrosis, brief outline of FACS and its applications.

Cells, tissues and organ systems

Tissues - Classification, epithelial, connective tissues. Extracellular matrix - cell matrix proteins, cell matrix interactions; cell-cell interactions.

Skeletal system - role of collagen and elastin in bone composition, growth and remodeling, factors affecting growth.

Blood and Body fluids: Composition of body fluids; blood; Properties, composition and functions; Erythropoiesis, blood coagulation - outline of extrinsic and intrinsic pathway. Composition and functions of CSF and Lymph. Anemias, polycythemia, hemophilia and thrombosis.

Cardiovascular system: Blood vessels- anatomy and physiology; Blood pressure. Regulation of heart rate.

Physiology of respiration, digestion and excretion

Respiratory system: Anatomy of Respiratory tract, Mechanism of respiration, Exchange of gases and transport of gases. Acid base balance by lungs and kidneys, Bohr's effect, chloride shift.

Digestive system: Outline of digestive system; composition and functions of major digestive secretions.

Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids.

Excretory system: structure and functions of nephron; glomerular filtration, tubular absorption and secretion;

Concentration of urine, GFR, composition of urine, renal failure, nephritis.

Physiology of muscular, nervous and endocrine systems

Muscular system: Muscle types; smooth, skeletal and cardiac muscle fibers; Muscle proteins –contractile and non-contractile. Definition of sarcomeres and mechanism of contraction. Energetics of muscle contraction. Regulation of skeletal muscle contraction. Muscular dystrophies.

Nervous system: Structure and classification of neurons, membrane potential, resting membrane potential and action potential; Mechanism of synaptic transmission, Neurotransmitters– classification, neurotransmitter receptors.

Endocrinology: Introduction to endocrine glands - chemistry of hormones and hormonal action. Functions of the hormones of hypothalamus, pituitary glands, adrenal cortex, thyroid, parathyroid and pancreas (Insulin, Glucagon and Somatostatin).

Books for Reference:

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893- 300-6.
2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), and ISBN: 13:978- 1-4641-0981-2 / ISBN: 10: 1-4641-0981-8.
3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J.,and Enlarge, M., Garland Science (Princeton), ISBN: 0-8153-1619-4 / ISBN: 0-8153-1620-8.
4. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York), ISBN: 13: 978-1-4641-0962-1 /ISBN: 10-14641-0962- 1.
5. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
6. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
7. Human Physiology by C. C. Chatterjee.13ed Vol 1 (PB 2020), CBS Publishers and Distributors.
8. Biochemistry By Debajyoti Das, Edition: 14th, Publisher: Academic Publishers, Year: 2010, ISBN: 9789380599175
9. Guyton and Hall, Textbook of Medical Physiology (Guyton Physiology) 2015, Elsevier Publication.

S21 BC 6.2: Physiology and Cell Biology Lab – Practical 6

Total Teaching Hours: 60

No. of Hours per Week: 4

(2 credits)

CObj Course Objectives

This course aims to

- CObj_1 Familiarize students with cell biology and physiological experimentation on cells and tissues
- CObj_2 Provide experimental practice of cellular techniques including microscopy, cell counting and organelle analysis
- CObj_3 Enable students to be able to perform analysis and interpret physiological data.

CO Course Outcomes

- CO_1 Evaluate and apply knowledge of techniques in cellular biology and physiology and interpret, analyse, describe and present experimental data
- CO_2 Develop skill and proficiency in preparation of slides and identifying structures in permanent slides
- CO_3 Evaluate cytological techniques including microscopy and cell counting
- CO_4 Perform systematic analysis of cell components like organelles and DNA
- CO_5 Understanding simple physiological functions such as sensory perception, heart rates and blood clotting

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	X	X	-	X	-
CO_2	X	X	X	X	-
CO_3	X	X	X	X	-
CO_4	X	X	X	X	-
CO_5	X	X	X	X	X

Course Content

Study of cell components, mitosis and meiosis using permanent slides

Study of divisional stages of mitosis by temporary preparation of onion root tip squash.

Temporary slide preparation of animal cells (squamous epithelium) and cytochemical staining of DNA by fuelgen

Cell counting and viability

ABO Blood grouping

Blood smear preparation and differential cell count

Estimation of hemoglobin by Sahli's haemocytometer

Determination of blood clotting time and bleeding time, ESR and PCV.

Isolation of organelles by sub-cellular fractionation.

Demonstration of diffusion and osmosis

Demonstration of the function of olfactory nerve.

Demonstration of positive and negative feedback mechanism experiments.

Books for Reference:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Principles and Techniques of Biochemistry and Molecular Biology 7th Edn. Keith Wilson and John Walker, Cambridge University Press, (2010).
4. Laboratory Manual of Cell Biology Paperback – 1. January 2018 by Rina Majumdar and Rama Sisodia. Prestige Publishers.
5. Molecular And Cell Biology Laboratory Manual Book. John S. Choinski, Jr., Dwight Dimaculangan and Jennifer Barwick. 2005. Indo-American Books.
6. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition, John Wiley & Sons. Inc.
7. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
8. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinauer Academic Press.
9. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

SEMESTER – VI

S 21 BC 7.1: Enzymology

Total Teaching Hours: 60

No. of Hours per Week: 4

(4 credits)

CObj Course Objectives

CObj_1

To provide detailed knowledge about enzymes, the biological catalysts with remarkable properties.

CObj_2

To outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry

CObj_3

To develop an understanding of enzyme kinetics, mechanism of enzyme action, enzyme inhibition and their regulation.

CO Course Outcomes

CO_1 To understand the nature and importance of enzymes in living systems.

CO_2 To gain insight into the molecular basis of catalysis by enzymes and the underlying basis of their specificity

CO_3 To comprehend the applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.

CO_4 To analyze the concepts of kinetics of enzyme catalyzed reactions, their mechanisms of enzyme action and clinical importance of enzyme inhibitors

CO_5 To appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	X	-	X	-	-
CO_2	X	-	-	X	-
CO_3	X	X	X	X	X
CO_4	X	X	X	X	X
CO_5	X	-	X	-	-

Course Content

Introduction to Enzymes and its classification

General characteristics of enzymes; Nomenclature and classification of enzymes and E.C. No. of enzymes. Co-factor and prosthetic group, apoenzyme, holoenzyme. Activation energy and transition state theory. active site and its characteristics. Enzyme specificity – bond specificity, substrate specificity (absolute and group specificity, optical and geometrical specificity; Theories related to enzyme substrate interaction – Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

Enzyme catalysis

Enzyme activity, specific activity, units to express enzyme activity. Factors affecting enzyme activity. Chemical nature of enzyme catalysis-General acid-base catalysis, electrostatic catalysis, covalent catalysis,

intramolecular catalysis. Metal activated enzymes and metalloenzymes. Coenzymes in enzyme catalyzed reactions (role of NAD, TPP and PLP). Fundamentals of enzyme assays.

Enzyme kinetics and inhibition

Michaelis-Menten equation, Lineweaver-Burk plot, Determination and significance of K_M and V_{max} .

Monomeric and oligomeric enzymes-Definition with examples. Cooperativity in catalysis. Deviation from Hyperbolic enzyme kinetics- Sigmoidal kinetics (MWC and KNF models). Significance of sigmoidal behavior. Types of bi-substrate reactions (sequential – ordered and random, ping pong reactions), examples. Reversible inhibition (competitive, uncompetitive, non-competitive and mixed) and irreversible inhibition. Substrate inhibition. Structural analogs (allopurinol and methotrexate).

Enzyme regulation and applications

Enzyme regulations- feedback inhibition, allosteric modulation (aspartate transcarbamylase), regulation by reversible covalent modification (glycogen phosphorylase and glycogen synthase). Proteolytic cleavage (zymogen activation- chymotrypsinogen). Regulation of multi-enzyme complex (pyruvate dehydrogenase). Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Applications of enzymes-Enzymes as reagents (glucose oxidase); Marker enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); Enzyme linked immunoassay (HRP); Enzyme therapy (streptokinase); Enzymes in research (Taq polymerase, restriction endonucleases). Immobilized enzymes and industrial applications of enzymes.

Books for Reference:

1. Dixon, M., and E. C. Webb. "Enzyme inhibition and activation." Enzymes 3 (1979): 126-136.
2. Palmer, T. Understanding Enzymes, 4th ed., Prentice Hall/Ellis Horwood, London (1995).
3. Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology. Oxford Science Publications. Second edition. New York, 2001.
4. Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. Biocatalysts and enzyme technology. John Wiley & Sons, 2012.
5. Copeland, Robert A. Enzymes: a practical introduction to structure, mechanism, and data analysis. John Wiley & Sons, 2004
6. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).
7. Biochemistry (2019) 9th ed., Stryer, L., Berg J., Tymoczko J., Gatto G., W.H. Freeman (New York).
8. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York).

S21 BC 7.2: Enzymology Lab – Practical VII

Total Teaching Hours: 60

No. of Hours per Week: 4
(2 credits)

CObj Course Objectives

This course aims to

CObj_1 Enable students to develop basic laboratory skills, implement experimental protocols and carryout investigations of enzymes.

CObj_2 Enable students to understand and learn the methods involved in enzyme isolation, purification and analysis.

CObj_3 Develop skills of performing specific enzyme assays and reporting their activity.

CO Course Outcomes

CO_1 Learn fractionation and purification of enzymes from different sources

CO_2 Understand the isolation of enzymes from various sources.

CO_3 Learn methods of enzyme assays and their activity assessment.

CO_4 Understand and learn kinetic and inhibition study of enzymes.

CO_5 Evaluate various physical and chemical factors affecting enzyme activity.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	X	X	X	X	-
CO_2	X	X	X	X	-
CO_3	X	X	X	X	-
CO_4	X	X	X	X	X
CO_5	X	X	X	X	-

Course Content

Determination of total activity of salivary amylase

a) Standard curve for maltose

b) Determination of rate of amylase activity

Determination of optimum temperature for salivary amylase

Determination of optimum pH for salivary amylase

Determination of specific activity of salivary amylase

Determination of total activity of acid phosphatase

a) Standard curve for p-Nitrophenol

b) Determination of rate of acid phosphatase

Determination of optimum temperature for acid phosphatase

Determination of optimum pH for acid phosphatase

Determination of specific activity of acid phosphatase

Fractionation of esterase by ammonium sulphate (Demonstration).

Determination of total activity of esterase in ammonium sulphate fractionated enzyme extracts

a) Standard curve for alpha naphthol

b) Determination of rate of esterase activity

Determination of the effect of inhibitor on the rate of enzyme activity (Demonstration).

Books for Reference:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry: Trevor Palmer, Horwood, (2001).
2. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis: Robert A. Copeland, Wiley-VCH Inc. (2000).
3. Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis: Robert A. Copeland, John Wiley & Sons (2000).
4. Enzyme Kinetics: A Modern Approach: Alejandro G. Marangoni, John Wiley & Sons (2002)
5. Enzyme Kinetics: Principles and Methods: Hans Bisswanger, Wiley-VCH (2002).
6. Fundamentals of Enzyme Kinetics: 4th ed. Athel Cornish-Bowden, Wiley-Blackwell (2012).
7. Fundamentals of Enzyme Kinetics: Athel Cornish-Bowden, Portland Press (2004)
8. Practical Enzymology: Hans Bisswanger, Wiley-VCH (2004)
9. Practical Enzymology, Second Revised Edition [PDF] [StormRG]: Hans Bisswanger, Wiley

S21 BC 8.1: Intermediary Metabolism

Total Teaching Hours: 60

**No. of Hours per Week: 4
(4 credits)**

CObj Course Objectives

CObj_1 To understand the concepts of biochemical reactions in cells.

CObj_2 To familiarize with understanding of metabolic pathways both catabolism and anabolism, and energy production.

CObj_3 To revisit the fundamental concepts of correlation of macromolecules and their chemical reactions.

CO Course Outcomes

CO_1 To appreciate the basics of biochemical reactions and its molecular and functional connection to the organization of a cell and sub-cellular components

CO_2 To know the fates of different types of carbohydrates and its regulation that can influence the growth and existence of living organism.

CO_3

To analyze the significance of lipid metabolic pathways

CO_4 To understand degradative and biosynthetic reactions of amino acids and nucleotides and associated metabolic disorders.

CO_5 To evaluate the biochemistry behind photosynthesis process and nitrogen fixation.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	X	X	X	-	-
CO_2	X	X	X	-	-
CO_3	X	X	X	-	-
CO_4	X	X	X	-	X
CO_5	X	X	X	-	-

Course Content

Carbohydrate metabolism

Definition, phases of metabolism, Anabolism and Catabolism- definition, schematic representation of metabolism. Glycolysis; definition, individual reactions with energetic. Irreversible reactions/ATP dependent reactions. Substrate level phosphorylation reactions of glycolysis. Net reaction of glycolysis. Entry of lactose, sucrose and glycogen into glycolysis. Fate of pyruvate- formation of Acetyl-CoA, Ethanol and Lactate. Stoichiometry and energetics of Glycolysis. Regulation of Glycolysis. TCA cycle- Individual reactions. Net reaction of TCA cycle. Number of ATP molecules production. Functions of TCA cycle- Amphibolic roles (Anapleorosis). Regulation of TCA cycle, energetics of TCA cycle. Pentose phosphate pathways (PPP/ HMP)- Significance, reactions. Gluconeogenesis- Definition and significance, flow chart for gluconeogenesis. CORI cycle-explanation, diagram, purpose. Substrate level phosphorylation (SLP) from TCA cycle. Glycogen metabolism- Glycogenolysis- definition, reactions. Glycogenesis- definition, reaction, Cori-diseases. **Regulation of blood glucose level; role of Insulin and Glucagon.**

Lipid metabolism

β -oxidation of saturated fatty acids; individual reactions, enzymes, coenzymes. Energetics of β -oxidation of palmitic acid and stearic acid (one to be worked in the class room and remaining two may be given as home assignment), role of carnitine, Oxidation fatty acids-with odd number of carbon atoms, fate of propionyl coA, oxidation of unsaturated fatty acids. Fatty acid synthetases; structure and functions. Biosynthesis of fatty acids-general flow chart, fatty acid oxidation v/s fatty acid synthesis. Cholesterol- structure and functions. cholesterol biosynthesis (chemical reactions up to the formation of mevalonate, remaining reactions may be given as flow scheme). Regulation of cholesterol biosynthesis. Atherosclerosis-cause, blood cholesterol levels (mentioning). **Ketone bodies-cause for the production. Ketogenesis-reactions, utilization, over production (ketosis).**

Amino acid and nucleic acid metabolism

General reactions- transamination- definition, reactions catalyzed by SGOT and SGPT, importance of transamination; Deamination - definition, oxidative and non-oxidative, examples for oxidative deamination- L-glutamate and non-oxidative- serine, aspartic acid and glutamine. Decarboxylation - definition, decarboxylation of glutamic acid, Histidine. Urea cycle- individual reactions, importance of urea cycle, hyperammonemia, regulation of urea cycle. Interrelationship between urea cycle and TCA cycle. Biosynthesis of glycine from serine and choline. Biosynthesis of alanine from transamination reaction. Biosynthesis of

cysteine from L- serine. Epinephrine and Nor-epinephrine- importance and biosynthesis from tyrosine. Histamine; biological importance and synthesis. PKU and AKU characteristic features, metabolic reasons. Biosynthesis of purine and pyrimidine nucleotides- sources of nitrogen and carbon atoms of purine and pyrimidine ring. Precursors of purine and pyrimidine biosynthesis. Reactions involved in the biosynthesis. Conversion of nucleotides to deoxynucleotides. [Orotic aciduria- general features](#). [Gout; general features](#).

Photosynthesis and Biological Nitrogen Fixation

Photosynthetic pigments and Photosynthetic unit. Light reactions – photosystem- I and II and their interactions. Synthesis of NADPH, photolysis of water, synthesis of ATP in cyclic and non-cyclic photophosphorylation. Dark reactions - chemical reactions upto the synthesis of fructose-6-phosphate. Trans-ketolation and aldolation reactions (shall be given in the flow chart). Interdependence of light and dark reactions. C3 and C4 plants- definition pathway (HSK pathway). [Bacterial photosynthesis](#). Nitrogen cycle, components of nitrogenase complex, stoichiometry of nitrogen fixation, nif genes.

Books for References:

1. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. John Wiley and sons.
2. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
3. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006).
4. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
5. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (2010), Wiley and sons.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
8. Photosynthesis, D.O. Hall and K. K. Rao, (1999), 6th Edn. Cambridge University Press.

S21 BC 8.2: Bioenergetics and Metabolism Lab - Practical VIII

Total Teaching Hours: 60

**No. of Hours per Week: 4
(2 credits)**

CObj Course Objectives

This course aims to

CObj_1	Familiarize students with the principles of basic analytical skills.
CObj_2	Provide experimental practice of qualitative estimations of various biomolecules and metabolites.
CObj_3	Enable students to prepare standard solutions and perform colorimetric estimations

CO Course Outcomes

- CO_1 Carry out independent and systematic analysis of biomolecules and report the result.
CO_2 Evaluate important metabolites of various metabolic pathways.
CO_3 Perform different methods of estimating metabolites such as colorimetric and titrimetric methods.
CO_4 Analyze the basic principles in each estimation and develop analytical skills.
CO_5 Evaluate the presence as well as the concentration of metabolites in different samples

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	X	X	-	X	-
CO_2	X	X	-	X	-
CO_3	X	X	X	X	-
CO_4	X	X	X	X	-
CO_5	X	X	X	X	-

Course Content

Buffer preparation – phosphate and acetate buffers

Spectrophotometric Determination of Total Protein by Biuret Method

Estimation of protein by FC method

Colorimetric estimation of Inorganic Phosphate by Fiske Subbarow method

Colorimetric Estimation of Lactose in milk by D.N.S method

Estimation of amino acid (alanine/glycine) using ninhydrin by colorimetric method

Preparation of mitochondria from animal liver tissue and marker assay

Glucose Oxidase Method for Estimation of Glucose (Demonstration)

Demonstration of respiration and photosynthesis

Demonstration of amylase activity in agar diffusion

Energy metabolism – BMR, calorie count and energetics

Fermentation – wine making, fermented foods

Books for Reference:

1. Practical Biochemistry; Principles and Techniques; K. Wilson and J. Walker (1995), Cambridge

University.

2. Practical Clinical Biochemistry- Harold Varley CBS, New Delhi
3. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
4. Introductory Practical Biochemistry – S.K.Sawhney and Randhir Singh.
5. Practical Clinical Biochemistry: Methods and Interpretation, 4th edn. Ranjna Chawla, Jaypee Brothers Medical Publishers

**Department of Physical
Sciences
Chemistry**

MATRIX AND SYLLABUS
For the Programme B.Sc. (Chemistry/ Microbiology)

Chemistry

NEP Based Curriculum (2021 onwards)

PEO_ID	Programme Educational Objectives
PEO1	Students will be well prepared for successful careers in the profession at an industry and/or in government in one or more of discipline of chemistry.
PEO2	Students will be academically prepared to become licensed professional chemists in due course and will contribute effectively in serving the society.
PEO3	Students will be engaged in professional activities to enhance their own achievement and simultaneously contribute in service of humankind.
PEO4	Students will be successful in higher education in Chemistry
PEO5	Students will provide leadership quality to work in all kind of circumstances, diverse environment such as interdisciplinary and multidisciplinary learning systems.

PO_ID	Programme Outcomes
PO1	Create enthusiasm among students for chemistry and its application in various fields of life.
PO2	Provide students with broad and balanced knowledge and understanding of key concepts in chemistry.
PO3	Develop in students a range of practical skills so that they can understand and assess risks and work safely measures to be followed in the laboratory.
PO4	Develop in students the ability to apply standard methodology to the solution of problems in chemistry.
PO5	Provide students with knowledge and skill towards employment or higher education in chemistry or multi-disciplinary areas.

SO_ID	Programme Specific Outcomes
PSO1	Students have a firm foundation in the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical branches of chemistry.

PSO2	Acquired the knowledge of terms, facts, concepts, processes techniques and principles of the subject.
PSO3	Carry out experiments and analysis in the area of organic analysis, estimation, separation, inorganic semi micro analysis, preparation.
PSO4	Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories.
PSO5	Developed skills in the proper handling of apparatus and chemicals.



MATRIX AND SYLLABUS

For the Programme B.Sc. (Chemistry/ Microbiology)

Chemistry

NEP Based Curriculum (2021 onwards)

I Semester

Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	S21KN 1.1/ S21HN 1.1/ S21AE 1.1	Language I (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	S21GE 1.1	Language II (Generic English)	60	3	1	-	3
DSC1	S21 MB1.1	General Microbiology	60		4	-	4
DSC 1	S21 MB 1.2	General Microbiology	45		-	4	2
DSC 1	S21 CH 1.1	Analytical & Organic Chemistry-I	60	-	4	-	4
DSC 1	S21 CH 1.2	Analytical & Organic Chemistry practicals-I	60	-	-	4	2
OE-1	S21OE/S21OE1.3	Microbial Technology for Human Welfare/Chemistry in Daily Life	45	2	1	-	3
SEC-SB	21SBC 1.1	Digital Fluency	30	1	-	2	2
SEC-VB	21VBC 1.1	Health and Well-being	30			2	1
SEC-VB	21VBC 1.2	Yoga	30			2	1
Total							25

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

DSE – Discipline-Specific Elective

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Exit Option with CERTIFICATE IN Chemistry (50 Credits)

AECC- Ability Enhancement Compulsory Courses
DSC- Discipline Specific Course
VBC- Value based Course
SEC- Skill Enhancement Course
DSE- Discipline Specific Elective
OE- Open Elective

**Continuous Internal Assessment – Scheme of Evaluation
For Theory Courses**

End Semester Examination: 60%
Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii. Classwork	05		
iii. Classroom participation	05		
Total			40

**Continuous Internal Assessment – Scheme of Evaluation
For Practical Courses**

End-Semester Examination: 50%
Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)	
Maximum Marks (Internal Assessment)	25
1. Weightage (Marks)	15
2. Record work (Marks)	05
3. Viva	05

Total (Marks)	25

DSC-1

S21CH 1.1: Analytical and Organic Chemistry-I

Total Teaching Hours: 60 No. of Hours / Week: 4

CObj_ID	Course Objectives
CObj_1	The main objective is to provide to the students an in depth understanding of the basic concepts of chemical sciences.
CObj_2	To enable them with tools needed for the practice of chemistry, which remains a discipline with much stress on experimentation.
CObj_3	To provide a detailed knowledge of the terms, concepts, methods, principles and experimental techniques of chemistry.

CO_ID	Course Outcomes
CO_1	Learn the concepts of chemical analysis, accuracy, precision and statistical data treatment
CO_2	Prepare the solutions after calculating the required quantity of salts in preparing the reagents/solutions and dilution of stock solution.
CO_3	Know the concept of volumetric and gravimetric analysis and deducing the conversion factor for determination
CO_4	Handle toxic chemicals, concentrated acids and organic solvents and practice safety procedures.
CO_5	Understand the concepts of Organic reactions and techniques of writing the movement of electrons, bond breaking, bond forming

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X				X		X			
CO_2	X			X	X			X		
CO_3	X				X				X	
CO_4			X		X					X
CO_5	X	X			X	X				

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Basic laboratory practices</u> Calibration of glassware (pipette, burette and volumetric flask), Sampling (solids and liquids), weighing, drying, dissolving, Acid treatment, Rules of work in analytical laboratory, General rule for performing quantitative determinations (volumetric and gravimetric), Safety in Chemical laboratory, Rules of fire prevention and accidents, First aid. Precautions to be taken while handling toxic chemicals, concentrated/fuming acids and organic solvents <u>Analytical chemistry:</u> Introduction, Role of analytical chemistry in the Sciences, Classification of Quantitative methods of analysis, steps in a typical quantitative analysis, selecting a method of analysis, sampling, preparing a laboratory sample, defining a replicate samples, preparing solutions of the samples, eliminating interferences, calibration and measurements, calculating results, evaluating results from estimating their reliability. <u>Errors in Chemical Analysis:</u> Definition of terms: Mean and Median, precision, accuracy, absolute error, relative error. Types	15	Transferrable and Analytical Skills

		of errors in experimental data: Systematic errors (source of systematic errors, instrument errors, method errors, personal errors). The effect of systematic errors: constant errors, proportional errors. Determination of systematic instrument and personal errors <u>Random errors in Analysis:</u> The nature of random errors, the statistically treatment of random errors(the sample and the population, properties of Gaussian curve, the sample standard deviation as a measure of precision, the reliability of S as a measure of precision, alternative terms for expressing the precision of samples of data) <u>The standard deviation of computed results:</u> The standard deviations of sums and differences, the standard deviation of products and quotients, the standard deviation in exponential calculations, the standard deviation of logarithms and antilogarithms. Numerical Problems		
2	Unit -2	<u>Acid-base titrimetry:</u> Titration curves for strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations. Titration curves, Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity. <u>Complexometric titrimetry:</u> Indicators for EDTA titrations - theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations, Application-	15	Employable and Entrepreneurship Skills

		determination of hardness of water. <u>Redox titrimetry:</u> Balancing redox equations, calculation of the equilibrium constant of redox reactions, titration curves, Theory of redox indicators, calculation of standard potentials using Nernst equation. Applications. <u>Precipitation titrimetry:</u> Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate-Volhard's and Mohr's methods and their differences. <u>Gravimetric Analysis:</u> Requisites of precipitation, mechanism of precipitation, Factors influencing precipitation, Co-precipitation, post-precipitation, Advantages of organic reagents over inorganic reagents, reagents used in gravimetry (8-hydroxy quinoline (oxine) and dimethyl glyoxime (DMG)). Numerical problems on all the above aspects.		

3	Unit-3	Classification and nomenclature of organic compounds including bi functional, Hybridization, Shapes of organic molecules. <u>Mechanisms of organic reactions:</u> Breaking of a covalent bond, Homolytic fission and heterolytic fission, bond formation, difference between ionic and free radical reactions, reactions intermediates: free radicals, carbanions, carbonium ions. Classifications of reagents: electrophilic reagents (electrophiles), Nucleophilic reagents (Nucleophiles), comparison of electrophiles and nucleophiles. Types of organic reactions: substitution reactions, addition reactions, elimination reactions, rearrangements. Concept of activation energy and transition state. <u>Reactions mechanism:</u> concerted mechanism, non concerted mechanism. Mechanism of substitution reactions: Free radical substitution reactions, electrophilic substitution reactions, nucleophilic substitution reactions, unimolecular mechanism (SN1) bimolecular mechanism (SN2), comparison between SN1 and SN2 reactions. Mechanism of addition reactions: electrophilic addition reactions, nucleophilic addition reactions and free radical addition reactions. Mechanism of elimination reactions: α- elimination reactions, β-elimination. Bimolecular mechanism(E-2 reactions), Unimolecular mechanism (E-1 reactions) Aliphatic Hydrocarbons:Alkanes:Nomenclature of branched chain alkanes; <i>Preparation:</i>	15	Evaluation and Research Skills

		Corey-House synthesis, Wurtz reaction and Wurtz-Fittig reaction. Physical and chemical properties (Free radical substitution, Halogenation- relative reactivity and selectivity) and commercial importance. Difference between conformation and configuration. Conformations of ethane, propane and n-butane, explanation of stability based on Energy profile diagrams. Nomenclature of n-butane conformations using Klyne-Prelog terminology. Conformation and stability of 1,2-dichloroethane, ethylene glycol and acetaldehyde Cycloalkanes: Nomenclature, Method of formation. Explanation for stability based on heat of hydrogenation data. Baeyer's strain theory and stability of cyclopropane. Conformations of cyclohexane (Chair, twist boat, boat, half-chair and envelop forms and their stability). Geometrical isomerism with examples. Cis and trans isomerism in 1,2-dimethylcyclopropane and 1,2-dimethylcyclohexane.		
4	Unit -4	Alkenes: Preparation of alkenes by dehydration of alcohols, dehydrohalogenation of alkyl halides, regio selectivity, Saytzeff rule and Hofmann eliminations. Reactions of alkenes: Addition of halides, hydrogen halides, water, markownikov's rule, antimarkownikov's addition(peroxide effect), oxymercuration, Hydroboration, oxidation with KMnO_4, Diels-Alder reaction. Alkynes: General methods of Preparation- dehydrohalogenation of vicinal and germinal dihalides and Higher alkynes from terminal alkynes. Reactions of alkynes: Electrophilic addition reactions, oxidation with KMnO_4, hydroboration-oxidation	15	Logical Skills/ creative thinking skills/ Analytical Skills

		and hydrogenation and ozonolysis Arenes: Nomenclature: Mono, di and tri substituted benzenes, Aromaticity: Huckel's rule -application to benzenoid (benzene, naphthalene, anthracene and phenanthrene) and non-benzenoid (cyclopropenyl cation, cyclopentadienyl anion, tropylium cation) compounds, Anti-aromaticity, Homoaromaticity. Benzene: Molecular orbital picture and resonance energy. Preparation-from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Mechanism of electrophilic substitution of benzene. Aromatic nucleophilic substitution <i>via</i> benzyne intermediate, Birch reduction, Side chain oxidation of toluene to benzaldehyde and benzoic acid. Polynuclear hydrocarbons: Naphthalene, Anthracene and phenanthrene-Preparations, resonance structures, oxidation of naphthalene, anthracene and phenanthrene. Electrophilic and nucleophilic substitution reactions of Naphthalene and Anthracene. Diels-Alder reaction of anthracene with 1,2-dichloroethene. Alkenyl benzenes: Styrene, cis- and trans-stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction		

References

1. McMurry, J. E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013
2. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
3. Organic Reaction mechanism by V. K. Ahluwalia and K. Parashar (Narosa Publishers).
4. Organic Chemistry by S. M. Mukherji, S. P. Singh and R. K. Kapoor. (Narosa Publishers).
5. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt.Ltd.(2007).
6. Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).

DSC-Lab-1

S21 CH 1.2:Analytical and Organic Practicals-1

Total Teaching Hours: 60 No. of Hours / Week: 4

CObj_ID	Course Objectives
CObj_1	To understand the uses of analytical methods in chemistry.
CObj_2	To establish an appreciation of the role of chemistry in qualitative and quantitative analysis.
CObj_3	To introduce different experiments to develop the skills and strategic approaches for organic synthesis and its purifications.

CO_ID	Course Outcomes
CO_1	Aware of methods of calibration of various glasswares.
CO_2	They will know the importance of purification of different chemicals
CO_3	Apply the organic synthetic strategies in multi-step synthesis
CO_4	Prepare organic compounds in an environmental friendly way
CO_5	Learn the qualitative and quantitative analysis of different chemicals

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X	X			X		X			X
CO_2	X	X		X	X			X		X
CO_3	X	X			X				X	X
CO_4		X	X		X					X
CO_5	X	X			X	X				X

Course Content**S21 CH 1.2:Analytical and Organic Practicals-1**

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	PART-A Analytical Chemistry	1. Safety Practices in the Chemistry Laboratory, knowledge about common toxic chemicals and safety measures in their handling, cleaning and drying of glass wares. 2. Calibration of glassware, pipette, burette and volumetric flask. 3. Determination of sodium carbonate and sodium bicarbonate in a mixture. 4. Determination of alkali present in soaps/detergents 5. Determination of iron(II) using potassium dichromate 6. Determination of oxalic acid using potassium permanganate solution 7. Determination of Fe^{2+} as Fe_2O_3 Virtual Experiments 8. Standardization of EDTA solution and determination of hardness of water 9. Gravimetric estimation of Barium 10. Gravimetric estimation of Nickel	30	Analytical Skills

2	PART-B Organic Chemistry	11. Selection of suitable solvents for Purification/Crystallization of organic compounds. 12. Preparation of acetanilide from aniline using Zn/acetic acid (Green method). 13. Synthesis of p-nitro acetanilide from acetanilide using nitrating mixture. 14. Hydrolysis of methyl m-nitrobenzoate to m-nitrobenzoic acid (Conventional method) 15. Synthesis of diazoaminobenzene from aniline (conventional method). 16. Preparation of dibenzalacetone (Green method). 17. Diels Alder reaction between furan and maleic acid (Green method). 18. Virtual Experiments 19. Simple Distillation 20. Separation of Compounds by Column Chromatography 21. 22. Detection of Functional Groups	30	Employability and Entrepreneurship Skills

Note: Questions from both sections should be given in each batch.

1. In the first 20 minutes the Teacher should discuss in detail the theory, principle, procedure and calculations
2. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemicals
3. The last 20 minutes the teacher is expected to solve related problems based on the experiments.

Text Books

1. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
2. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).

3. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).
4. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T R Govindachari, Allied Publishers, New Delhi, (1996).
5. Practical Organic Chemistry – Mann and Saunders, (1980).
6. Text Book of Practical Organic Chemistry- A. I. Vogel, (1996).
7. Test Book of Quantitative Organic Analysis- A. I. Vogel, (1996).

OE-1

S21OE1.3: CHEMISTRY IN DAILY LIFE

Total Teaching Hours: 45 No. of Hours / Week: 3

CObj_ID	Course Objectives
CObj_1	Visualize the importance of Chemistry in daily life.
CObj_2	Know about artificial sweetening agents and food preservatives.
CObj_3	Make students more aware of the chemical found in all aspects of daily life.

CO_ID	Course Outcomes
CO_1	Learn the constituents of milk and milk products and their analysis
CO_2	Students will learn about food adulterants and food additives and their analysis.
CO_3	Students will learn the concepts of manufacturing of soaps and detergents
CO_4	Students will learn the checking the purity of edible oils and will understand the importance of vitamins
CO_5	Students will learn about batteries and basic concepts of polymers

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X				X		X			X
CO_2	X		X	X	X			X		
CO_3	X				X	X			X	
CO_4			X		X		X			X
CO_5	X	X			X	X				

Course Content

OE-1: S21OE1.3CHEMISTRY IN DAILY LIFE

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Dairy Products:</u> Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk. Beverages: Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, determination of methyl alcohol in alcoholic beverages. <u>Food additives, adulterants, and contaminants-</u> Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate. Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate. <u>Artificial food colorants:</u>Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.	15	Employability and Entrepreneurship Skills
2	Unit -2	<u>Vitamins:</u> Classification and Nomenclature. Sources, deficiency diseases, and structures of Vitamin A1, Vitamin B1, Vitamin C, Vitamin D, Vitamin E & Vitamin K1. <u>Oils and fats:</u> Composition of edible oils, detection of purity, rancidity of fats and oil. Tests for adulterants like argemone oil and mineral oils. Halphen test.	15	Employability and Entrepreneurship Skills

		<u>Soaps & Detergents:</u> Definition, classification, manufacturing of soaps and detergents, composition and uses		
3	Unit-3	<u>Chemical and Renewable Energy Sources:</u> Principles and applications of primary & secondary batteries and fuel cells. Basics of solar energy, future energy storer. <u>Polymers:</u> Basic concept of polymers, classification and characteristics of polymers. Applications of polymers as plastics in electronic, automobile components, medical fields, and aerospace materials. Problems of plastic waste management. Strategies for the development of environment-friendly polymers.	15	Employability and Entrepreneurship Skills

Text Books

1. B. K. Sharma: Introduction to Industrial Chemistry, Goel Publishing, Meerut (1998)
2. Medicinal Chemistry- Ashtoush Kar.
3. Analysis of Foods – H.E. Cox: 13.

References

1. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4thed. New Age International (1998)
2. Handbook on Fertilizer Technology by Swaminathan and Goswamy, 6th ed. 2001, FAI.



MATRIX AND SYLLABUS

For the Programme B.Sc. (Chemistry/ Microbiology)

Chemistry

NEP Based Curriculum (2021 onwards)

II Semester

II Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	S21KN 2.1/ S21HN 2.1/ S21AE 2.1	Language I (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	S21GE 2.1	Language II (Generic English)	60	3	1	-	3
AECC	21SBC 2.1	Environmental Studies	45	2	1	-	3
DSC2	S21 CHE2.1	Inorganic & Physical Chemistry-I	60	4	-	-	4
DSC2	S21 CHE2.2	Inorganic & Physical Chemistry Practical-I	60	-	-	4	2
DSC2	S21 MB 2.1	Microbial Biochemistry and Physiology	60	4	-	-	4
DSC2	S21 MB 2.2	Microbial Biochemistry and Physiology - Practical	60	-	-	4	2
OE-2	OPE 2.1/OE-2	Environmental and health microbiology/Molecules of Life	45	2	1	-	3
SEC-VB	21VBC 2.1	NCC/NSS/Cultural	30	-	-	2	1
SEC-VB	21VBC 2.2	Sports	30	-	-	2	1
Total							26

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

DSE – Discipline-Specific Elective

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

**Continuous Internal Assessment – Scheme of Evaluation
For Theory Courses**
End Semester Examination: 60%
Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)		20	20
i. Writing	10		
ii. Classwork	05		
iii. Classroom participation	05		
Total			40

**Continuous Internal Assessment – Scheme of Evaluation
For Practical Courses**
End-Semester Examination: 50%
Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)	
Maximum Marks (Internal Assessment)	25
1. Weightage (Marks)	15
2. Record work (Marks)	05
3. Viva	05
Total (Marks)	25

DSC-2**S21CH 2.1: Inorganic and Physical Chemistry-I****Total Teaching Hours: 60****No. of Hours / Week: 4**

CObj_ID	Course Objectives
CObj_1	To understand the structure of the atom, shapes of different orbital's and properties of periodic table
CObj_2	To develop the ability to correlate the chemical and physical properties of elements and their compounds in the periodic table
CObj_3	An overview of close packing of metallic crystals, unit cell and crystal lattice, determination of surface tension, viscosity and refractive index of liquids. Colligative properties

CO_ID	Course Outcomes
CO_1	Students will learn the structure of an atom, electronic configuration, Schrodinger wave equation, Heisenberg's uncertainty principle, quantum numbers.
CO_2	Students will understand periodic properties of elements and their compounds.
CO_3	Students should be able to determine the difference between solids, liquids and gases.
CO_4	Students will be able to understand gas laws, theories and its application.
CO_5	Students will learn the physical properties of liquids and Colligative properties

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X				X		X			X
CO_2	X	X		X	X			X		
CO_3	X		X		X				X	
CO_4			X		X		X			X
CO_5	X	X			X	X			X	

Course Content-II Semester

Course content

S21CH 2.1: Inorganic and Physical Chemistry-I

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Atomic structure</u> Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations- Electronic configurations of the elements (Z=1-30), effective nuclear charge, shielding/screening effect, Slater's rules. Variation of effective nuclear charge in Periodic Table.	15	Employability and Entrepreneurship Skills
2	Unit -2	<u>Periodic Table & Periodic Properties</u> s, p, d and f-block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s and p-block elements: (a) Atomic radii (van der Waals) (b) Ionic and crystal radii. (c) Covalent radii (d) Ionization enthalpy, successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (e) Electron gain enthalpy, trends of electron gain enthalpy.	15	Employability and Entrepreneurship Skills

		(f) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Trends in the chemistry of the compounds of groups 13 to 17 (hydrides, carbides, oxides and halides) are to be discussed		
3	Unit-3	Gaseous State Elementary aspects of kinetic theory of gases, Ideal and real gases. Boyle temperature (derivation not required), Molecular velocity, collision frequency, collision diameter, Collision cross section, collision number and mean free path and coefficient of viscosity, calculation of σ and η, variation of viscosity with temperature and pressure. Maxwell's Boltzmann distribution law of molecular velocities (Most probable, average and root mean square velocities). Relation between RMS, average and most probable velocity and average kinetic energies. (Mathematical derivation not required), law of equipartition of energy. Behaviour of real gases: Deviation from ideal gas behaviour. Compressibility factor (Z) and its variation with pressure for different gases. Causes of deviation from ideal behaviour, vander Waals equation of state (No derivation) and application in explaining real gas behaviour. Critical phenomena - Andrews isotherms of CO₂, critical constants and their calculation from van der Waals equation, Continuity of states, Law of corresponding states. Numerical problems. Liquid State Surface Tension: Definition and its determination using stalagmometer, effect of temperature and solute on surface tension Viscosity: Definition, Coefficient of viscosity. Determination of viscosity of a liquid using Oswald viscometer.	15	Employability and Entrepreneurship Skills

		Effect of temperature, size, weight, shape of molecules and intermolecular forces. Refraction: Specific and molar refraction- definition and advantages. Determination of refractive index by Abbes Refractometer. Additive and constitutive properties. Parachor: Definition, Atomic and structure parachor, Elucidation of structure of benzene and benzoquinone. Viscosity and molecular structure. Molar refraction and chemical constitution. Numerical Problems.		
4	Unit -4	Dilute solutions- Review of colligative properties and concentration terms Determination of molecular mass of a solute by: (i) Berkeley-Hartley's method (Π); (ii) Beckmann's method (ΔT_f) and (iii) Landsberger's method. Numerical problems Distribution Law Nernst Distribution Law – Statement. Distribution constant, factors affecting distribution constant, validity of Distribution Law, Modification of distribution law when molecules undergo a) Association b) Dissociation. Application of Distribution Law in Solvent extraction. Nernst distribution law. Numerical Problems Solids Forms of solids: Unit cell and space lattice, anisotropy of crystals, size and shape of crystals, Laws of Crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of symmetry (Symmetry elements), Crystal systems, Bravais lattice types and identification of lattice planes. Miller indices and its calculation, X-Ray diffraction by crystals: Bragg's law and derivation of Bragg's equation, Single crystal and powder diffraction methods. Defects in crystals, glasses and liquid crystals. Numerical problems.	15	Employability and Analytical Skills

Text Books

1. Concise Inorganic Chemistry: J D Lee, 4th Edn, Wiley, (2021)
2. Atkins Physical Chemistry.8th Edition. Peter Atkins & Julio De Paula Oxford University Press.
3. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co.
4. Advanced Physical Chemistry, Gurdeep Raj, Goel Publishing House (2018)

References

1. Basic Inorganic Chemistry, F A Cotton, G Wilkinson and P. L. Gaus, 3rd Edition. Wiley. India
2. Physical Chemistry by Samuel Glasstone, ELBS (1982).
3. A Text Book of Physical Chemistry P.L.Soni , O.P. Dharmarhaand and U.N.Dash, Sultan Chand and Sons.

Course Content

SEMESTER–II

DSC-Lab-2

S21 CH 2.2: Inorganic and Physical Practicals

Total Teaching Hours: 60

No. of Hours / Week: 4

CObj_ID	Course Objectives
CObj_1	To educate the methods of preparation of solutions different concentrations.
CObj_2	To measure different physical parameter like viscosity, surface tension.
CObj_3	To confidently make use of different apparatus in the laboratory

CO_ID	Course Outcomes
CO_1	Students will be confident in preparing various concentration of different solution.
CO_2	They will get expertise in analysis of real time samples.
CO_3	Students will understand acid- base, redox and precipitation reactions
CO_4	Students will be able to determine the molecular weight of unknown compounds by using Walker –Lumsden and cryoscopic methods.
CO_5	Students will be aware of determining physical constants of different chemicals.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X		X		X	X	X			X
CO_2	X			X	X	X		X		X
CO_3	X				X	X			X	X
CO_4			X		X	X				X
CO_5	X	X			X	X				X

Course Content

S21 CH 2.2 Inorganic and Physical Practicals

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	PART-A Inorganic Chemistry	TITRIMETRY 1. Determination of carbonate and hydroxide present in a mixture. 2. Determination of oxalic acid and sodium oxalate in a given mixture using standard $\text{KMnO}_4/\text{NaOH}$ solution 3. Standardization of potassium permanganate solution and determination of nitrite in a water sample 4. Determination of alkali content in antacids 5. Determination of chlorine in bleaching powder using iodometric method. Virtual Experiments 6. Determination of concentration of Potassium Permanganate solution using Ferrous Ammonium sulphate 7. Standardization of silver nitrate and determination of chloride in a water sample 8. Soil Analysis-Determination of pH of soil.	30	Employability and Entrepreneurship Skills

2	PART-B Physical Chemistry	9. Determination of density using specific gravity bottle and viscosity of liquids using Ostwald's viscometer (Ethyl acetate, Toluene, Chloroform, Chlorobenzene or any other non-hazardous liquids) 10. Study of the variation of viscosity of sucrose solution with the concentration of a solute 11. Determination of the density using specific gravity bottle and surface tension of liquids using Stalagmometer (Ethyl acetate, Toluene, Chlorobenzene, any other non-hazardous liquids) 12. Study of variation of surface tension of detergent solution with concentration. 13. Determination of molar mass of non-electrolyte by Walker-Lumsden method 14. Determination of the composition of liquid mixture by refractometry. (Toluene & Alcohol, Water & Sucrose) 15. Determination of partition/distribution coefficient of Benzoic acid in water and toluene. 16. Virtual Experiments 17. Determination of molar mass of a non-volatile solute by cryoscopic method 18. Determination of viscosity average molecular weight of a polymer 19. Determination of partition coefficient of Iodine between water and carbon tetrachloride	30	Employability and Entrepreneurship Skills

Note:

1. Questions from both sections should be given in each batch.
2. In the first 20 minutes the Teacher should discuss in detail the theory, principle, procedure and calculations
3. Instructions to be given for operating instruments, weighing chemicals and precautions while handling chemicals
4. The last 20 minutes the teacher is expected to solve related problems based on the experiments.

References

1. Findlays practical physical chemistry revised by P. B. Levitt, Longman's London (1966).
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill International Edn. (1966)
3. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988)
4. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987)
5. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
6. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
7. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
8. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).
9. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).

OE-2: Molecules of Life

Total Teaching Hours: 45 No. of Hours / Week: 3

CObj_ID	Course Objectives
CObj_1	Draw the basic structures and classification of biomolecules.
CObj_2	The physiological action of biomolecules in the body.
CObj_3	Concepts of bioenergetics

CO_ID	Course Outcomes
CO_1	The students will learn about the chemical structures of carbohydrate, and their structural and metabolic role in cellular system
CO_2	The students will learn about structure and function of lipids.
CO_3	They will also learn about primary, secondary, tertiary, quaternary structure of proteins, and composition, functions.
CO_4	The students will understand about the structure and function of nucleosides and nucleotides.
CO_5	They will also learn energy transformation in biological system.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X				X		X			
CO_2	X			X	X			X		
CO_3	X				X	X	X	X	X	X
CO_4			X		X					X
CO_5	X	X			X	X				

Course Content

OE-2: Molecules of Life

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Carbohydrates</u> Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structures. Epimers, mutarotation and anomers. Linkage between monosaccharides, structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation. Carbohydrates as a source of energy <u>Amino Acids, Peptides and Proteins</u> Classification of amino acids, Zwitter ion structure and Isoelectric point. Peptides: structure and conformation, example and function of biologically important Peptides. Proteins: Classification based on composition, shape and function with examples. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Importance of primary structure by taking sickle cell anemia as example. Determination of primary structure of peptides. Denaturation of proteins; Renaturation of proteins.	15	Employability Skills
2	Unit -2	<u>Enzymes and correlation with drug action</u>	15	Employability and

		Brief Introduction, Nomenclature (E.C. No. upto 2nd digit) and classification of enzymes, Effect of pH and temperature. Enzyme specificity and theories-Lock and key model, induced fit theory. Active site and its characteristics, Mechanism of enzyme action, factors affecting enzyme action, Co-enzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereo specificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Noncompetitive inhibition including allosteric inhibition). <u>Drug action-receptor theory.</u> Structure-activity relationships of drug molecules, binding role of –OH group, -NH₂ group, double bond and aromatic ring. <u>Lipids</u> Introduction to lipids, classification. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Rancidity of oils. Triglycerides:: Biological importance of triglycerides. Saponification, saponification value and its significance, Unsaturation in acyl glycerols- iodine number and iodine number of different oils. Prostaglandins: definition and example, biological role of prostaglandins in general, Waxes: definition, types, biological importance. Lipoproteins: Types and functions, clinical significance.		Entrepreneurship Skills
3	Unit-3	<u>Nucleic Acids</u> Components of nucleic acids: Adenine, guanine, thymine and cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, -(general features and about Central dogma of Molecular biology)Biological roles of DNA and RNA: Replication, Transcription and Translation. Physico-chemical properties of nucleic acids - effect of alkali, acid and heat	15	Employability and Entrepreneurship Skills

		(denaturation and renaturation), Mutation Mutagens- chemical and physical, Molecular basis of mutation: spontaneous and induced mutations. Types of mutation <u>Concept of Energy in Bio systems</u> Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate- Glycolysis, Fermentation, and Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates. Introduction to bioenergetics, stages of energy transformation- Photosynthesis respiration and utilization of energy. Exergonic and endergonic reactions. standard free energy change.		

References

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. A Text Book of Biochemistry, V. S. S. Rama Rao, UBSPD, 1998.
3. Concise Text Book of Biochemistry, T. N. Pattabhiraman, All India Publishers, 2000.
4. W. H. Freeman. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, 2002.



MATRIX AND SYLLABUS

For the Programme B.Sc. (Chemistry/ Microbiology)

Chemistry

NEP Based Curriculum (2021 onwards)

III Semester

III Semester

Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	S21KN 3.1/ S21HN 3.1/ S21AE 1.1	Language I (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	S21GE 3.1	Language II (Generic English)	60	3	1	-	3
DSC3	S21 MB 3.1	Microbial diversity - Theory	60		4	-	4
DSC3	S21 MB 3.2	Microbial diversity – Practical	45		-	4	2
DSC3	S21 CH 3.1	Analytical & Organic Chemistry-II	60	-	4	-	4
DSC3	S21 CH 3.2	Analytical & Organic Chemistry Practicals-II	60	-	-	4	2
OE-3	S21OE MB 3.8/	Cosmetic Microbiology/Atomic structure ,Bonding and concepts in Organic chemistry	45	2	1	-	3

SEC- SB	21SBC 3.1	Digital fluency-II	30	1	-	2	2
SEC-VB	21VBC 3.1	NCC/NSS/Cultural	30	-	-	2	1
SEC-VB	21VBC 3.2	Sports	30	-	-	2	1
Total							25

Note 1:

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)		20	20
i. Writing		10	
ii. Classwork		05	
iii. Classroom participation		05	
Total			40

Continuous Internal Assessment – Scheme of Evaluation

For Practical Courses

End-Semester Examination: 50%

Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)	
Maximum Marks (Internal Assessment)	25

1. Weightage (Marks)	15
2. Record work (Marks)	05
3. Viva	05
Total (Marks)	25

DSC-3

S21 CH 3.1: Analytical and Organic Chemistry-II

Contact Hours: 60

Work load: 4 Hours/Week.

Credit Points :4

Evaluation: Continuous Internal Assessment-40 MarksSemester End

Examination -60 Marks

CObj_ID	Course Objectives
CObj_1	Interrelationship among frequency, wavelength and wave number and importance of validation parameters of an instrumental method will be taught .
CObj_2	Principle, instrumentation and applications of spectrophotometry, nephelometryand turbidometry will be taught .
CObj_3	Fundamentals of separation methods and principles of paper, thin layer and columnchromatography will be taught

CO_ID	Course Outcomes
CO_1	Understand the importance of fundamental law and validation parameters in chemical analysis
CO_2	Know how different analytes in different matrices (water and real samples) can be determined by spectrophotometric, nephelometric and turbidimetric methods.
CO_3	Fundamentals of separation methods and principles of paper, thin layer and column chromatography will be taught
CO_4	Principle and mechanism of ion-exchange, types of resins and domestic and industrial applications of ion-exchange chromatography will be taught
CO_5	Apply solvent extraction method for quantitative determination of metal ions in different samples

Course content

Contact Hours: 60

Work load: 4 Hours/Week.

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Quantitative analysis-Instrumental methods Electromagnetic spectrum, absorption of electromagnetic radiation, Definition and units of frequency, wavelength, wave number, Beer's law, Beer-Lambert law derivation, deviations from Beer's law, limitations, construction of calibration graph (Plot of absorbance versus concentration), Evaluation Procedures- standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, dynamic/linearity range, Instrumentation, single beam and double beam spectrophotometers, quantitative applications of colorimetry (determination of Fe, Mo, Cu, Ti and PO_4^{3-}) and numerical problems on application of Beer's law. Nephelometry and Turbidimetry: Introduction, principle, instrumentations of nephelometry and turbidimetry; effects of concentration, particle size and wavelength on scattering; choice between nephelometry, applications of nephelometry and turbidimetry (determination of SO_4^{2-} and PO_4^{3-})	15	Employable Skills
2	Unit -2	Separation methods Fundamentals of chromatography:	15	Employable Skills and analytical Skills

		General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phase and nature of adsorbents. Principles of paper, thin layer, column chromatography. Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version. Paper chromatography: Theory and applications Thin layer chromatography (TLC): Mechanism, R_f value, efficiency of TLC plates, methodology–selection of stationary and mobile phases, development, spray reagents, identification and detection, qualitative applications. Solvent Extraction: Types- batch, continuous, efficiency, selectivity, distribution coefficient, Nernst distribution law, derivation, factors affecting the partition, relationship between % extraction and volume fraction, Numerical problems on solvent extraction. Solvent extraction of iron and copper. Ion exchange chromatography: resins, types with examples- cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion-exchange chromatography (softening of hard water, separation of lanthanides, industrial applications).		
3	Unit-3	Reaction Intermediates: Generation, Stability and Reactions of, i) Carbocations: Dienone-	15	Employable Skills

		phenol; and Pinacol-Pinacolone Rearrangement. ii) Carbanions: Perkin Reaction, Aldol condensation, Claisen-Schmidt condensation. iii) Free Radicals: Sandmeyer Reaction iv) Carbenes and Nitrenes: Singlet and Triplet states, their relative stability and reactions v) Arynes: Formation, detection etc. Methods for Identifying Reaction Mechanism: Product analysis, Isolation and Identification of Intermediates, Stereochemical Evidences, Effect of Catalyst, Crossover experiments, Isotopic studies, Kinetic Studies.		
4	Unit-4	Stereochemistry of Organic Compounds: Fischer projection, Newmann and Sawhorse projection formulae and their interconversions. Geometrical isomerism: Cis-trans and syn-anti isomerism, E/Z notations with C.I.P rules. Optical Isomerism: Optical activity, Specific rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral centres, Diastereoisomers, meso structures, Racemic mixtures and Resolution, Relative and absolute configuration, D/L and R/S designations	15	Employable Skills

References:

- 1) Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, Saunders College Publishing, New York (2005).
- 2) Analytical Chemistry, G.D. Christian, 6th edition, Wiley-India (2007).
- 3) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd.(2007).
- 4) Organic Reaction Mechanism by V.K. Ahluwalia and R.K. Parashar (Narosa Publishers)
- 5) Organic Chemistry by S.M. Mukherji, S.P. Singh and R.K. Kapoor (Narosa Publishers)
- 6) Morrison R.N and Boyd R.N, Organic Chemistry, Darling Kindersley (India) Pvt. Ltd. (Pearson Education)
- 7) Finar I.L, Organic Chemistry (Volume I); Finar I.L (Volume II) Stereochemistry and the Chemistry of Natural Products., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
- 8) Kalsi P.S. Stereochemistry, conformation and Mechanism, New age International
- 9) Eliel E.L and Wilen S.H, Stereochemistry of Organic Compounds, Wiley, (London)

S21 CH 3.2 :Analytical & Organic Chemistry Practicals
Credit Points: 2 **Teaching Hours:4 hrs**

CObj_ID	Course Objectives
CObj_1	To impart skills related to preparation of stock and working solutions and handling of instrumental methods.
CObj_2	To know the principle of colorimetric analysis and construction of calibration plot. .
CObj_3	To understand the chemistry involved in colorimetric determination of metal ions and anion.

CO_ID	Course Outcomes
CO_1	Understand the importance of instrumental methods for quantitative applications.
CO_2	Apply colorimetric methods for accurate determination of metal ions and anions in water or real samples (real samples) can be determined by spectrophotometric, nephelometric and turbidimetric methods.
CO_3	Learn the importance of qualitative tests in identifying functional groups
CO_4	Learn how to prepare a derivative for particular functional groups and how to purify it'.
CO_5	Understand how functional groups in a compound are responsible for its characteristic property.

S21CH 3.2: Analytical & Organic Chemistry Practicals
Credit Points: 2 **Teaching Hours: 4 hrs**

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	PART-A Analytical Chemistry	1) Colorimetric determination of copper using ammonia solution 2) Colorimetric determination of iron using thiocyanate solution 3) Colorimetric determination of nickel using DMG solution 4) Colorimetric determination of titanium using hydrogen peroxide 5) Colorimetric determination of nitrite in a water sample (diazo coupling Reaction/Griess reagent) 6) Colorimetric determination of phosphate as ammonium phosphomolybdate 7) Determination of R _f values of two or three component systems by TLC 8) Separation of different metal ions by paper chromatography/ Solvent extraction of iron using oxine solution (demonstration)	30	Analytical Skills

2	PART-B Physical Chemistry	PART-B (Organic Chemistry) 9) Qualitative analysis of bifunctional Organic compounds such as 1) Salycilic acid, p-Nitro benzoic acid, Antranilic acid, p-Chloro benzoic acid 2) o-Cresol, p-Cresol, Resorcinol, o-Nitrophenol, p-nitrophenol 3) o-Nitro aniline, p-Nitroaniline, p-Toluidine, p-Chloroaniline, p-Bromoaniline, 4) Ethyl Salicylate, Salicylaldehyde, Acetophenone, p-Dichlorobenzene, p-Nitro toluene, Benzamide etc. (Atleast 6-8 compounds to be analysed in a semester)	30	Research Skills

References

- 1) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd. (2007)
- 2) Vogel's Text Book of Qualitative Chemical Analysis, ELBS

Open Elective-3:

Title of the Course :ATOMIC STRUCTURE, BONDING AND CONCEPTS IN ORGANIC CHEMISTRY

**Contact Hours: 45
week**

Workload: 3 hours per

Credit Points: 3

CObj_ID	Course Objectives
CObj_1	To develop an understanding of principles of atomic structure.
CObj_2	To know the importance of quantum numbers, writing of electronic configurations and representation of orbitals.
CObj_3	To develop an understanding of the periodic trends.

CO_ID	Course Outcomes
CO_1	The concept of atomic structure, significance of quantum numbers, filling of electrons of atoms/ions in various orbitals as per rules the trends in periodic properties .The formation of sigma and pi bonds and the bond strength.
CO_2	Tthe structures of ionic solids, applications of B-H cycle, solubility of compounds and consequences of polarization of ions.
CO_3	The construction of MO energy level diagrams and prediction of properties of molecules/ions like bond order, bond energies, bond lengths and magnetic properties.
CO_4	The shapes of molecules/ions based on VSEPR theory.
CO_5	To develop an understanding of the periodic trends.

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Atomic Structure and Pperiodic Properties History of an atom. Idea of de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation, significance of wave functions, Bohr's model of hydrogen atom and its limitations. Quantum numbers and their importance, atomic orbitals and shapes of s, p, d orbitals, multi-electron atoms, Aufbau's and Pauli exclusion principle and Hund's multiplicity rule- Electronic configurations of the elements (atomic no. up to 30), effective nuclear charge and shielding Periodic Properties Atomic radius, Covalent, ionic and van der Waal radii-explanation with examples. Definition and periodicity of the following properties - ionic radii, ionization potential, electron affinity and electronegativity, methods of determination of electronegativity. Factors affecting the values of ionization energy.	15	Employable Skills
2	Unit -2	Ionic Solids– Ionic structures (NaCl, CsCl, TiO₂, ZnS), radius ratio rule and coordination number, limitation of	15	Employable Skills

		radius ratio rule, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule and their consequences. Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization with examples and shapes of simple inorganic molecules and ions. Shapes of NH_3, I_3^+, I_3^-, SF_4, ClF_3, IF_5, ICl_2^- and H_2O using valence shell electron pair repulsion (VSEPR) theory, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, physical picture of bonding and antibonding wave functions. Applications of MO theory to explain the stability of homo dinuclear (He_2, N_2, O_2, F_2, C_2) and hetero binuclear (NO and CO) molecules. Comparison of M.O. and V.B. Models. Metallic bond-free electron, Band theory-electrical properties of metals, semiconductors and insulators. Weak interactions – Hydrogen bonding and its consequences, van der Waals forces.		
3	Unit-3	Bonding and molecular structure and hydrocarbons	15	Employable Skills

		Bonding and molecular structure: Introduction to organic chemistry, atomic orbitals, sigma and pi bond formation-molecular orbital [MO] method, sp, sp² and sp³ hybridization, bond length, bond dissociation energies and bond angles (open chain and cyclic compounds). Electronegativity and polarity of the bonds. Classification and reactions of organic compounds (with examples). Aliphatic Hydrocarbons: Alkanes, Alkenes and Alkynes Definition, Nomenclature, preparations (any two methods) Reactions: Electrophilic, nucleophilic and free radical addition reactions Alicyclic compounds: Nomenclature, preparation and stability of cyclopropane, cyclobutane, Cyclopentane and cyclohexane.		

Reference Books:

1. J. D. Lee Concise Inorganic Chemistry, ELBS, 1996.
2. A. K. Das Fundamental Concepts of Inorganic Chemistry, CBS; 2nd edition (2019)
3. James E. Huheey, Ellen A. Keiter, Richard L. Keiter Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India; 4th edition (2006)
4. Shriver, D.F. & Atkins, P.W =Inorganic Chemistry, Oxford University Press (2009)
5. Morrison and Boyd Organic Chemistry Sixth Edition by Pearson Education India; 7th edition (2010)
6. I.L. Finar Organic Chemistry Vol. 1 Pearson Education India; 6th edition (2002)



MATRIX AND SYLLABUS

For the Programme B.Sc. (Chemistry/ Microbiology)

Chemistry

NEP Based Curriculum (2021 onwards)

IV Semester

Code	Course Code	Course	Teaching Hours	Course Components		
				L	T	P
AECC	S21KN 4.1/ S21HN4.1/ S21AE 4.1	Language I (Kannada/Hindi/Additional English)	45	3	1	-
AECC	S21GE4.1	Language II (Generic English)	60	3	1	-
AECC	21SBC 4.1	Constitution of India	45	2	1	-
DSC4	S21 MB 4.1	Microbial Enzymology and Metabolism	60		4	
DSC4	S21 MB 4.2	Microbial Enzymology and Metabolism practical	45			4
DSC4	S21 CH 4.1	Inorganic & Physical-II Chemistry-II	60	-	4	-
DSC4	S21 CH 4.2	Inorganic & Physical Chemistry Practicals-II	60	-	-	4
OE-4	OEC MB 4.1/ OE- 4.1	Microbial Biotechnology/Electrochemistry, corrosion and Metallurgy	45	3	-	-
SEC-VB	21VBC 4.1	Sports	30	-	-	2
SEC-VB	21VBC 4.2	NCC/NSS/Cultural	30	-	-	2
Total						

Note 1:

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses
End Semester Examination: 60%
Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)		20	20
i. Writing	10		
ii. Classwork	05		
iii. Classroom participation	05		
Total			40

Continuous Internal Assessment – Scheme of Evaluation
For Practical Courses
End-Semester Examination: 50%
Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)	
Maximum Marks (Internal Assessment)	25
1. Weightage (Marks)	15
2. Record work (Marks)	05
3. Viva	05
Total (Marks)	25

DSC-4

S21CH4.1: Inorganic and Physical Chemistry-II

**Contact Hours: 60
Hours/Week.**

Work load: 4

Credit Points: 4

**Evaluation: Continuous Internal Assessment-40 Marks Semester End
Examination -60 Marks**

CObj_ID	Course Objectives
CObj_1	Different types of bonding in molecules/compounds/ions Properties of compounds based on bonding and structure
CObj_2	Electrochemistry dealing with electrolytes in solution.
CObj_3	Properties of compounds based on bonding and structure.

CO_ID	Course Outcomes
CO_1	Predict the nature of the bond formed between different elements
CO_2	Identify the possible type of arrangements of ions in ionic compounds
CO_3	Relate different energy parameters like, lattice energy, entropy, enthalpy and solvation energy in the dissolution of ionic solids
CO_4	Explain covalent nature in ionic compounds

CO_5	To develop an understanding of the periodic trends

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Structure and Bonding -I The ionic bond: Structures of ionic solids Radius ratio rules, Calculation of some limiting radius ratio values, Coordination number 3 (planar triangle), Coordination number 4 (tetrahedral and square planar), Coordination number 6 (octahedral), Close packing, Classification of ionic structures: Ionic compounds of the type AX (ZnS, NaCl, CsCl) Ionic compounds of the type AX₂ (Calcium fluoride (fluorite) and Rutile structure Layer structures CdI₂, Cadmium iodide structure Limitations of radius ratio concept. Lattice energy and Born-Haber cycle, Derivation of Born-Landé equation and its drawbacks, Kapustinskii equation, solvation energy and solubility of ionic solids, polarizing power and polarizability, Fajan's rules with applications. Numerical problems Covalent bond: Valence bond theory, The Lewis theory, The octet rule, Exceptions to the octet rule, Sidgwick-Powell theory. Valence shell electron pair repulsion (VSEPR) theory, Effect of lone pairs, electronegativity, isoelectronic principle, Examples using VSEPR theory: BF₃ and BF₄⁻, NH₃ and NH₄⁺, H₂O, PCl₅, ClF₃, SF₄, I₃⁻ and I₃⁺, SF₆, and IF₇. Limitations of VSEPR	15	Employable Skills
2	Unit -3	Structure and Bonding -II Concept of resonance, resonance energy, hybridisation, types of hybridization, sp, sp², sp³ dsp²		Employable Skills

	dsp^3, d^2sp^3, sp^3d^2 with one example each, and energetics of hybridization. Bent's rule, Limitations of Valence Bond Theory. Molecular Orbital theory: LCAO concept: s-s, s-p, p-p, p-d and d-d combinations of orbitals, bonding, nonbonding and antibonding molecular orbitals, non-bonding combinations of orbitals, Rules for linear combination of atomic orbitals Examples of molecular orbital treatment for homonuclear diatomic molecules H_2 molecule, H^+ He_2 molecule, He^+ molecule ion, Li_2 molecule Be_2 molecule B_2 molecule, C_2 molecule, N_2 molecule, N_2^+, O_2 molecule O_2 molecule, O_2^- and O_2^{2-} M.O. energy diagrams of heteronuclear diatomic molecules with examples (NO, NO^+ CO and HCl). Calculation of bond order, relationship between bond order, bond energy and bond length, magnetic properties based on MOT. Metallic Bonding: General properties of metals: Conductivity, Lustre, Malleability and cohesive force Crystal structures of metals and Bond lengths Theories of bonding in metals: Free electron theory, Valence bond theory, Molecular orbital or band theory of solids Prediction of conducting properties of conductors. insulators and semiconductors, extrinsic and intrinsic semiconductors using		

		M.O. theory		
3	Unit -3	First Law of Thermodynamics- Thermodynamic Processes, Reversible and Irreversible Processes, Nature of Heat and Work, Internal Energy, First Law of Thermodynamics, Enthalpy of a System, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule -Thomson Expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters Second law of Thermodynamics Concept of entropy, thermodynamic scale of temperature, Statements of the Second Law of Thermodynamics, molecular and statistical interpretation of entropy, Calculation of entropy change for reversible and irreversible processes, Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation. Third Law of Thermodynamics Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Types of Catalysis and theories with examples (intermediate	15	Employable Skills

		compound theory and adsorption theory), Theory of acid base catalysis, Michaelis-Menten mechanism. Catalysis Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements		
4	Unit-4	Chemical Kinetics Differential and integrated form of rate expressions up to second order reactions, Derivation of expression of rate constant of second order reaction ($a=b$ and $a \neq b$), Problems on rate constant ($a=b$), Methods of determination of order of a reaction, temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates, Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide. Electrochemistry – I Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and	15	Employable Skills

		molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems. Kohlrausch's law of independent migration of ions and its applications, Debye-Hückel-Onsager equation. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems.		

Reference Books

1. Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford University Press (2010)
2. G W Castellan, Physical Chemistry, 4th Ed., Narosa (2004)
3. R G Mortimer, Physical Chemistry 3rd Ed., Elsevier: Noida, UP (2009)
4. B R Puri, L R Sharma and M S Pathania, Principles of Physical Chemistry, Vishal Publishing Co.
5. B S Bahl, G D Tuli and Arun Bahl, Essentials of Physical chemistry, S Chand & Company Ltd.
6. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age International Publishers.
7. B N Bajpai, Advanced Physical chemistry, S Chand and Company Ltd.
8. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and Company Ltd.
9. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons.

DSC-4

S21CH4.2 : Inorganic and Physical Chemistry Practicals -II

Credit Points: 2

Teaching Hours: 4Hrs

Evaluation: Continuous Internal Assessment-20 marks Semester End

Examination: 30 marks

Course objectives:

CObj_ID	Course Objectives
CObj_1	Analytical skills in detecting the constituents present in unknown samples by systematically carrying out the qualitative analysis.
CObj_2	The methods of determining rates of chemical reactions.
CObj_3	Designing electrochemical cells and making measurements related to it.

CO_ID	Course Outcomes

CO_1	Understand the chemical reactions involved in the detection of cations and anions.
CO_2	Explain basic principles involved in classification of ions into groups in semi-microqualitative analysis of salt mixture
CO_3	Carryout the separation of cations into groups and understand the concept of commonion effect.
CO_4	Understand the choice of group reagents used in the analysis
CO_5	Analyse a simple inorganic salt mixture containing two anions and cations

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	PART-A Inorganic Chemistry Practicals	Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of different reactions. The following cations and anions are suggested. Cations: NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^+, K^+ and Li^+. Anions: CO_3^{2-}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-}, $\text{C}_2\text{O}_4^{2-}$ and PO_4^{3-}-Spot tests and flame tests to be carried out wherever possible.	30	Analytical skills

2	PART-B Physical Chemistry Practicals	1) Determination of the enthalpy of neutralization of a strong acid with strong base. 2) Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal. 3) The study of kinetics of potassium persulphate and potassium iodide volumetrically. 4) Determination of velocity constant for acid catalyzed hydrolysis of methyl acetate. 5) Determination of velocity constant for the saponification of ethyl acetate (a = b) volumetrically. 6) Determination of equivalent conductivity of strong electrolyte and verification of DHO equation. 7) Determination of dissociation constant of weak acid by conductivity method. 8) Conductometric titration of strong acid and strong base. 9) Conductometric titration of weak acid and strong base. 10) Determination of the hydrolysis constant of aniline hydrochloride conductometrically. 11) Determination of solubility product of sparingly soluble salt conductometrically	30	Analytical skills

References

1. Vogel's Qualitative analysis, Revised by G. Svehla, Pearson education, 2002
2. J B Yadav, Advanced Physical Chemistry, Krishna Prakashan Media (P) Ltd, Meerut.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

4. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
5. Halpern, A. M. & Mc Bane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

Open Elective-4

Title of the Course: Electrochemistry, Corrosion and Metallurgy

Contact Hours: 42

Workload: 3 hours per week

Credit Points: 3

Evaluation: Continuous Internal Assessment - 40 marks

Semester End Examination - 60 marks

This course provides a broad introduction to the fundamental principles of Electrochemistry, Corrosion and Metallurgy. The student will gain an understanding of basic and practical applications in various fields of Electrochemistry, Corrosion and Metals and Alloy behaviour and manufacturing processes. This course is a valuable prerequisite for taking more technically challenging courses that will be required for career development

Course objective:

CObj_ID	Course Objectives
CObj_1	Types of conductance, concept of electrolytes, electrolysis, redox reactions and EMF
CObj_2	Concept of different types of electrochemical cells, Types of electrodes and electrode potential. Application of electrochemical series.
CObj_3	Basic principles and applications of conductometric, potentiometric and pH titrations.

CO_ID	Course Outcomes
CO_1	Understand the concept of conductance in electrolytic solutions, electrolysis and redox reactions involved in electrode reactions.
CO_2	Learn the different types of electrochemical cells, their symbolical representation and application of electrochemical series.
CO_3	Apply conductometric, potentiometric and pH titrations.
CO_4	Know the principle, construction and working of batteries.
CO_5	Understand different types of corrosion and its prevention by different methods.

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed

1	Unit -1	Electrochemistry Conductance, specific and molar conductance Types of Electrolytes, Conductivity in electrolytic solution, Electrolysis, Kohlrausch's law and its application, Equivalent Conductance of Weak electrolyte at Infinite dilution. Oxidation -reduction reactions, electrode potential, EMF of an electrochemical cell, cell reaction, Daniel cell, dry Cells - electrolytic and Galvanic cell, Representation of a cell. Standard electrode potential, Nernst equation (No derivation) and its application to chemical cell, Electrochemical series and its importance. Types of Electrodes. Basic Principles of (i) Conductometric titrations- HCl Vs NaOH, CH₃COOH Vs NaOH (ii) Potentiometric titrations: Acid-base titration HCl Vs NaOH, Redox titration(FAS Vs K₂Cr₂O₇) Determination of P^H using glass electrode. Batteries- Primary and Secondary batteries, Battery components and their role. Working of the following Batteries- Lead acid, Lithium Storage, Batteries, Fuel cells	15	Employable Skills

2	Unit -2	Corrosion: Introduction, definition, Types of Corrosion, Corrosion rate, Factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen over voltage, nature of corrosion product. Environmental Factors- Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity of the medium, velocity of the medium, concentration of the medium. Prevention of Corrosion: Material selection - Metals and alloys, metal purification, non-metallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating. Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electro less plating: Introduction, distinction between electroplating and electrodes plating processes. Electroless plating of copper.	15	Employable Skills
3	Unit -3	Metallurgy Introduction: Ore, minerals, important ores of some common elements in India, General Principles of pyro metallurgy, roasting, Calcination, Gangue,	15	Employable Skills

		Smelting, Flux, Gravity separation, Froth flotation process, leaching. Techniques employed for Purification of metal (Distillation process, Bessemerization, Electro-refining, Van Arkel and De Boer's Filament. Extraction of metals: Extraction of Manganese (Pyrolusite), Titanium (Ilmanite) and Uranium. Alloys: Introduction, Classification of alloys, commercially important alloys, gold karats, Production of Ferro alloys; Ferrochrome, Ferro Manganese, Uses of alloys.		

Reference Books

1. Barrow. G.M, Physical Chemistry, Tata McGraw-Hill, (2007)
2. An introduction to electrochemistry, Samuel Glasstone, East-West edition New Delhi, (1942)
3. Text book of physical chemistry, Samuel Glasstone, 2nd Edition, Mac Millan India Ltd, (1991)
4. Principles and applications of Electrochemistry, D. R. Crow, 3rd edition, Chapmanhall London, (1988)
5. Fundamentals of electrochemical deposition, Milan Paunovic and Mordechai Schlesinger, Wiley Interscience Publications, New York, (1998)
6. Engineering Chemistry, V R Kulkarni and K Ramakrishna Reddy, New Age International, (2015)
7. Electrochemistry and Corrosion Science, Nestor Perez, Springer (India) Pvt. Ltd., (2004)
8. Principles and Prevention of Corrosion, D. A. Jones, Macmillan Publ. Co., (1996)
9. Essential of Materials Science and Engineering, Donald R. Askeland, Thomson Learning, 5th Edition, (2006)
10. Introduction to Engineering Materials, B. K. Agarwal, Tata McGraw Hill, 1st Edition

(2013)

11. Material Science and Engineering, V. Raghavan, PHI Learning, 5th Edition (2004)
12. Engineering Materials and Metallurgy, R. K. Rajput, S. Chand - 1st Edition, (2011)



MATRIX AND SYLLABUS

For the Programme Bachelor of Computer Applications (B.C.A)

NEP Based Curriculum (2021 onwards)

I Semester

NEP- Curriculum Framework

Bachelor of Computer Applications (B.C.A) - Course Matrix (w.e.f. 2021 onwards)

I SEMESTER							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	B21KN1.1/ B21HN1.1/ B21AE1.1	Language-1 (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	B21GE1.1	Language-2 (Generic English)	60	3	1	-	3
DSC1	B21DC 1.1	Discrete Structures	45	2	1	-	3
DSC1	B21DC 1.2	Problem Solving Techniques using C	45	2	1	-	3
DSC1	B21DC 1.3	Data Structures	45	2	1	-	3
DSC1	B21DC 1.4	C-Programming Lab	60	-	-	4	2
DSC1	B21DC 1.5	Data Structures Lab	60	-	-	4	2
OE-1	B21OE 1.1	Office Automation and Designing	45	2	1	-	3
SEC-SB	21SBC 1.2	Office Management Tools	30	-	-	2	2
SEC-VB	21VBC 1.1	Health and Well-being	30	-	-	2	1
SEC-VB	21VBC 1.2	Physical Education-Yoga	30	-	-	2	1
Total							26

Note:

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

DSE – Discipline-Specific Elective

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii.Quiz / Presentation	05		
iii. Classroom participation	05		
Total			40

For Practical Courses

End Semester Examination: 50%

Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)

Activities	Total Marks
1. Lab Performance	10
2. Observation record	05
3. Internal exam	10
Total	25

B21DC 1.1: DISCRETE STRUCTURES**THEORY****Total Teaching Hours: 45****No. of Hours per Week: 3****(3 credits)**

CObj	Course Objectives
CObj_1	To provide a strong understanding of the concepts of sets, relations and functions.
CObj_2	To provide good foundation of probabilities and statistical analysis
CObj_3	To distinguish between discrete and continuous random variables and to compute probabilities using discrete and continuous distribution.

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Demonstrate the basic principles of sets and operations, relations and functions, mathematical induction.
CO2	Acquire ability to implement propositional and counting principles.
CO3	Apply the recurrence relations in computer science specific problem domains
CO4	Compute probabilities using discrete and continuous distribution and apply in real world problems
CO5	Gain aptitude to implement practical solutions using graph theory

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*		*	
CO_2	*	*		*	
CO_3	*	*		*	
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Set Theory and Logic: Fundamentals of Set theory, Set Operations and the Laws of Set Theory, Counting and Venn Diagrams, Cartesian Products and Relations-Definition and types of relations, Representing relations using matrices and digraphs, Functions–One-to-One, Onto Functions, Function Composition and Inverse Functions. Fundamentals of Logic, Propositional Logic, Logical Connectives and Truth Tables, Logic Equivalence.	12 Hrs	Cognitive Skills
2	Unit- II	Mathematical Induction and Counting: Mathematical Induction, Basics of counting, Pigeonhole Principle, Permutation and Combinations, Binomial coefficients. Recurrence relations, Modeling with recurrence relations with examples of Fibonacci numbers and the tower of Hanoi problem. Divide and Conquer relations with examples.	12 Hrs	Analytical / Cognitive Skills
3	Unit- III	Probability: The Concept of Probability-Sample Spaces, Probability as Relative Frequency, Axiomatic Definition of Probability, Properties of Probability, Additive Property, Conditional Probability, Multiplicative Law of Probability, Law of Total Probability, Bayes' Formula, Independent Events. Random Variables, Distribution Functions, Discrete Random Variables, Continuous Random Variables, Probability Mass Function and Probability Density Function, Expectation and Variance.	10 Hrs	Cognitive / Synthesis Skills
4	Unit- IV	Graph Theory: Graphs: Introduction, Representing Graphs in memory, Graph Isomorphism, Operations on graphs. Trees: Introduction, Applications of Trees, Tree Traversal, Spanning Trees, Minimum cost Spanning Trees, Prim's and Kruskal's Algorithms. Euler and Hamiltonian Paths, Planar Graphs. Directed graphs: Fundamentals of Digraphs, Directed Graphs, Out-degree, in-degree, orientation, Eulerian and Hamilton directed graphs, tournaments.	11 Hrs	Cognitive / Analytical / Synthesis Skills

Books for Reference:

1. Kenneth H Rosen, Kamala Krithivasan (2022). Discrete Mathematics and its Applications (8th Edition). Mc Gram Hill.
2. S C Gupta and V K Kapoor (2020). Fundamentals of Mathematical Statistics (12th Edition). Sultan Chand & Sons.
3. S C Gupta(2018). Fundamentals of Statistics (7th Edition). Himalaya Publishing House.
4. Balakrishnan (2019).A text book of Graph Theory (2nd Edition).Springer.
5. Sheldon M Ross. (2020). Introduction to Probability and Statistics for Engineers and Scientists. (6th edition). Academic Press.
6. J. P. Tremblay and R.P. Manohar. (2017). Discrete Mathematical Structures with applications to Computer Science. Mc Graw Hill Ed. Inc.
7. Michael Baron. (2019). Probability and Statistics for Computer Scientists. (3rd Edition). CRC.

Web Resources:

1. <https://www.my-mooc.com/en/categorie/mathematics>
2. <http://www.nptelvideos.in/2012/11/discrete-mathematical-structures.html>
3. <https://ocw.mit.edu/courses/mathematics/>

B21DC 1.2: PROBLEM SOLVING TECHNIQUES USING C**THEORY****Total Teaching Hours: 45****No. of Hours per Week: 3****(3 credits)**

CObj	Course Objectives
CObj_1	To inculcate necessary skills, design algorithms and flowcharts for developing applications to solve real world problems.
CObj_2	To provide appropriate knowledge of structured programming concepts using C.
CObj_3	To inculcate the ability to develop modular programs and small projects in C.

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Devise algorithms and draw flow charts to provide solutions to problems.
CO2	Develop C programs by using the program constructs efficiently.
CO3	Apply proper data structure to efficiently store and retrieve data in memory.
CO4	Design modular programs to solve real world problems.
CO5	Create mini projects in C

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	
CO_2	*	*	*	*	
CO_3	*	*	*	*	
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Introduction: The Role of Algorithms in Computing, Algorithms as a technique, Designing algorithms, Fundamental Algorithms: Finding the largest of three numbers, Exchanging the values of two variables, Counting, Summation of a set of numbers, Factorial Computation, Generating of the Fibonacci sequence, Reversing the digits of an integer, Checking if a given number is prime or not, Summation of two matrices.	10 Hrs	Cognitive Skills
2	Unit- II	C Programming: Getting Started, Variables and Arithmetic expressions. Input and Output: Standard input and output, formatted output-printf, variable length argument list, formatted input-scanf. Control Flow: Statements and Blocks, If-else, else-if, switch, loops: while loop, for loop, do while, break and continue, goto and labels. Factoring Methods: Finding the square root of a number, the smallest Divisor of an integer, the greatest common divisor of two integers, computing the prime factors of an integer, generation of pseudo random numbers, raising a number to a large power.	12 Hrs	Analytical / Cognitive / Employable Skills
3	Unit- III	Arrays: Definition, Linear arrays, Traversing Linear arrays, Inserting and deleting, Multi-dimensional arrays, Matrices and Sparse matrices. Array Techniques: Array order Reversal, Finding the maximum number in a set, removal of duplicates from an ordered array, partitioning an array, Finding the kth smallest element, multiplication of two matrices. Command line arguments. Storage classes. Structures and Unions in C. Preprocessor directives, Macros in C.	12 Hrs	Cognitive / Employable Skills Synthesis Skills
4	Unit- IV	Functions in C: Types of Functions, Passing arguments to functions, Nested and recursive functions in C. Pointers in C: pointers and address. Pointers as function arguments. Text processing and Pattern searching: User-defined functions to perform various string related operations, Naïve string pattern matching algorithm. User-defined header files.	11 Hrs	Analytical / Cognitive / Employable Skills Synthesis Skills

Books for Reference:

1. R.G.Dromey. (2008). How to Solve it by Computer. Pearson Education India.
2. Thomas H. Cormen, Charles E. Leiserson. (2009). Ronald L. Rivest, Clifford Stein, Introduction to Algorithms. 3rd Edition, The MIT Press Cambridge, Massachusetts London, England.
3. Brain M. Kernighan, and Dennis M. Ritchie. (2012). The C Programming Language. (2nd edition). Princeton Hall Software Series.
4. E. Balagurusamy. (2019). Programming in ANSI C. 8th Edition, McGrawHill
5. Steven S. Skiena. (2008). The Algorithm Design Module. 2nd Edition, Springer-Verlag London Limited.
6. Donald E. Knuth. (1997). The Art of Computer Programming. Volume 1: Fundamental Algorithms, 3rd Edition, Addison Wesley Longman.
7. Donald E. Knuth. (1998).”The Art of Computer Programming. Volume 2: Seminumerical Algorithms, 3rd Edition, Addison Wesley Longman.
8. Greg Perry and Dean Miller. (2014). C programming Absolute Beginner’s Guide. (3rd edition). Pearson Education, Inc.
9. Ashok N. Kamthane. (2006). Programming with ANSI and Turbo C. Pearson Education.

Web Resource:

1. <http://algorithmsforinterviews.com> Algorithms for Interviews
2. https://onlinecourses.nptel.ac.in/noc20_cs06/preview

B21DC 1.3 : DATA STRUCTURES

THEORY

Total Teaching Hours: 45

No. of Hours per Week: 3

(3 credits)

CObj	Course Objectives
CObj_1	To impart knowledge on storing and managing data in various structures
CObj_2	To emphasize the importance of data structures in developing and implementing efficient algorithms
CObj_3	To provide an understanding of the operations on different data structures and their applications

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Demonstrate an understanding of the concepts, types and operations of data structures
CO2	Sort, search and implement higher order data structure using arrays.
CO3	Apply concepts of dynamic memory allocation, linked list in developing solutions to real world problems
CO4	Apply the concept of Stacks and Queues in real world applications
CO5	Identify and apply appropriate graph and tree data structure to solve a given problem.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*		*	
CO_2	*	*		*	
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Introduction and Overview: Definition, Elementary data organization, Data Structures, data Structures operations, Abstract data types. control structures, Complexity of algorithms, asymptotic notations for complexity of algorithms, time-space trade off. Arrays as data structure, arrays as ADT, Representation of Linear Arrays in Memory. Searching:, Sequential Search, Binary Search, Comparison of search Methods.	10 Hrs	Cognitive Skills
2	Unit- II	Linked list: Definition, Representation of Singly Linked List in memory, Traversing a Singly linked list, Searching in a Singly linked list, Memory allocation, Garbage collection, Insertion into a singly linked list, Deletion from a singly linked list; Doubly linked list, Header linked list, Circular linked list. Stacks: Definition, Array representation of stacks, Linked representation of stacks, Stack as ADT, Arithmetic Expressions: Polish Notation, Conversion of infix expression to postfix expression, Evaluation of Postfix expression, Application of Stacks, Recursion, Towers of Hanoi, Implementation of recursive procedures by stack.	12 Hrs	Analytical / Cognitive Skills
3	Unit- III	Queues: Definition, Array representation of queue, Linked list representation of queues. Types of queue: Simple queue, Circular queue, Double-ended queue, Priority queue, Operations on Queues, Applications of queues. Binary Trees: Definitions, Tree Search, Traversal of Binary Tree, Building a Binary Search Tree, Tree Sort, Height Balance: AVL Trees, Contiguous Representation of Binary Trees: Heaps, Applications of Trees. Graphs: Mathematical Background, Computer Representation, Graph Traversal	12 Hrs	Cognitive / Synthesis Skills
4	Unit- IV	Sorting: Introduction and Notation, Bubble sort, Insertion Sort, Selection Sort, Divide And Conquer: Merge sort, Quick sort. Hashing: Sparse Tables, Choosing a Hash function, Collision Resolution with Open Addressing, Collision Resolution by Chaining.	11 Hrs	Cognitive / Analytical / Synthesis skills

Books for Reference:

1. Seymour Lipschutz. (2011). Data Structures with C. Schaum's outLines, Tata Mc Graw Hill,.
2. Robert Kruse. (2009). C.L.Tondo, Bruce Leung, Shashi Mogalla, Data Structures and Program Design using C. Pearson Education.
3. Mark Allen Weiss. (2013). Data Structures and Algorithm Analysis in C. Second Edition, Pearson Education.
4. Forouzan. (2008). A Structured Programming Approach using C. 2nd Edition, Cengage Learning India.
5. Ellis Horowitz. (2008). Fundamentals of Data Structures in C". Second Edition, Universities Press.

Web Resource:

1. <https://www.geeksforgeeks.org/data-structures/>
2. <https://www.javatpoint.com/data-structure-tutorial>

B21DC 1.4: C PROGRAMMING LAB

PRACTICAL

Total Teaching Hours: 60

No. of Hours per Week: 4

(2 credits)

Programs	Skills Developed
1. Write a C program to read radius of a circle and to find area and circumference 2. Write a C program to read three numbers and find the biggest of three 3. Write a C program to check whether the number is prime or not 4. Write a C program to read a number, find the sum of the digits, reverse the number and check it for palindrome 5. Write a C program to read numbers from keyboard continuously till the user presses 999 and to find the sum of only positive numbers 6. Write a C program to read percentage of marks and to display appropriate message (Demonstration of else-if ladder) 7. Write a C program to find the roots of quadratic equation 8. Write a C program to read marks scored by n students and find the average of marks (Demonstration of single dimensional array) 9. Write a C program to remove Duplicate Element in a single dimensional Array 10. Write a C program to perform addition and subtraction of Matrices 11. Write a C program to find factorial of a number 12. Write a C program to generate fibonacci series 13. Write a C program to remove Duplicate Element in a single dimensional Array 14. Write a C program to find the length of a string without using built in function 15. Write a C program to demonstrate string functions 16. Write a C program to read, display and add two m x n matrices using functions	Employable / Analytical Skills

17. Write a C program to read a string and to find the number of alphabets, digits, vowels, consonants, spaces and special characters. 18. Write a C program to Swap Two Numbers using Pointers 19. Write a C program to demonstrate student structure to read & display records of n students 20. Write a C program to demonstrate the difference between structure & union.	

B21DC 1.5: DATA STRUCTURES LAB

PRACTICAL

Total Teaching Hours: 60

No. of Hours per Week: 4

(2 credits)

List of Programs	Skills Developed
1. Write a program to implement Linear search 2. Write a program to implement Binary search 3. Write a program to implement Bubble Sort Algorithm 4. Write a program to implement Selection Sort Algorithm 5. Write a program to implement Stack data structure 6. Write a program to convert an infix expression to its postfix expression 7. Write a program to evaluate a postfix expression 8. Write a recursive program to find GCD of three numbers. 9. Write a program to insert the elements into a linear queue and delete elements from the list. Display your list after each insertion and deletion. 10. Write a program to insert the elements into a circular queue and delete elements from the queue. Display your queue after each insertion and deletion. 11. Write a program to insert the elements into a singly linked list and delete elements from the list. Display your list after each insertion and deletion. 12. Write a program to create a binary tree and find the height of the tree 13. Write a program to create a binary search tree with the elements and perform inorder, preorder and post order traversal. 14. Write a program to Sort the following elements using heap sort 15. Given two strings perform the following: I. Find the length of the string II. Concatenate the strings III. Extract the substring IV. Replace a string with another string	Employable / Analytical / Cognitive Skills

21SBC 1.1: OFFICE MANAGEMENT TOOLS

PRACTICALS

Total Teaching Hours: 30

No. of Hours per Week: 2

(2 credits)

CObj	Course Objectives
CObj_1	To provide hands-on experience on word processing
CObj_2	To impart the skills to work on data using spreadsheets
CObj_3	To equip the skills to design presentations

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Demonstrate an understanding of creating formatted documents
CO2	Acquire skills to analyze data using spreadsheets
CO3	Design attractive presentations
CO4	Create charts in spreadsheets and visualize the data
CO5	Demonstrate an understanding of the usage of common shortcut keys in the office management tools

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*		*	
CO_2	*	*		*	
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I Word Processing	Working with Documents - Formatting page & setting Margins, Converting files to different formats, Importing & Exporting documents, Sending files to others, Using Toolbars, Ruler, Using Icons, using help, Formatting Documents - Setting Font styles, Font selection, Setting Paragraph style, Alignments, Indents, Line Space, Margins, Bullets & Numbering. Setting Page style - Formatting Page, Page tab, Margins, Layout settings, Paper tray, Border & Shading, Columns, Header & footer, Setting Footnotes & endnotes – Shortcut Keys; Inserting manual page break, Creating sections & frames, Anchoring & Wrapping, Table of Contents, Index, Creating Master Documents, Web page. Creating Tables- Table settings, Borders, Alignments, Insertion, deletion, Merging, Splitting, Sorting, and Formula, Drawing - Inserting ClipArts, Tools – Word Completion, Spell Checks, Mail merge, Templates, Creating contents for books, Creating Letter/Faxes, Creating Web pages, Using Wizards, Tracking Changes, Security, Digital Signature. Printing Documents Skill based exercises to be done: 1. Creating the documents with Special effects like underline, bold, different size, different font and different color. 2. Creating Paragraphs Inserting Date & Time, Pictures, Bullets & Numbering, indentation etc. in MS-Word, librewriter 3. Formatting features of MS-Word: it includes paper-size, margins, header and footer, page no. and creation of table options. 4. Creation of mail merge for sending the new year wish to your class group.	10 Hrs	Transferable / Employable / Cognitive Skills
2	Unit- II Spreadsheet	Spread Sheet & its Applications, Opening Spreadsheet, Menus - main menu, Formula Editing, Formatting, Toolbars, Using Icons, Using help, Shortcuts, Spreadsheet types. Working with Spreadsheets- opening, Saving files, setting Margins, Converting files to different formats (importing, exporting, sending files to others), Spread sheet addressing - Rows, Columns & Cells, Referring Cells	15 Hrs	Transferable / Employable / Cognitive / Analytical Skills

		& Selecting Cells – Shortcut Keys. Entering & Deleting Data- Entering data, Cut, Copy, Paste, Undo, Redo, Filling Continuous rows, columns, Highlighting values, Find, Search & replace, Inserting Data, Insert Cells, Column, rows & sheets, Symbols, Data from external files, Frames, Clipart, Pictures, Files etc, Inserting Functions, Manual breaks, Setting Formula - finding total in a column or row, Mathematical operations (Addition, Subtraction, Multiplication, Division, Exponentiation), Using other Formulae. Formatting Spreadsheets- Labelling columns & rows, Formatting- Cell, row, column & Sheet, Category - Alignment, Font, Border & Shading, Hiding/ Locking Cells, Anchoring objects, Formatting layout for Graphics, Clipart etc., Worksheet Row & Column Headers, Sheet Name, Row height & Column width, Visibility - Row, Column, Sheet, Security, Sheet Formatting & style, Sheet background, Colour etc, Borders & Shading – Shortcut keys. Working with sheets – Sorting, Filtering, Validation, Consolidation, and Subtotal. Creating Charts - Drawing. Printing. Using Tools – Error checking, Spell Checks, Formula Auditing, Creating & Using Templates, Pivot Tables, Tracking Changes, Security, Customization. Skill based exercises to be done: 1. Creating Worksheets in Excel-, Inserting, Deleting, Copying, Moving worksheets in Excel Usage of formulas, Built-in functions in Excel 2. Graph-Plotting facilities in MS Excel 3. Writing conditional expressions (using IF) and Using logical functions (AND, OR, NOT) Using lookup and reference functions (VLOOKUP, HLOOKUP, MATCH, INDEX) 4. Data Validations :Specifying a valid range of values for a cell, Specifying a list of valid values for a cell, Specifying custom validations based on formula for a cell, Sorting and Filtering Data ,Macro facility in MS Excel		
3	Unit- III Presentation	Introduction to presentation – Opening new presentation, Different presentation templates, Setting backgrounds, Selecting presentation layouts. Creating a presentation - Setting Presentation style, Adding text to the Presentation. Formatting a Presentation - Adding style, Colour, gradient fills, Arranging objects,	5 Hrs	Transferable / Employable / Cognitive Skills

		Adding Header & Footer, Slide Background, Slide layout. Adding Graphics to the Presentation- Inserting pictures, movies, tables etc into presentation, Drawing Pictures using Draw. Adding Effects to the Presentation- Setting Animation & transition effect. Printing Handouts, Generating Standalone Presentation viewer. Skill based exercises to be done: 1. Creating a presentation in PowerPoint-- Inserting/Deleting slides in PowerPoint. 2. Creation of Slide transition and Editing special effects in PowerPoint. 3. Creation of Inserting sound and picture in PowerPoint. 4. Creation of Inserting chart and organization chart in PowerPoint.		

Books for Reference:

1. Wallace Wang. (2018). Microsoft Office 2019 for Dummies. Wiley.
2. Ken Blattman. (2020). Microsoft Excel Formulas & Functions for Dummies. Wiley
3. CA Manmeet Singh Mehta. (2022). Microsoft Excel Professional 2021 Guide. BPB Publications.
4. [Beth Brown](#). (2019). Microsoft PowerPoint 2019 In 90 Pages. Belleyre Books.
5. John Walkenbach, Herb Tyson, Faithe Wempen, Cary N. Prague, Michael R. Groh, Peter G. Aitken, and Lisa A. Bucki. (2007). Office 2007 bible. Wiley.

COMPUTER SCIENCE OPEN ELECTIVE FOR FIRST SEMESTER

B21OE1.1: OFFICE AUTOMATION AND DESIGNING

THEORY

Total Teaching Hours: 45

No. of Hours per Week: 3

(3 credits)

CObj	Course Objectives
CObj_1	To provide hands-on experience on word processing
CObj_2	To impart skills to work on data using spreadsheets
CObj_3	To instill skills to design presentations

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Create formatted documents.
CO2	Analyze and interpret data using spreadsheets.
CO3	Design attractive presentations.
CO4	Create charts in spreadsheets and visualize the data.
CO5	Demonstrate the usage of common shortcut keys in the office management tools.

Course Contents

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Working with Documents -Opening & Saving files, Editing text documents, Inserting, Deleting, Cut, Copy, Paste, Undo, Redo, Find, Search, Replace, Formatting page & setting Margins, Converting files to different formats, Importing & Exporting documents, Sending files to others, Using Tool bars, Ruler, Using Icons, using help, Formatting Documents - Setting Font styles, Font selection- style, size, colour etc, Type face - Bold, Italic, Underline, Case settings, Highlighting, Special symbols, Setting Paragraph style, Alignments, Indents, Line Space, Margins, Bullets & Numbering. Setting Page style - Formatting Page, Page tab, Margins, Layout settings, Paper tray, Border & Shading, Columns, Header & footer, Setting Footnotes & end notes – Shortcut Keys; Inserting manual page break, Column break and line break, Creating sections & frames, Anchoring & Wrapping, Setting Document styles, Table of Contents, Index, Page Numbering, date & Time, Author etc., Creating Master Documents, Web page. Creating Tables- Table settings, Borders, Alignments, Insertion, deletion, Merging, Splitting, Sorting, and Formula, Drawing - Inserting ClipArts, Pictures/Files etc., Tools – Word Completion, Spell Checks, Mail merge, Templates, Creating contents for books, Creating Letter/Faxes, Creating Web pages, Using Wizards, Tracking Changes, Security, Digital Signature. Printing Documents – Shortcut keys.	10 Hrs	Transferable / Employable / Cognitive / Analytical Skills
2	Unit- II	Spread Sheet & its Applications, Opening Spreadsheet, Menus - main menu, Formula Editing, Formatting, Toolbars, Using Icons, Using help, Shortcuts, Spreadsheet types. Working with Spreadsheets- opening, Saving files, setting Margins, Converting files to different formats (importing, exporting, sending files to others), Spread sheet addressing - Rows, Columns & Cells, Referring Cells & Selecting Cells – Shortcut Keys. Entering & Deleting Data- Entering data, Cut, Copy, Paste, Undo, Redo, Filling Continuous rows, columns, Highlighting values, Find, Search & replace, Inserting Data, Insert Cells, Column, rows & sheets, Symbols, Data from external files, Frames, Clipart, Pictures, Files etc, Inserting Functions, Manual breaks, Setting Formula - finding total in a column or row, Mathematical operations (Addition, Subtraction, Multiplication, Division, Exponentiation), Using other Formulae. Formatting Spreadsheets- Labelling columns & rows, Formatting-	15 Hrs	Transferable / Employable / Cognitive / Analytical Skills

		Cell, row, column & Sheet, Category - Alignment, Font, Border & Shading, Hiding/ Locking Cells, Anchoring objects, Formatting layout for Graphics, Clipart etc., Worksheet Row & Column Headers, Sheet Name, Row height & Column width, Visibility - Row, Column, Sheet, Security, Sheet Formatting & style, Sheet background, Colour etc, Borders & Shading – Shortcut keys. Working with sheets – Sorting, Filtering, Validation, Consolidation, and Subtotal. Creating Charts - Drawing. Printing. Using Tools – Error checking, Spell Checks, Formula Auditing, Creating & Using Templates, Pivot Tables, Tracking Changes, Security, Customization.		
3	Unit- III	Introduction to presentation – Opening new presentation, Different presentation templates, Setting backgrounds, Selecting presentation layouts. Creating a presentation - Setting Presentation style, Adding text to the Presentation. Formatting a Presentation - Adding style, Colour, gradient fills, Arranging objects, Adding Header & Footer, Slide Background, Slide layout. Adding Graphics to the Presentation- Inserting pictures, movies, tables etc into presentation, Drawing Pictures using Draw. Adding Effects to the Presentation- Setting Animation & transition effect. Printing Handouts, Generating Standalone Presentation viewer	10 Hrs	Transferable / Employable / Cognitive / Analytical Skills
4	Unit- IV	Introduction to Designing , Open source design tools, card designing, Poster making	10 Hrs	Employable / Cognitive / Analytical Skills

Books for Reference:

1. Wallace Wang. (2018). Microsoft Office 2019 for Dummies. Wiley.
2. Ken Blattman. (2020). Microsoft Excel Formulas & Functions for Dummies. Wiley
3. CA Manmeet Singh Mehta. (2022). Microsoft Excel Professional 2021 Guide. BPB Publications.
4. Beth Brown. (2019). Microsoft PowerPoint 2019 In 90 Pages. Belleyre Books.
5. John Walkenbach, Herb Tyson, Faithe Wempen, Cary N. Prague, Michael R. Groh, Peter G. Aitken, and Lisa A. Bucki. (2007). Office 2007 bible. Wiley.

Web Resources:

1. <https://spreadsheeto.com/excel-crash-course/>
2. <https://24slides.com/presentbetter/powerpoint-101-the-ultimate-tutorial-for-beginners>
3. <https://opentextbc.ca/computerstudies/part/basic-word-processing-skills/>



MATRIX AND SYLLABUS

For the Programme Bachelor of Computer Applications (B.C.A)

NEP Based Curriculum (2021 onwards)

II Semester

NEP- Curriculum Framework

Bachelor of Computer Applications (B.C.A) - Course Matrix (w.e.f. 2021-22 onwards)

II SEMESTER							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	B21KN2.1/ B21HN2.1/ B21AE2.1	Language-1 (Kannada/Hindi/Additional English)	45	3	1		3
AECC	B21GE2.1	Language-2 (Generic English)	60	3	1		3
AECC	21SBC 2.1	Environmental Studies	45	2	1	-	3
DSC2	B21DC 2.1	Computer Architecture	45	2	1	-	3
DSC2	B21DC 2.2	Object Oriented Programming Using Java	45	2	1	-	3
DSC2	B21DC 2.3	DataBase Management Systems	45	2	1	-	3
DSC2	B21DC 2.4	Java Lab	60	-	-	4	2
DSC2	B21DC 2.5	DBMS Lab	60	-	-	4	2
OE-2	B21OE 2.1	Cyber Space	45	2	1	-	3
SEC-VB	21VBC 2.1	NCC/NSS/Cultural	30	-	-	2	1
SEC-VB	21VBC 2.2	Sports	30	-	-	2	1
Total							27

Note:

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

DSE – Discipline-Specific Elective

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii.Quiz / Presentation	05		
iii. Classroom participation	05		
Total			40

For Practical Courses

End Semester Examination: 50%

Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)

Activities	Total Marks
1. Lab Performance	10
2. Observation record	05
3. Internal exam	10
Total	25

B21DC 2.1: COMPUTER ARCHITECTURE**THEORY****Total Teaching Hours: 45****No. of Hours per Week: 3****(3 credits)**

CObj	Course Objectives
CObj_1	To provide an understanding of the basic concepts and structure of computers and concepts of Instruction code and computer register.
CObj_2	To instill knowledge of different types of addressing modes and data transfer techniques.
CObj_3	To provide knowledge of the memory hierarchy and types in computer architecture and concepts of parallel computing.

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Comprehend the fundamental concepts of electronics.
CO2	Demonstrate an understanding of the functional units of a processor.
CO3	Develop an understanding on the addressing modes, instruction formats and program control statements.
CO4	Demonstrate a good understanding of system memory hierarchy.
CO5	Apply the basic concept of parallel computing.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*			
CO_2	*	*	*		
CO_3	*	*			
CO_4	*	*	*	*	*
CO_5	*		*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Number Systems: Binary, Octal, Hexadecimal numbers, base conversion, addition, subtraction of binary numbers, one's and two's complements, positive and negative numbers, character codes ASCII, EBCDIC. Computer Arithmetic: Addition and Subtraction, Multiplication and Division algorithms, Floating-point Arithmetic Operations, Decimal arithmetic operations. Structure of Computers: Computer types, Functional units, Basic operational concepts, Von-Neumann Architecture, Bus Structures, Software, Performance, Multiprocessors and Multicomputer, Digital Logic Circuits: Logic gates, Boolean algebra, Map Simplification. Combinational Circuits: Half Adder , Full Adder, flip flops. Sequential circuits: Shift registers, Counters, IntegratedCircuits, Mux, Demux, Encoder, Decoder. Data representation: Fixed and Floating point.	11 Hrs	Cognitive Skills
2	Unit- II	Basic Computer Organization and Design: Instruction codes, Computer Registers, Computer Instructions and Instruction cycle. Timing and Control, Memory-Reference Instructions, Input-Output and interrupt. Central processing unit: Stack organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Complex Instruction Set Computer (CISC) Reduced Instruction Set Computer (RISC), CISC vs RISC.	11 Hrs	Analytical / Cognitive Skills
3	Unit- III	Register Transfer and Micro-operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro-Operations, Logic Micro-Operations, Shift Micro-Operations, Arithmetic logic shift unit. Micro-programmed Control: Control Memory, Address Sequencing, Micro-Program example, Design of Control Unit. Input Output: I/O interface, Programmed IO, Memory Mapped IO, Interrupt Driven IO, DMA. Instruction level parallelism: Instruction level parallelism (ILP)-overcoming data hazards, limitations of ILP.	12 Hrs	Cognitive Skills

4	Unit- IV	Memory System: Memory Hierarchy, Semiconductor Memories, RAM(Random Access Memory), Read Only Memory (ROM), Types of ROM, Cache Memory, Performance considerations, Virtual memory, Paging, Secondary Storage, RAID. Multiprocessors And Thread level Parallelism: Characteristics of multiprocessors, Multi-Threaded Architecture, Distributed Memory MIMD Architectures, Interconnection structures.	11 Hrs	Cognitive / Analytical skills

Books for Reference:

1. Mano M Morris.(2019).Computer System Architecture. (3rd edition). Pearson India.
2. William Stallings.(2016). Computer Organization and Architecture designing for performance. (10th edition). Pearson
3. Subrata Ghoshal, Computer Architecture And Organization. Pearson India(2011).
4. Andrew S. Tanenbaum.(2006). Structured Computer Organization. (5th edition). Pearson Education Inc
5. Carl Hamacher, Zvonks Vranesic, SafeaZaky.(2002). Computer Architecture And Organization. (5th edition) McGraw Hill New Delhi, India.
6. Kai Hwang.(2008) , Advanced Computer Architecture - Parallelism, Scalability, Programmability. Tata McGraw-Hill.

Web Resources:

1. <https://www.javatpoint.com/computer-organization-and-architecture-tutorial>
2. <https://www.geeksforgeeks.org/computer-organization-and-architecture-tutorials/>

B21DC 2.2: OBJECT ORIENTED PROGRAMMING USING JAVA

THEORY

Total Teaching Hours: 45

No. of Hours per Week: 3

(3 credits)

CObj	Course Objectives
CObj_1	To impart knowledge of object-oriented programming concepts using Java
CObj_2	To instill the skills to create graphical user interface using graphical tools
CObj_3	To provide knowledge for designing and implementing console based and GUI based Java applications.

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Demonstrate a good understanding of object oriented concepts using java.
CO2	Design, write, and test Java programs to provide solutions to a given problem.
CO3	Design and implement console based and GUI based Java applications
CO4	Create multithreaded applications and animations in Java
CO5	Apply the acquired skills to implement object-oriented projects using Java

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*			
CO_2	*	*		*	
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Introduction to Java: Basics of Java programming, Data types, Variables, Operators, Control structures including selection, Looping, Java methods, Overloading, Math class, Arrays in java. Objects and Classes: Basics of objects and classes in java, Constructors, Finalizer, Visibility modifiers, Methods and objects, Inbuilt classes like String, Character, String Buffer, File, this reference	11 Hrs	Cognitive Skills
2	Unit- II	Inheritance and Polymorphism: Inheritance in java, Super and subclass, Overriding, Object class, Polymorphism, Dynamic binding, Generic programming, Casting objects, Instance of operator, Abstract class, Interface in java, Package in java, UTIL package.	12 Hrs	Analytical / Cognitive / Employable Skills
3	Unit- III	Event and GUI programming: Event handling in java, Event types, Mouse and key events, Frames, Layout Managers: Flow Layout, Border Layout, Grid Layout, GUI components like Buttons, Check Boxes, Radio Buttons, Labels, TextFields, Text Areas, Choice, Lists, Applet and its life cycle. Exception handling with try-catch-finally, multi-catch, Arithmetic Exception, NumberFormatException, ArrayIndexOutOfBoundsException, Introduction to swing,	12 Hrs	Cognitive / Synthesis / Employable Skills
4	Unit- IV	Multithreading in java: Thread life cycle and methods, Runnable interface, Thread synchronization, Introduction to Collections in java, Introduction to JavaBeans and Network Programming. I/O programming: Text and Binary I/O, Binary I/O classes, Object I/O, Random Access Files. Reading and writing bytes from/to a file, Reading and writing characters from/to a file.	10 Hrs	Cognitive / Analytical / Synthesis / Employable Skills

Books for Reference:

1. E. Balagurusamy. (2007). Programming with JAVA, McGraw Hill, New Delhi
2. Raj Kumar Buyya,. (2014). Object Oriented Programming with JAVA, McGraw Hill, 2009
3. Herbert Schildt. (2014). Java A Beginner's Guide – Create, Compile, and Run Java Programs Today, Sixth Edition, Oracle Press
4. Ken Arnold, James Gosling. (2005). The Java Programming Language, Fourth Edition, Addison Wisely.

5. Herbert Schildt. (2007). The Complete Reference Java, 7th Edition, McGraw Hill

Web Resource:

1. <https://docs.oracle.com/javase/tutorial/>
2. <https://javabeginnerstutorial.com/core-java-tutorial/>

B21DC 2.3: DATABASE MANAGEMENT SYSTEMS

THEORY

Total Teaching Hours: 45

No. of Hours per Week: 3

(3 credits)

CObj	Course Objectives
CObj_1	To provide knowledge on organizing and maintaining data in a database.
CObj_2	To provide an understanding of the mathematical principles and concepts implemented in DBMS.
CObj_3	To impart knowledge on storing, manipulating and retrieving data efficiently and effectively using DBMS.

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Demonstrate an understanding of the fundamental elements of relational database management systems.
CO2	Apply the concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
CO3	Design ER-models to represent database applications effectively to solve societal problems.
CO4	Formulate SQL queries to handle data in relational databases and apply the acquired skills to solve research problems.
CO5	Create database designs, applying normalization and familiarize with transaction processing.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*			
CO_2	*	*			
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Databases and Database Users: Introduction, an example, Characteristics of the Database Approach, Actors on the Scene, Workers behind the Scene, Advantages of Using DBMS Approach, A Brief History of Database Applications, When Not to Use a DBMS. Database System Concepts and Architecture: Data Models, Schemas, and Instances, Three-schema Architecture and Data Independence, Database Languages and Interfaces, The Database System Environment, Centralized and Client-Server Architectures, Classification of Database Management Systems.	10 Hrs	Cognitive Skills
2	Unit- II	Data Modeling Using Entity-Relationship Model: Using High-Level Conceptual Data Models for Database Design, An Example Database Application, Entity Types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Refining the ER Design Company Database Diagrams, Naming Conventions and Design. Issues, File organization and storage, secondary storage devices, type of single level ordered index, multi-level indexes, indexes on multiple keys, other types of indexes.	12 Hrs	Analytical / Cognitive / Employable Skills
3	Unit- III	Relational Model and Relational Algebra: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and Dealing with Constraint Violations, Unary Relational Operations: SELECT and PROJECT, Relational Algebra Operations from SET Theory, Binary Relational Operations: JOIN and DIVISION, Additional Relational Operations, Examples of Queries in Relational Algebra. Relational Database Design: Anomalies in a database, functional dependency, normal forms, lossless join and dependency, BCNF, normalization through synthesis, higher order normal forms. SQL- SQL Data Definition and Data Types, Specifying Constraints in SQL, Schema Change Statements in SQL, Basic Queries in SQL, More Complex SQL Queries, Insert, Delete and Update Statements in SQL, Specifying Constraints as Assertion and Trigger, Views(Virtual Tables) in SQL, Embedded SQL, Dynamic SQL	12 Hrs	Cognitive / Employable Skills Synthesis Skills

4	Unit- IV	Introduction to transaction processing, transaction and system concepts, desirable properties of transactions, transaction support in SQL. Concurrency control techniques: two-phase locking techniques, concurrency control based on timestamp ordering. Recovery techniques: recovery concepts, recovery in multi-database systems, database backup and recovery from catastrophic failures.	11 Hrs	Analytical / Cognitive / Employable Skills Synthesis Skills

Books for Reference:

1. Elmasri and Navathe. (2016). Fundamentals of Database Systems, 7th Edition, Addison - Wesley.
2. Silberschatz, Korth and Sudharshan. (2019). Database System Concepts, 7th Edition, Tata McGraw Hill.
3. C.J. Date, A. Kannan, S. Swamynatham. (2009). An Introduction to Database Systems, 8th Edition, Pearson education
4. Raghu Ramakrishnan and Johannes. (2003).Gehrke Database Management Systems, 3rd Edition, McGraw- Hill.

Web Resources:

1. <https://www.javatpoint.com/dbms-tutorial>
2. <https://www.geeksforgeeks.org/dbms/>
3. <https://www.tutorialspoint.com/dbms/index.htm>

B21DC 2.4: JAVA LAB

PRACTICAL

Total Teaching Hours: 60

No. of Hours per Week: 4

(2 credits)

List of Programs	Skills Developed
1. Write a simple java application, to print the message, "Welcome to java" 2. Write a program to display the month of a year. Months of the year should be held in an array. 3. Write a program to demonstrate a division by zero exception 4. Write a program to create a user defined exception say Pay Out of Bounds.. 5. Write a java program to add two integers and two float numbers. When no arguments are supplied, give a default value to calculate the sum. Use function overloading. 6. Write a program to perform mathematical operations. Create a class called AddSub with methods to add and subtract. Create another class called MulDiv that extends from AddSub class to use the member data of the super class. MulDiv should have methods to multiply and divide A main function should access the methods and perform the mathematical operations. 7. Write a program with a class variable that is available for all instances of a class. Use static variable declaration. Observe the changes that occur in the object's member variable values. 8. Write a java program to create a student class with following attributes: Enrollment_id: Name, Mark of sub1, Mark of sub2, mark of sub3, Total Marks. Total of the three marks must be calculated only when the student passes in all three subjects. The pass mark for each subject is 50. If a candidate fails in any one of the subjects his total mark must be declared as zero. Using this condition, write a constructor for this class. Write separate functions for accepting and displaying student details. In the main method create an array of three student objects and display the details.	Employable / Analytical Skills

9. In a college first year class are having the following attributesName of the class (BCA, BCom, BSc), Name of the staff No of the students in the class, Array of students in the class
10. Define a class called first year with above attributes and define a suitable constructor. Also write a method called bestStudent() which processes a first-year object and returns the student with the highest total mark. In the main method define a first-year object and find the best student of this class
11. Write a Java program to define a class called employee with the name and date of appointment. Create ten employee objects as an array and sort them as per their date of appointment. ie, print them as per their seniority.
12. Create a package‘ student.Fulltime.BCA‘ in your current working directory
 - a. Create a default class student in the above package with the following attributes: Name, age, sex.
 - b. Have methods for storing as well as displaying
13. Write a small program to catch Negative Array Size Exception. This exception is caused when the array is initialized to negative values.
14. Write a program to handle Null Pointer Exception and use the "finally" method to display a message to the user.
15. Write a program which create and displays a message on the window
16. Write a program to draw several shapes in the created window
17. Write a program to create an applet and draw grid lines
18. Write a program which creates a frame with two buttons: father and mother. When we click the father button the name of the father, his age and designation must appear. When we click mother, similar details of mother also appear.
19. Create a frame which displays your personal details with respect to a button click
20. Create a simple applet which reveals the personal information of yours.
21. Write a program to move different shapes according to the arrow key pressed.
22. Write a java Program to create a window when we press M or m the window displays Good Morning, A or a the window displays Good After Noon E or e the window displays Good Evening, N or n the window displays Good Night
23. Demonstrate the various mouse handling events using suitable examples.
24. Write a program to create menu bar and pull-down menus.

B21DC2.5: DBMS LAB**PRACTICAL****Total Teaching Hours: 60****No. of Hours per Week: 4****(2 credits)**

Programs to be done using any DBMS software	Skills Developed
PART – A 1. Draw E-R diagram and convert entities and relationships to relation table for a given scenario. Two assignments shall be carried out i.e. consider two different scenarios (eg. bank, college) 2. Consider the Company database with following Schema EMPLOYEE (FNAME, MINIT, LNAME, SSN, BDATE, ADDRESS, SEX, SALARY, SUPERSSN, DNO) DEPARTMENT (DNAME, DNUMBER, MGRSSN, MSRSTARTDATE) DEPT_LOCATIONS (DNUMBER, DLOCATION) PROJECT (PNAME, PNUMBER, PLOCATION, DNUM) WORKS_ON (ESSN, PNO<HOURS) DEPENDENT (ESSN, DEPENDENT_NAME, SEX, BDATE, RELATIONSHIP) 3. Perform the following: Viewing all databases, Creating a Database, Viewing all Tables in a Database, Creating Tables (With and Without Constraints), Inserting/Updating/Deleting Records in a Table, Saving (Commit) and Undoing (rollback) 4. Perform the following: Altering a Table, Dropping/Truncating/Renaming Tables, Backing up / Restoring a Database. 5. For a given set of relation schemes, create tables and perform the following Simple Queries, Simple Queries with Aggregate functions, Queries with Aggregate functions (group by and having clause). 6. Execute the following queries How the resulting salaries if every employee working on the ‘Research’ Departments is given a 10% raise. Find the sum of the salaries of all employees of the ‘Accounts’ department, as well as the maximum salary, the minimum salary, and the average salary in this department 7. Execute the following queries Retrieve the name of each employee Controlled by Department number 5 (use EXISTS operator). Retrieve the name of each dept and number of employees working in each Department which has at least 2 employees 8. Execute the following queries	Employable / Analytical Skills

For each project, retrieve the project number, the project name, and the number of employees who work on that project. (use GROUP BY)
 Retrieve the name of employees who born in the year 1990's
 For each Department that has more than five employees, retrieve the department number and number of employees who are making a salary more than 40000.
 For each project on which more than two employees work, retrieve the project number, project name and the number of employees who work on that project.
 For a given set of relation tables perform the following: Creating Views (with and without check option), Dropping views, Selecting from a view

PART B

9. Create the following tables with properly specifying Primary keys, Foreign keys and solve the following queries.
 BRANCH (Branchid, Branchname, HOD) STUDENT (USN, Name, Address, Branchid, sem)
 BOOK (Bookid, Bookname, Authorid, Publisher, Branchid) AUTHOR (Authorid, Authorname, Country, age) BORROW (USN, Bookid, Borrowed_Date)
10. Perform the following:
 Viewing all databases, Creating a Database, Viewing all Tables in a Database, Creating Tables (With and Without Constraints), Inserting/Updating/Deleting Records in a Table, Saving (Commit) and Undoing (rollback)
11. Execute the following Queries:
 - a. List the details of Students who are all studying in 2nd sem BCA.
 - b. List the students who have not borrowed any books.
12. a. Display the USN, Student name, Branch_name, Book_name, Author_name, Books_Borrowed_ Date of 2nd sem BCA Students who borrowed books.
 b. Display the number of books written by each Author.
13. a. Display the student details who borrowed more than two books.
 b. Display the student details who borrowed books of more than one Author.
14. a. Display the Book names in descending order of their names.
 b. List the details of students who borrowed the books which are all published by the same publisher.
15. Consider the following schema:
 STUDENT (USN, name, date_of_birth, branch, mark1, mark2, mark3, total, GPA)
16. Perform the following:
 Creating Tables (With and Without Constraints), Inserting/Updating/Deleting Records in a Table, Saving (Commit) and Undoing (rollback)
17. Execute the following queries:
 Find the GPA score of all the students.
 Find the students who were born on a particular year of birth from the date_of_birth column.

a. List the students who are studying in a particular branch of study. b. Find the maximum GPA score of the student branch-wise.	

COMPUTER SCIENCE OPEN ELECTIVE FOR SECOND SEMESTER

B21OE2.1: CYBER SPACE

THEORY

Total Teaching Hours: 45

No. of Hours per Week: 3

(3 credits)

CObj	Course Objectives
CObj_1	To provide an understanding of cyberspace and role of social media in cyberspace.
CObj_2	To create an awareness on IT Act 2000/2008 including their pros and cons.
CObj_3	To provide basic understanding of concepts such as Digital Signature, Electronic Signature, e-commerce, and e-governance.

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Comprehend the various cyber laws and the importance of the current cyber law in force.
CO2	Develop an awareness on cyber rules and regulations and security issues
CO3	Develop an understanding of the concepts of Digital Signature, Electronic Signature, e-commerce, and e-governance and the associated benefits and drawbacks.
CO4	Develop an insight into accountability in the governance process.
CO5	Effectively apply the knowledge of search engines and social media platforms.

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Basics of internet, www, http, html, DNS, IP Address, electronic mail, web browsers, search engines, Social Media: advantages, disadvantages, privacy issues, e-commerce, advantages of e-commerce, survey of popular e-commerce sites.	10 Hrs	Transferable / Employable / Cognitive / Analytical Skills
2	Unit- II	Introduction to e-governance, stages of e-governance, advantages, challenges, International Status, Indian status, Need of E-Governance, E-assistance, E-Democracy, E-Administration, On-line Citizen Services - E-governance implementations: Software and Hardware required for E governance Implementation, E-governance in a Small Office, Web Portal for E-governance, E governance for Public utilities, E-governance in a Medium Enterprise, E-governance & Finance.	20 Hrs	
3	Unit- III	IT Act 2000/2008 salient features, Cyber laws, Cyber Laws in India: Need for cyber-laws, nature and scope of cyber laws, approaches to cyber laws, cyber – crimes, piracy, Convergence bill, Information Technology Legislation, digital signature, electronic signature, Cyber Appellate Tribunal, Adjudicator, offenses, and penalties.	15 Hrs	

Books for Reference:

1. Information Technology Amended Act. (2008). Ministry of Law and Justice, Government of India.
2. Tom Huskerson. (2014). Social Media, the Good, Bad, and Ugly: Volume 3.
3. RitendraGoel. (2008). e-commerce. New Age International Publishers,
4. Dougals E Comer. (2008). Computer Network and Internet. Pearson Education.

Web Resources:

1. https://www.tutorialspoint.com/information_security_cyber_law/introduction.htm
2. <https://www.studocu.com/my/document/multimedia-university/cyber-law/cyber-law-tutorial-1/>



MATRIX AND SYLLABUS

For the Programme Bachelor of Computer Applications (B.C.A)

NEP Based Curriculum (2021 onwards)

III Semester

NEP- Curriculum Framework

Bachelor of Computer Applications (B.C.A) - Course Matrix (w.e.f. 2021-22 onwards)

III SEMESTER							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	B21KN 3.1/ B21HN 3.1/ B21AE 3.1	Language-1 (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	B21GE3.1	Language-2 (Generic English)	60	3	1	-	3
DSC3	B21DC3.1	Operating System	45	2	1	-	3
DSC3	B21DC3.2	Computer Networks	45	2	1	-	3
DSC3	B21DC3.3	Python Programming	45	2	1	-	3
DSC3	B21DC3.4	Computer Networks Lab	60	-	-	4	2
DSC3	B21DC3.5	Python Programming Lab	60	-	-	4	2
OE-3	B21OE 3.1	Computer Fundamentals and Program Concepts in C	45	2	1	-	3
SEC-SB	21SBC 3.1	PC Assembling and Troubleshooting	30	1	-	2	2
SEC-VB	21VBC 3.1	NCC/NSS/R&R/Cultural	30	-	-	2	1
SEC-VB	21VBC 3.2	Sports	30	-	-	2	1
Total							26

Note:

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

DSE – Discipline-Specific Elective

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii.Quiz / Presentation	05		
iii. Classroom participation	05		
Total			40

For Practical Courses

End Semester Examination: 50%

Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)

Activities	Total Marks
1. Lab Performance	10
2. Observation record	05
3. Internal exam	10
Total	25

**B21DC 3.1: OPERATING SYSTEM
THEORY**
Total Teaching Hours: 45
No. of Hours per Week: 3
(3 credits)

CObj	Course Objectives
CObj_1	To provide knowledge of basic concepts and functions of operating systems
CObj_2	To instill an understanding of the different process scheduling algorithms and synchronization techniques to achieve better performance of a computer system
CObj_3	To familiarize the concepts of file management and secondary storage management.

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Analyze different types of Operating Systems.
CO2	Analyze process scheduling algorithms and synchronization techniques to achieve better performance of a computer system.
CO3	Demonstrate an understanding of Mutual exclusion concept, Deadlock detection and agreement protocols of an operating system.
CO4	Develop an understanding of various memory management techniques in Operating system.
CO5	Demonstrate an understanding of the various techniques of file management and secondary storage management.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*			
CO_2	*	*			
CO_3	*	*			
CO_4	*	*		*	
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Introduction: Batch Systems, Concepts of Multiprogramming and Time Sharing, Parallel, Distributed and real time Systems, Operating System Structures, Components & Services, System calls, System programs, Virtual machines. Process Management: Process Concept, Process Scheduling, Co – Operating process, Threads, Inter process communication, CPU Scheduling Criteria, Scheduling algorithm, Multiple Processor Scheduling, Real time Scheduling, Algorithm evolution.	10 Hrs	Cognitive / Analytical / Synthesis Skills
2	Unit- II	Process Synchronization and deadlocks: The Critical Section Problem, Synchronization hardware, Semaphores, Classical problems of synchronization, Critical regions, monitors, Dead locks – system model, Characterization, Deadlock prevention, avoidance and detection, Recovery from deadlock, Combined approach to deadlock handling.	12 Hrs	Analytical / Cognitive / Synthesis Skills
3	Unit- III	Memory Management: Logical and Physical address space, Swapping, Contiguous allocation, Paging, Segmentation, Segmentation with paging in Mastics and Intel 386, Virtual memory-Demand paging and its performance, Page replacement algorithms, Allocation of frames, thrashing, page size and other considerations. Demand Segmentation	12 Hrs	Cognitive / Analytical Skills
4	Unit- IV	File management (Systems, Secondary Storage Structure): File Concepts, Access methods, Directory Structure, Protection and consistency, File system structure, Allocation methods, Free space management, Directory Implementation, Efficiency and Performance, Recovery. Disk Management (Structure, Disk Scheduling Methods): Disk Structure & Scheduling methods, Disk management, Swap – Space management.	11 Hrs	Cognitive / Analytical / Synthesis Skills

Books for Reference:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne. (2018). Operating System Concepts. 10th Edition, Wiley.
2. H.M.Deitel. (2003). Operating Systems. 3rd Edition. Pearson Learning Solutions.
3. William Stallings. (2010). Operating Systems. 6th Edition, Pearson Education.
4. Stuart, Operating systems. (2008). Principles, Design and Implementation. 1st Edition. Cengage Learning India.
5. Andrew S Tanenbaum. (2015). Modern Operating System. 3rd Edition. Prentice Hall India.
6. D. M. Dhamdhere. (2008). Operating System : A concept based approach. Tata McGraw Hill.

Web Resource:

1. <https://www.geeksforgeeks.org/web-operating-system/>
2. <https://www.cse.iitb.ac.in/~mythili/os/>

B21DC 3.2: COMPUTER NETWORKS
THEORY
Total Teaching Hours: 45
No. of Hours per Week: 3
(3 credits)

CObj	Course Objectives
CObj_1	To provide an understanding of the fundamental concepts of computer networking
CObj_2	To impart knowledge of the basic concepts of layered models and fundamental protocols
CObj_3	To instill knowledge of implementation concepts in congestion control, error detection and routing

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Assimilate the features of computer networks, protocols, and network design models
CO2	Comprehend the fundamental characteristics of the physical layer and analyze the design issues of data link layer, link layer protocols, bridges and switches
CO3	Evaluate different error detection and correction methods required for error control
CO4	Apply appropriate routing algorithms, congestion control techniques, and Quality of Service requirements for designing a network
CO5	Demonstrate an understanding of network topologies, functions and protocols of the OSI layers in order to design networks for given situations

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*			
CO_2	*	*			
CO_3	*	*		*	
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Introduction – Uses of computer networks, Network hardware, Network software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models. Physical Layer – Modes of communication, Physical topologies, Signal encoding, Transmission media overview. Performance indicators – Bandwidth, Throughput, Latency, Queuing time, Bandwidth–Delay product	10 Hrs	Cognitive / Transferable Skills
2	Unit- II	Data link layer - Data link layer design issues, Error detection and correction, Sliding window protocols, High-Level Data Link Control(HDLC)protocol. Medium Access Control (MAC) sublayer –Channel allocation problem, Multiple access protocols, Ethernet, Wireless LANs - 802.11, Repeaters, Hubs, Bridges, Switches, Routers and Gateways.	12 Hrs	Cognitive / Evaluation / Synthesis Skills
3	Unit- III	Network layer. Routing algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast routing, Routing for mobile hosts. Congestion control algorithms, IP protocol, IP addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), IPv6 header	12 Hrs	Cognitive / Analytical / Synthesis Skills
4	Unit- IV	Transport service – Services provided to the upper layers, Transport service primitives. User Datagram Protocol (UDP). Transmission Control Protocol (TCP) – Overview of TCP, TCP segment header, Connection establishment & release, Connection management modeling, TCP retransmission policy, TCP congestion control. Session Layer: functions , Presentation Layer: functions, Application Layer – File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, Multipurpose Internet Mail Extension (MIME)	11 Hrs	Cognitive / Analytical Skills

Books for Reference:

1. Andrew S. Tanenbaum. (2018). Computer Networks.(4th edition). PHI (Prentice Hall India).
2. Behrouz A Forouzan. (2007).Data Communication and Networking. (4th edition). Tata McGraw Hill.
3. Larry L Peterson and Bruce S Dave. (2011). Computer Networks – A Systems Approach. (5th edition). Morgan Kaufmann Publishers.
4. Fred Halsall, Computer Networking and the Internet. (5th edition). Addison Wesley
5. James F. Kurose, Keith W. Ross. (2017). Computer Networking: A Top-Down Approach. (6th edition). Pearson.
6. Keshav. (1998). An Engineering Approach to Computer Networks, Addison Wesley.
7. W. Richard Stevens. (2011). TCP/IP Illustrated Volume 1. Addison-Wesley.
8. William Stallings. (2003). Computer Networking with Internet Protocols. Pearson Education India

Web Resource:

1. Request for Comments (RFC) Pages - IETF -<https://www.ietf.org/rfc.html>
2. <https://www.cs.vu.nl/~ast/CN5/>

B21DC 3.3 : PYTHON PROGRAMMING
THEORY
Total Teaching Hours: 45
No. of Hours per Week: 3
(3 credits)

CObj	Course Objectives
CObj_1	To provide an Understanding of the features of Python Programming language
CObj_2	To instill the ability to implement file handling and database handling in python
CObj_3	To impart the knowledge to create projects using Python

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Apply the concepts of lists, tuples, functions, and classes for various python applications
CO2	Analyze different python built in libraries and implement aspects like exceptions, regular expressions and functions.
CO3	Demonstrate an understanding of the database and file handling in python
CO4	Evaluate mathematical operations using NumPy and Pandas in python
CO5	Create file and database accessing applications using python.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*		*	
CO_2	*	*		*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Installation and Working with Python- Understanding Python variables-Python basic Operators- Understanding python blocks-Declaring and using Numeric data types: int, float, complex. Using string data type and string operations. Defining list and list slicing -Use of Tuple data type and methods in tuples. List manipulation using in built methods-Dictionary manipulation -Programming using string, list and dictionary in built functions Conditional blocks using if, else and elif -Simple for loops in python-For loop using ranges, string, list and dictionaries-Use of while loops in python-Loop manipulation using pass, continue, break.	10 Hrs	Cognitive / Analytical / Synthesis Skills
2	Unit- II	Organizing python codes using functions-Organizing python projects into modules-Importing own module as well as external modules. Regular expression: Powerful pattern matching and searching-Power of pattern searching using regex in python, Pattern finding programs using regular expression. Files: reading and writing text files, reading and writing binary files using pickle module. Safeguarding file operation using exception handling	12 Hrs	Cognitive / Analytical / Synthesis Skills
3	Unit- III	Concept of class, object and instances-Constructor, class attributes and destructors-Inheritance, overlapping and overloading operators -Adding and retrieving dynamic attributes of classes Programming using Oops - exception handling - Safe guarding file operation using exception handling - Programming using Exception handling. Understanding threads- Forking threads - Synchronizing the threads-Programming using multithreading	11 Hrs	Cognitive / Analytical / Synthesis Skills
4	Unit- IV	Numpy:1 dim, 2 dim, max, min - row wise , column wise, linalg module - 5 functions. pandas: series, dataframes, read_csv, read_excel, data cleaning methods, 1 dim, 2 dim, max, min - row wise , column wise, linalg module - 5 functions. Pandas: series, dataframes, read_csv, read_excel, data cleaning methods, accessing specific rows and columns.	12 Hrs	Cognitive / Analytical / Synthesis Skills

		Using Databases in Python: Python MySQL Database Access -Install the MySQLdb and other Packages -Create Database Connection - CREATE, INSERT, READ, UPDATE and DELETE Operation- DML and DDL operation with Databases -Performing Transactions- Handling Database Errors.		

Books for Reference:

1. Ashok Namdev Kamthane, Amit Ashok Kamthane. (2020). Programming And Problem Solving With Python. (2nd edition). McGraw Hill.
2. Gowrishankar S, Veena A. (2019). Introduction to Python Programming. (1st Edition). CRC Press.
3. Charles R. Severance. (2016). Python for Everybody: Exploring Data Using Python 3. (1st Edition). CreateSpace Independent Publishing Platform
4. Jake VanderPlas. (2016). Python Data Science Handbook: Essential Tools for Working with Data. (1st Edition). O'Reilly Media.

Web Resource:

1. <https://www.programiz.com/python-programming>
2. <https://www.w3schools.com/python/>

B21DC 3.4: COMPUTER NETWORKS LAB
PRACTICAL
Total Teaching Hours: 60
No. of Hours per Week: 4
(2 credits)

Course Content

List of Programs	Skills Developed
PART A Simulation experiments using NS2/ NS3/ OPNET/ NCTUNS/ NetSim/QualNet or any other equivalent tool 1. Simulate a three nodes point-to-point network with duplex links between them. Set the queue size, vary the bandwidth and find the number of packets dropped. 2. Implement a four node point to point network with links n0-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP/UDP. 3. Implement Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate. 4. Simulate the different types of Internet traffic such as FTP, a TELNET over a network and analyse the throughput. 5. Simulate the transmission of ping messages over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion 6. Simulate an Ethernet LAN using N nodes and set multiple traffic nodes and plot congestion windows for different sources/destinations. PART B 1. The following experiments shall be conducted using C/C++/Java. 2. Implement the data link layer framing methods such as character-stuffing and bit stuffing. 3. Write a program for error detecting code using CRC-CCITT (16-bits). 4. Implement Dijkstra's algorithm to compute the shortest path through a network. 5. Write a program for distance vector algorithm to find suitable path for transmission 6. Write a program for Hamming code generation for error detection and correction. 7. Write a program for congestion control using Leaky bucket algorithm	Employable / Analytical / Cognitive Skills

B21DC 3.5: PYTHON PROGRAMMING LAB
PRACTICAL
Total Teaching Hours: 60
No. of Hours per Week: 4
(2 credits)

Course Content

List of Programs	Skills Developed
1. Write a program to demonstrate lists in python. 2. Write a program to demonstrate tuples in python. 3. Write a program to count the numbers of characters in the string and store them in a dictionary data structure. 4. Python program to remove all the lines that contain the character 'a' in a file and write it to another file. 5. Write a Python function to evaluate $\exp(x)$ using Taylor's expansion series. 6. Write a Python program to a random number generator that generates random numbers between 1 and 6 (simulates a dice). 7. Write a Python program to implement a stack and queue using a list data-structure. 8. Write a Python program to create a line plot. 9. Write a Python program to copy odd lines of one file to another file in Python 10. Write a Python program to create Histogram using Pyplot in Python 11. Write a Python program to create an Employee table, insert 5 tuples and delete a particular employee from the table. 12. Write a Python program to create a student table and find the min, max, sum, and average of the marks in a student marks table. 13. Write a Python program to create a customer table and find the total number of customers from each country in the table (customer ID, customer name, country) using group by.	Employable / Analytical / Cognitive Skills

21SBC 3.1: PC ASSEMBLING AND TROUBLESHOOTING**Total Teaching Hours: 30****No. of Hours per Week: 2****(2 credits)**

CObj	Course Objectives
CObj_1	To impart basic knowledge in computer hardware and peripherals installation and PC assembly
CObj_2	To provide the skills in troubleshooting and maintenance
CObj_3	To impart knowledge in system management, backup and disaster prevention

CO	Course Outcomes After completion of this module, students should be able to:
CO1	Acquire hands-on experience in PC assembling
CO2	Demonstrate an understanding of Linux and Windows Operating systems installation
CO3	Comprehend PC maintenance and troubleshooting
CO4	Perform backup and recovery of files
CO5	Demonstrate an understanding of system management and disaster prevention

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*			
CO_2	*	*			*
CO_3	*	*	*	*	
CO_4	*	*	*	*	
CO_5	*	*	*	*	*

Course Content

This skill based course is conducted only through Practical sessions. The topics to be covered are as follows:

Sl. No.	Content	Number of hours
1	Introduction to PC Hardware	3 Hrs
2	Hardware installation and configuration	7 Hrs
3	PC debugging , troubleshooting and Maintenance	7 Hrs
4	Software installation and Configuration	7 Hrs
5	Backup and recovery	6 Hrs

Books for Reference:

1. Craig Zacker, John Rourke. (2017). PC Hardware: The Complete Reference. (1st edition).Mc Graw Hill Education.
2. Robert Bruce Thompson, Barbara Fritchman Thompson. (2003).PC Hardware in A Nutshell, a Desktop Quick reference.(3rd edition). O'Reilly.
3. C. Campbell. (2022). Computer Hardware. Complete Hardware Guide ,Troubleshooting,Maintenance. Code Academy.
4. Cheryl A.Schmidt. (2002). The Complete Computer Upgrade & Repair Textbook. Dream tech press.

Web Resource:

1. <https://artofpc.com/how-to-assemble-and-troubleshoot-pc/>
2. <https://www.studocu.com/in/document/i-k-gujral-punjab-technical-university/pc-assembly-and-troubleshooting/pc-assembly-full-notes-ptu-bca-3/33990652>



MATRIX AND SYLLABUS

For the Programme Bachelor of Computer Applications (B.C.A)

NEP Based Curriculum (2021 onwards)

IV Semester

NEP- Curriculum Framework

Bachelor of Computer Applications (B.C.A) - Course Matrix (w.e.f. 2021-22 onwards)

IV SEMESTER							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	B21KN 4.1/ B21HN 4.1/ B21AE 4.1	Language-1 (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	B21GE4.1	Language-2 (Generic English)	60	3	1	-	3
AECC	21SBC 4.1	Constitution of India	45	2	1	-	3
DSC4	B21DC4.1	Software Engineering	45	2	1	-	3
DSC4	B21DC4.2	Artificial Intelligence	45	2	1	-	3
DSC4	B21DC4.3	Internet Technologies and Web Designing	45	1	2	-	3
DSC4	B21DC4.4	Artificial Intelligence Lab	60	-	-	4	2
DSC4	B21DC4.5	Internet Technologies and Web Designing Lab	60	-	-	4	2
OE-4	B21OE 4.1	Web Designing	45	2	1	-	3
SEC-VB	21VBC 4.1	NCC/NSS/R&R/Cultural	30	-	-	2	1
SEC-VB	21VBC 4.2	Sports	30	-	-	2	1
Total							26

Note:

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

DSE – Discipline-Specific Elective

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii.Quiz / Presentation	05		
iii. Classroom participation	05		
Total			40

For Practical Courses

End Semester Examination: 50%

Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)

Activities	Total Marks
1. Lab Performance	10
2. Observation record	05
3. Internal exam	10
Total	25

**B21DC 4.1: SOFTWARE ENGINEERING
THEORY**
Total Teaching Hours: 45
No. of Hours per Week: 3
(3 credits)

CObj	Course Objectives
CObj_1	To provide the idea of decomposing the given problem into Analysis, Design, Implementation, Testing and Maintenance phases.
CObj_2	To provide an idea of using various process models in the software industry according to given circumstances
CObj_3	To provide an Understanding of the role of project management including planning, scheduling, risk management, etc.

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Understand the process models of the Software Development Life Cycle (SDLC) and implement appropriate models to develop projects to solve real world problems.
CO2	Analyse the concept of Design architecture, Design principles, Design quality and software prototyping.
CO3	Develop applications using Object Oriented and Function oriented approach
CO4	Gain expertise in designing User Interfaces, adopting reuse-driven approaches in software development, and ensuring software reliability.
CO5	Apply the knowledge gained on testing process to test software products

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2		*	*		
CO_3	*	*	*	*	*
CO_4	*	*		*	
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Introduction: Software Products and Software process, Process models: Waterfall model, Evolutionary Development, Bohemia's Spiral model, RAD Model, Agile Model, Overview of risk management, Process Visibility, Professional responsibility. Computer based System Engineering: Systems and their environment, System Procurement, System Engineering Process, System architecture modelling. Human Factors, System reliability Engineering. Requirements and Specification: The requirement Engineering Process, The Software requirement document, Validation of Evolution of requirements, Viewpoint – oriented & method based analysis , system contexts , Social & organizational factors. Data flow , Semantic, Objects, models , Requirement Specification, Functional and Nonfunctional requirement.	10 Hrs	Cognitive / Analytical / Synthesis Skills
2	Unit- II	Software Prototyping: Prototyping in software process, Prototyping techniques, User interface prototyping. Software Design: Design Process, Design Strategies, Design Quality , System Structuring control models, Modular decomposition , Domain Specific architecture. Object Oriented & function oriented design: Objects, object Classes and inheritance Object identification, An object oriented design example, Concurrent Objects, Data flow design Structural decomposition, Detailed Design, A Comparison of design Strategies. User interface design: Design Principles, User System interaction, Information Presentation, User Guidance, Interface Evaluation.	12 Hrs	Cognitive / Synthesis Skills
3	Unit- III	Software Reliability and reusability : Software reliability metrics , Software reliability Specification , Statistical testing ,Reliability Growth modeling, Fault avoidance & tolerance, Exception handling & defensive programming , Software development with reuse, Software development for reuse , Generator based reuse,	10 Hrs	Cognitive / Synthesis Skills

		Application System Portability.		
4	Unit- IV	Software Verification and Validation : The testing Process , Test Planning & Strategies, Black Box , Structural, interface testing , Program inspections , Mathematically based verification, Static analysis tools, Cleanroom software development. Management Issues: Project management, Quality management, Software cost estimation, Project Scheduling- work tasks, timeline charts and CPM, PERT , Software maintenance.	13 Hrs	Cognitive / Analytical / Synthesis Skills

Books for Reference:

1. Ian Sommerville. (2010). Software Engineering. (9th Edition). Pearson Education Ltd.
2. Roger S. Pressman. (2010). Software Engineering- A Practitioner's approach. (7th Edition). McGraw-Hill Publication.
3. Pankaj Jalote. (2013). An integrated approach to Software Engineering. (3rd Edition). Narosa Publishing House.

Web Resource:

1. <http://ww25.softwareengineering-9.com/>
2. <https://www.theforage.com/blog/careers/software-engineering-resources>

**B21DC 4.2: ARTIFICIAL INTELLIGENCE
THEORY**
Total Teaching Hours: 45
No. of Hours per Week: 3
(3 credits)

CObj	Course Objectives
CObj_1	To impart knowledge about Artificial Intelligence and understand the basic principles of Artificial Intelligence in various applications
CObj_2	To understand the various approaches of knowledge representations and to enable computers to perform such intellectual tasks as decision making, problem solving
CObj_3	To provide knowledge on Expert systems and to implement the AI concepts using prolog

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Demonstrate an understanding of Artificial intelligence concepts and techniques
CO2	Apply basic principles of AI in solutions that require problem solving
CO3	Apply knowledge on representing simple facts by predicate logic
CO4	Design and implement expert systems to solve real world problems
CO5	Comprehend Prolog for implementation of Artificial intelligence concepts

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*		
CO_2	*	*		*	
CO_3	*	*		*	
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Overview of AI: Introduction to AI, Importance of AI, AI and its related field, AI techniques, Criteria for success. Problems, problem space and search: Defining the problem as a state space search, Production system and its characteristics, Issues in the design of the search problem. Heuristic search techniques: Generate and test, hill climbing, best first search technique, mean and end analysis, A* and AO* Algorithms.	11 Hrs	Evaluation / Synthesis Skills
2	Unit- II	Knowledge Representation: Definition and importance of knowledge, Knowledge representation, various approaches used in knowledge representation, Issues in knowledge representation. Predicate Logic: Representing Simple Facts in logic, representing instances and is-a relationship, Computable function and predicate. Planning: block world, strips, Implementation using goal stack, Non linear planning with goal stacks	10 Hrs	Analytical Skills
3	Unit- III	Natural language processing: Introduction syntactic processing, Semantic processing, Discourse and pragmatic processing Learning: Introduction learning, Rote learning, learning by taking advice, learning in problem solving, learning from example-induction, Explanation based learning.	10 Hrs	Cognitive Skills
4	Unit- IV	Expert System: Introduction: Representing using domain specific knowledge, Architecture of expert system, knowledge representation Expert system shells, case studies on expert systems. Prolog -Basics, Relations, Data objects, operators, Decision making, recursion, built-in predicates, conjunction and disjunction	14 Hrs	Cognitive / Analytical / Synthesis Skills

Books for Reference:

1. Elaine Rich, Kevin Knight. Artificial Intelligence. Tata McGraw Hill.
2. David W. Rolston. Principles of Artificial Intelligence and Expert System Development. McGraw Hill.
3. Ivan Bratko. Prolog Programming for Artificial Intelligence. (4th Edition). Addison-Wesley.
4. Russel & Norvig. Artificial Intelligence: A Modern Approach. Pearson Education.

Web Resource:

1. <https://www.datacamp.com/blog/how-to-learn-ai>
2. <https://www.freecodecamp.org/news/how-to-get-the-best-artificial-intelligence-education-for-free-21af8c47e36b/>

**B21DC 4.3: INTERNET AND WEB TECHNOLOGIES
THEORY**

Total Teaching Hours: 45

No. of Hours per Week: 3

(3 credits)

CObj	Course Objectives
CObj_1	To impart knowledge on Web & Internet technologies
CObj_2	To provide an understanding of the fundamental tools and technologies for web design
CObj_3	To instill knowledge on client/server relationships in the context of the Internet

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Demonstrate an understanding of the technological foundations of the Internet and core Internet protocols
CO2	Demonstrate an understanding of the basic working scheme of the Internet and World Wide Web
CO3	Integrate suitable JavaScript functions and develop real time web application
CO4	Apply CSS and design attractive web applications
CO5	Create XML documents and Schemas

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*			
CO_2	*	*			
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Internet, Growth of Internet, Owners of the Internet, Anatomy of Internet, ARPANET and Internet history of the World Wide Web, basic Internet Terminology, Net etiquette. Internet Applications – Commerce on the Internet, Governance on the Internet, Impact of Internet on Society – Crime on/through the Internet. Overview of Internet Security, Firewalls, Information Privacy and Copyright Issues Software requirement, modem configuration, Addressing in Internet: DNS, Domain Name and their organization, understanding the Internet Protocol Address, Internet Addressing Scheme	10 Hrs	Cognitive / Diagnostic Skills
2	Unit- II	Internet accounts by ISP: Telephone line options, Protocol options, Service options Telephone line options – Dialup connections through the telephone system, dedicated connections through the telephone system, ISDN Protocol options – Shell, SLIP, PPP Services on Internet (Definition and Functions): WWW, Telnet, FTP, IRC, Search and Meta Search Engines Electronic Mail: Email Networks and Servers, Email protocols –SMTP, POP3, IMAP, MIME, Structure of an Email – Email Address, Email Header, Body and Attachments Email Clients: Netscape mail Clients, Outlook Express, Web based E-mail. Email encryption- Address Book, Signature File. Languages, Internet Phone, Internet Video, collaborative computing	12 Hrs	Analytical / Employable skills
3	Unit- III	Web Publishing and Browsing Overview, Web Browsers, and Web Servers, URLs, HTTP, Security, The Web Programmers Toolbox. Publishing Tools, SGML, Web hosting, Documents Interchange Standards, Components of Web Publishing, Document management, Web Page	12 Hrs	Analytical / Employable / Evaluation / Synthesis Skills

		Design Consideration and Principles XHTML: Origins and evolution of HTML and XHTML, HTML Programming Basics HTML page structure, HTML Text, HTML links, HTML document tables, HTML Images, multimedia, Lists, Forms, Frames in HTML and XHTML, Syntactic differences between HTML and XHTML. CSS: Introduction, Levels of style sheets, Style specification formats, Selector forms, Property value forms, Font properties, List properties, Color, Alignment of text, The Box model, Background images, The and tags, Conflict resolution. Introduction to Bootstrap		
4	Unit- IV	Java Script: Overview of JavaScript, General syntactic characteristics, Primitives, Operations, and expressions, Screen output and keyboard input, Control statements, Arrays, Functions, The Document Object Model, Element access in JavaScript, Introduction to Events and event handling Dynamic Documents with JavaScript: Introduction to dynamic documents; Positioning elements; Moving elements; Element visibility; Changing colors and fonts; Dynamic content; Stacking elements; Locating the mouse cursor; Reacting to a mouse click; Slow movement of elements; Dragging and dropping elements. XML: Introduction; Syntax; Document structure; Document Type definitions; Namespaces; XML schemas; Displaying raw XML documents; Displaying XML documents with CSS; XSLT style sheets; XML Processors; Web service.	11 Hrs	Employable / Evaluation / Synthesis Skills

Books for Reference:

1. Greenlaw R and Hepp E. (2007). Fundamentals of the Internet and www. (2nd Edition). Tata McGrawHill.
2. Ivan Bayross. HTML, DHTML, JavaScript, Perl CGI. (3rd Edition). BPB Publications.
3. D. Comer. (2009). The Internet Book. Pearson Education.

4. M.Deitel, P.J.Deitel, A.B.Goldberg. (2004). Internet & World Wide Web How to program. (3rd Edition). Pearson Education / PHI.
5. Chris Bates. (2006). Web Programming Building Internet Applications. (3rd Edition). Wiley India.

Web Resource:

1. <https://www.geeksforgeeks.org/the-internet-and-the-web/>
2. https://kp.kiit.ac.in/pdf_files/02/Study-Materials_CSE_-5th_-IWT_AK-Panda-1.pdf

**B21DC 4.4 : ARTIFICIAL INTELLIGENCE LAB
PRACTICALS**

Total Teaching Hours: 60

**No. of Hours per Week: 4
(2 credits)**

Course Content

List of Programs	Skills Developed
1. Write a Program to Implement Best First Search. 2. Write a Program to Implement Hill climbing. 3. Write a Program to Implement A* search algorithm. 4. Write a Program to Implement AO* search algorithm. 5. Write predicates One converts centigrade temperatures to Fahrenheit, the other checks if a temperature is below freezing. 6. Write a Program to Implement the Tower of Hanoi. 7. Write a Program to solve a 4-queen problem. 8. Write a Program to implement factorials of a given number. 9. Write a Program to implement fibonacci series. 10. Write a Program to find the frequency distribution of words in a text file. 11. Write a Program to demonstrate monkey and banana problems. 12. Write a Program to Count the number of words that contain "tion" in a given list. 13. Write a Program to implement tree data structure.	Employable / Analytical / Cognitive Skills

B21DC 4.5 : INTERNET AND WEB TECHNOLOGIES LAB
PRACTICALS
Total Teaching Hours: 60
No. of Hours per Week: 4
(2 credits)

Course Content

List of Programs	Skills Developed
1. Design a web page using CSS 2. Print table of numbers from 5 to 15 and print their squares and cubes using alert. 3. Enter positive number terminated by zero and find sum and average 4. Write a JavaScript code to find the sum of N natural Numbers. (Use user-defined function) 5. Find factorial of a number using java script 6. Read n numbers count positive, negative and zeros in the list 7. Display Fibonacci series using java script 8. Create a form having a number of elements (Textboxes, Radio buttons, Checkboxes, and so on). Write JavaScript code to count the number of elements in a form 9. Create a HTML form that has a number of Textboxes. When the form runs in the Browser fill the textboxes with data. Write JavaScript code that verifies that all textboxes have been filled. If a textbox has been left empty, popup an alert indicating which textbox has been left empty. 10. Develop a HTML Form, which accepts any Mathematical expression. Write JavaScript code to Evaluate the expression and Displays the result. 11. Write a JavaScript code block using arrays and generate the current date in words, this should include the day, month and year. 12. Create a form for Student information. Write JavaScript code to find Total, Average, Result and Grade. 13. Create a form for Employee information. Write JavaScript code to find DA, HRA, PF, TAX, Gross pay, Deduction and Net pay. 14. Create a form consists of a two Multiple choice lists and one single choice list a. The first multiple choice list, displays the Major dishes available b. The second multiple choice list, displays the Starters available. c. The single choice list displays the Soft drinks available. 15. Create a page with dynamic effects. Write the code to include layers and basic animation.	Employable / Analytical / Cognitive Skills



Programme

Matrix and Syllabus

NEP Scheme

B.Com. (Hons.)

BOARD OF STUDIES MEETING
Department of Commerce UG
AGENDA FOR THE BoS -18-04-
2022

AGENDA -1 NEP based Curriculum Discussion for 3rd & 4th Semester B.Com.

- Programme Matrix
- Syllabus

AGENDA- 2 Discussion & Approval for Open Elective Courses

- Managing Personal Finance
- Business Entrepreneurship

AGENDA -3 Question Paper Pattern for 3rd & 4th Semester B.Com.

- Question Paper Pattern for 3rd & 4th Semester B.Com.
- Blue Print including Bloom's Taxonomy and CO mapping

AGENDA -4 Any other matter

- Teaching and Evaluation
- Skill-based activities

INDIAN ACADEMY

Degree College - Autonomous

DEPARTMENT OF COMMERCE – UG Resolutions of Board of Studies Meeting

Date: 18th April 2022

Venue: Board Room (Room No 504)

Time: 2:00 pm

Subject: Board of Studies Meeting

Chairperson: Dr Mutharasi M, HOD, Dept of Commerce - UG

Members:

Prof Suryanarayana	DIRECTOR – ACADEMIC EXCELLENCE
Dr. Mutharasi M	CHAIRPERSON
Dr. Sarvamangala	BNU NOMINEE
Dr. Anuradha P.S	SUBJECT EXPERT
Prof Ravi R. A	SUBJECT EXPERT
Mr Srikrishna Ramamoorthy	INDUSTRY EXPERT
Mr Santosh G Kalburgi	INDUSTRY EXPERT
Mr Kiran Kumar G	ALUMNI
Ms Shobha	MEMBER
Ms Lakshmi K	MEMBER
Ms Maria Mendes	MEMBER
Ms Revathi S	MEMBER
Ms C Indrani Vidyadhar	MEMBER

Ms Adeeba Ahamed	MEMBER
Ms Venessa Priya M	MEMBER
Ms Mary Sharmila Sangeetha	MEMBER
Ms Preethi G S	MEMBER
Ms Marwa Mona	MEMBER
Ms Asma Banu	MEMBER
Ms SyedaFirdose	MEMBER
Mr Ranganath PR	MEMBER
Mr Naveen N	MEMBER

Resolutions:

- The Programme matrix and curriculum for the 3rd and 4th-semester B.Com. Programme based on the National Education Policy 2020 were proposed in the BOS meeting and is approved.
- The board discussed the importance of making assignments for students more skill-based, enhancing their subject knowledge and building life skills as well.
- The new question paper pattern, the distribution of marks and the mapping of units, course outcomes and Bloom's taxonomy are linked. The blueprint is linked with the ERP as well to aid examination work.
- Teaching and evaluation - The current practice of CIA will be calculated for 40 marks and the same to be continued this semester as well. There is a good opportunity to incorporate blended learning techniques for the NEP batch students
- The teaching pedagogy should incorporate blended learning techniques.
- Technology-based teaching is imperative. Technological up-gradation is a prerequisite for the successful implementation of NEP 2020.

PEOs	Programme Educational Objectives
PEO1	To develop student competencies in the development, measurement, analysis, validation, and communication of accounting, financial, banking, and other related information.
PEO2	To provide an understanding of various systems, policy frameworks, and strategies needed to administer the rapid changes in global, legal, regulatory, and ethical issues relating to Commerce, Business, and Accounting.
PEO3	To equip students with an understanding of financial modeling, financial engineering, business analytics, its constituents, the principles on which it operates, inter-linkages, and regulatory concerns apart from exposure to different functional domains of management.
PEO4	To equip students with professional skills, values, leadership, and entrepreneurial skills required for setting up incubation centers and small- scale enterprises, in the present-day context.
PEO5	Increased student autonomy in the learning & research process, and ability to self-reflect and engage in lifelong learning.

POs	Programme Outcomes After completion of this course, students should be able to
PO1	Demonstrate a sound understanding and knowledge of the accounting concepts, and principles, to measure, analyze, validate, and communicate various accounting and financial information to appropriate authorities.
PO2	Apply the various techniques in the decision-making process with updated knowledge in implementing business practices of Finance, Taxation, Business Laws, and other areas of business and the context in which it operates.
PO3	Apply appropriate tools and techniques to plan, organise, coordinate, direct, and control business enterprises, private, government, and non-governmental organizations to meet the current and future expectations of the business and industry.
PO4	Demonstrate an ability to inculcate a sense of professional ethics, integrity, and social responsibility in various domains and adapt to changing technology with applied skills toward sustainable development.

PO5	Demonstrate the ability to self-reflect on research skills, and other functional areas of management, commerce, and accounting and engage in lifelong learning.

Year	Exit Programme	Outcome Attained
1st Year	Certificate in Commerce	PO1
2nd Year	Diploma in Commerce	PO1,PO2, and PO3
3rd Year	B.Com Degree	PO1,PO2,PO3, and PO4
4th Year	B.Com (Honors)	PO1,PO2,PO3,PO4, and PO5

NEP-2020

B.Com. (Hons.) – Programme Matrix (w.e.f. 2021 Onwards)

NEP-2020

I Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	LAN 1.1	Language – 1	3	3	1	-	3
AECC	LAN 1.2	Language – 2	3	3	1	-	3
DSC	BCM1.1	Financial Accounting	5	3	0	2	4
DSC	BCM1.2	Corporate administration	4	4	0	0	4
DSC	BCM1.3	Principles of management	4	4	0	0	4
OE-1	OPE 1.1	Financial literacy	3	3	0	0	3
SEC-1	SBC 1.1	Digital Fluency	3	1	0	2	2
SEC-2	VBC 1.1	Health and Well-being				1	1
SEC-3	VBC 1.2	Yoga				1	1
Total							25
II Semester							
AECC	LAN 2.1	Language – 1	3	3	1	0	3
AECC	LAN 2.2	Language – 2	3	3	1	0	3
AECC	EVS 2.	Environmental Studies	2	2	0	0	2
DSC	BCM2.1	Advance financial accounting	5	3	0	2	4
DSC	BCM2.2	Quantitative Analysis for Business Decisions I	5	3	0	2	4
DSC	BCM2.3	Cost accounting	5	3	0	2	4
OE-2	OPE 2.1	Investing in stock market	3	3	0	0	3
SEC-4	VBC 2.1	NCC/NSS/Cultural				1	1
SEC-5	VBC 2.2	Sports				1	1
Total							25

III Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	LAN 3.1	Language – I	4	3	1	-	3
AECC	LAN 3.2	Language – II	4	3	1	-	3
DSC	BCM-N3.1	Corporate Accounting	4	3	1	-	4
DSC	BCM-N 3.2	Quantitative Analysis for Business Decisions II	4	3	1	-	4
DSC	BCM-N 3.3	E- Commerce and Digital Marketing	4	3	1	-	4
OEC	OEC 3.1	Open Elective (Managing Personal Finance)	3	2	1	-	3
SEC-SB	SBC 3 .1	Digital Fluency (Artificial Intelligence / IoT / Cloud Computing / Cyber Security)	3	-	1	2	2
SEC-VB	SEC - VB 3.1	Sports	2	-	-	2	1
SEC-VB	SEC - VB 3.2	NCC/NSS/R&R/Cultural	2	-	-	2	1
Total							25
IV Semester							
AECC	LAN 4.1	Language - I	4	3	1	-	3
AECC	LAN 4.2	Language - II	4	3	1	-	3
AECC	COI 4.1	Constitution of India	3	2	1	-	2
DSC	BCM –N 4.1	Financial Statement Analysis	4	3	1	-	4
DSC	BCM– N 4.2	Financial Management	4	3	1	-	4
DSC	BCM-N 4.3	Financial Systems and Services	4	3	1	-	4
OEC	OEC4.1	Open Elective (Business Entrepreneurship)	3	2	1	-	3
SEC-VB	SEC - VB 4.1	Sports	2	-	-	2	1
SEC-VB	SEC - VB 4.2	NCC/NSS/Cultural	2	-	-	2	1
Total							25

Semester V			
Course Code	Title of the course	Category of courses	Credits
BCM 5.1	Entrepreneurship Development	DSC	4
BCM 5.2	Management Accounting	DSC	4
BCM 5.3	Income Tax - I	DSE	4
BCM 5.4	Elective - I International Finance/ International Banking/Brand Management/Human Capital Management	DSE	4
BCM 5.5	Financial Modelling	Vocational - 1	3
BCM 5.6	Advanced Excel Techniques	SEC-SB	2
	Total		25

Semester VI			
Course Code	Title of the course	Category of courses	Credits
BCM 6.1	Quantitative Techniques in Accounting & Finance	DSC	4
BCM 6.2	Principles & Practice of Auditing	DSC	4
BCM 6.3	Income Tax - II	DSE	4
BCM 6.4	Elective - II Security Analysis & portfolio Management/Work Psychology/Retail Banking/Service Marketing Management	DSE	4
BCM 6.5	Small Business Finance	Vocational-2	3
BCM 6.6	Public relations and Corporate Communications	DSC	4
	Total		23

Exit option with bachelor's degree – with ability to solve complex problems that are ill structured requiring multidisciplinary skills to solve.

Semester VII			
Course Code	Title of the course	Category of courses	Credits
BCM 7.1	International Business (MIS?)	DSC	4
BCM 7.2	Advanced Management Accounting	DSC	4
BCM 7.3	Financial Engineering	DSC	3
BCM 7.4	Strategic Finance//International Banking/Strategic HRM/Strategic Marketing	DSE	4
BCM 7.5	Business Analytics	Vocational-3	3
BCM 7.6	Research Methodology	AECC	3
	Total		21

Semester VIII			
Course Code	Title of the course	Category of courses	Credits
BCM 8.1	Forensic Accounting	DSC	4
BCM 8.2	Management Information System	DSC	4
BCM 8.3	Financial Reporting/Digital Banking/Digital Marketing/Work Psychology	DSC	4
BCM 8.4	ERP Application	Vocational-4	3
BCM 8.5	Research Project	DSE	6
	Total		21

AECC- Ability Enhancement Compulsory
 Courses DSC- Discipline Specific Course
 VBC- Value-based Course
 SEC- Skill Enhancement Course
 DSE- Discipline Specific
 Elective OE- Open Elective

Continuous Internal Assessment – Scheme of Evaluation for Theory Courses

End Semester Examination: 60%

**Continuous Internal Assessment:
40%**

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii.Quiz / Presentation / Creating diagrams /charts / Classwork / Case study / Viva / Field work etc.	05		
iii. Classroom participation	05		
Total			40

SEMESTER–I
BCM 1.1: FINANCIAL ACCOUNTING
Total Teaching Hours: 60 No. of Hours A Week: 4

CObj_ID	Course Objectives
CObj_1	To acquaint students with the accounting concepts, tools and techniques influencing Business Organizations.
CObj_2	Prepare organisation's financial accounts (statements) for a specific period of time.
CObj_3	To improve clarity, consistency and comparability of the communication of financial information.

CO_ID	Course Outcomes
CO_1	Be able to develop the skill of recording financial transactions and preparation of reports in accordance with Ind AS.
CO_2	Be able to understand and prepare the financial statements required for today 's business .
CO_3	Be able to understand the concepts and theoretical knowledge of Financial accounting.
CO_4	Be able to understand the accounting treatment required for converting a Partnership firm into a Limited company.
CO_5	Be able to apply the concept of accounting to find out the profitability at different activity/departmental levels and analyse the same for decision making in business.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5

CO_1	*				
CO_2					*
CO_3	*				
CO_4	*				*
CO_5		*			*

Course Content

Sl. No	Module title	Module Content	Number of Hours	Skills Developed
1.	UNIT 1: INTRODUCTION TO FINANCIAL ACCOUNTING	Introduction – Meaning and Definition – Objectives of Accounting – Functions of Accounting –Users of Accounting Information – Limitations of Accounting – Accounting Principles – Accounting Concepts and Accounting Conventions- Social accounting & green accounting concepts-Accounting Standards: List of Indian Accounting Standards.	10 Hrs	Transferable Skills
2.	UNIT2: CONVERSION OF SINGLE ENTRY INTO DOUBLE ENTRY SYSTEM	Single entry system- Meaning – Features – Merits – Demerits – Types. Conversion into Double Entry system – Need for Conversion – Preparation of Statement of Affairs – Cashbook – Memorandum Trading Account – Total Debtors Account – Total Creditors Account – Bills Receivable Account –Bills Payable Account – Trading and Profit & Loss Account and Balance Sheet.	14Hrs	Cognitive Skills
3.	UNIT 3: HIRE PURCHASE SYSTEM	Meaning of Hire Purchase and Instalment Purchase System- difference between Hire Purchase and Instalments Purchase – Important Definitions – Hire Purchase Agreement – Hire Purchase Price – Cash Price – Hire Purchase Charges – Net Hire Purchase Price – Net Cash Price – Calculation of Interest – Calculation of Cash Price –Journal Entry and Ledger Accounts in the books of Hire Purchaser and Hire Vendor (Asset Accrual Method only).	14Hrs	Employable Skills

4.	UNIT 4: DEPARTMENTAL ACCOUNTS	Meaning, Objectives, basis of allocation of expenses, Trading and Profit and Loss Account in Columnar form – (Excluding Inter Departmental Transfers at invoice price). Loss of profit in consequential loss, Inter Departmental transfer at invoice price.	10Hrs	Analytical Skills
5.	UNIT 5: CONVERSION OF PARTNERSHIP FIRM INTO A LTD COMPANY	Meaning – Need for conversion - Purchase Consideration – Mode of Discharge of Purchase Consideration – Methods of calculation of Purchase Consideration – Net Payment Method – Net Assets Method – Journal Entries and Ledger Accounts in the books of Vendor – Treatment of items: Dissolution Expenses, Unrecorded Assets and Liabilities, Assets and Liabilities not taken over by the Purchasing Company, Contingent liabilities, Incorporation entries and preparation of balance sheet of the purchasing company under vertical format.	12Hrs	Evaluation and Synthesis

Books for Reference:

- Arulanandam & Raman, 2018 – Financial Accounting – I, HPH
- Jawaharlal & Seema Srivastava, 2017 : Financial Accounting, HPH
- Dr. S.N. Maheswari: Financial Accounting, Revised 2017, Vikas Publications
- S P Jain and K. L. Narang, Revised 2017: Financial Accounting- I, Kalyani Publishers
- S. Jayapandian, Revised 2016 : Financial Accounting from Zero.
- Radhaswamy and R.L. Gupta: Revised 2017, Advanced Accounting, Sultan Chand
- Guruprasad Murthy: Revised 2017, Financial Accounting, HPH
- Soundarrajan & K. Venkataramana, Revised 2015, Financial Accounting, SHBP.
- Dr. Venkataraman & others (7 lecturers): Revised 2019, Financial Accounting, VBH
- Dr. Alice Mani: Revised 2019, Financial Accounting, SBH.
- S.N Maheshwari, Revised 2017, Advanced Accounting, vol-I, vikas publishing house

Web Resources:

- **Icai.bos**
- **Google.com**

Journals:

- <https://www.resurchify.com/ed/icaaf-2020-international-conference-on-accounting-auditing/8732>
- <https://www.resurchify.com/ed/accounting-principles-2020-mind-the-gaap-what/7811>
- <https://www.resurchify.com/ed/iccabm-2019-international-conference-on-current-research/2779>

BCM 1.2: CORPORATE ADMINISTRATION

Total Teaching Hours: 60 No. of Hours a Week: 4

CObj_ID	Course Objectives
CObj_1	To enable students to get familiarized with the existing Company Law and Secretarial Procedure.
CObj_2	Understand the various roles played by top executives.
CObj_3	To familiarize students about the different types of meetings conducted by the company.

CO_ID	Course Outcomes
CO_1	Be able to understand the framework of Companies Act of 2013 and different types of companies.

CO_2	Be able to identify the stages and documents involved in the formation of companies in India.
CO_3	Be able discuss the role, responsibilities and functions of key Management Personnel in Corporate Administration.
CO_4	Be able to recognize the procedure involved in the corporate meetings and the role of company secretary in the meeting.
CO_5	Be able to draw the role of liquidator in the process of winding up of the company.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*				
CO_2		*			
CO_3			*		
CO_4					*
CO_5					*

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed

1.	UNIT 1: INTRODUCTION TO COMPANY	Meaning and Definition – Features of Joint Stock Company, Highlights of Companies Act 2013 – Types of Companies – One Person Company, Private Company, Public Company, Company limited by Guarantee, Company limited by Shares, Holding Company, Subsidiary Company, Government Company, Associate Company, Small Company, Foreign Company, Global Company, Body Corporate, Listed Company	12Hrs	Employable Skills
2.	UNIT 2: FORMATION OF A COMPANY	Promotion Stage: Meaning of Promoter, Position of Promoter & Functions of Promoter Incorporation Stage – Meaning & contents of Memorandum of Association & Articles of Association, Distinction between Memorandum of Association and Articles of Association, Certificate of Incorporation, Subscription Stage – Meaning & contents of Prospectus, Statement in lieu of Prospectus and Book Building, Commencement Stage – Document to be filed, e- filing, Register of Companies, Certificate of Commencement of Business.	16Hrs	Employable Skills
3	UNIT 3: COMPANY ADMINISTRATION	Key Managerial Personnel – Managing Director, Whole time Directors, the Companies Secretary, Chief Financial Officer, Resident Director, Independent Director, Auditors – Appointment – Powers - Duties & Responsibilities. Managing Director – Appointment – Powers – Duties & Responsibilities. Audit Committee, CSR Committee. Company Secretary - Meaning, Types, Qualification, Appointment, Position, Rights, Duties, Liabilities & Removal or dismissal.	18Hrs	Employable Skills

4	UNIT 4: CORPORATE MEETINGS	Corporate Meetings - Types of Meetings – Annual General Meeting – Extraordinary General Meetings – Board Meetings and Resolutions - Requisites of a valid meeting.	08Hrs	Employable Skills
5	UNIT 5: WINDING UP OF COMPANIES	Winding up – meaning, modes of winding up -compulsory winding up, voluntary winding up, winding up subject to supervision of court; Liquidators -duties and powers of liquidator.	06Hrs	Employable Skills

Books for Reference:

- S.N Maheshwari; 2014 Elements of Corporate Law, HPH.
- Balchandran – Revised 2017, Business Law for Management HPH
- Dr. B.G. Bhaskar, K.R. Mahesh Kumar ,Revised 2015– Corporate Administration, VBH
- Dr. P.N. Reddy and H.R. Appanaiah; Revised 2019 Essentials of Company Law and Secretarial Practice, HPH.
- K. Venkataramana, Revised 2019 Corporate Administration, SHBP.
- N.D. Kapoor; Revised 2015 Company Law and Secretarial Practice, Sultan Chand.
- C.L Bansal; Revised 2019 Business and Corporate Law
- M.C. Bhandari: Revised 2017 Guide to Company Law Procedures, Wadhwa Publication.
- S.C. Kuchal: Revised 2017 Company Law and Secretarial Practice.
- S.C. Sharma : Revised 2017 Business Law, I.K. International Publishers
- S.N Maheshwari ; Revised 2017 Elements of Corporate Law, Vikas Publisher

Web Resources:

- **Google.com**
- **mca.in**

Journals:

- Academy of Management Journal. ...
- Academy of Management Learning & Education. ...
- Academy of Management Perspectives. ...
- Academy of Management Review

BCM 1.3 PRINCIPLES OF MANAGEMENT

**Total Teaching Hours: 60 No. of Hours a Week: 4
4 CREDITS**

CObj_ID	Course Objectives
CObj_1	To familiarize the students to the concepts and principles of organization management.
CObj_2	To Create awareness of the principles to be followed in an organisation
CObj_3	To study the system and process of effective controlling in the organization
CO_ID	Course Outcomes

CO_1	Be able to understand the managerial concepts related to business.
CO_2	Be able to demonstrate the roles, skills and functions of management.
CO_3	Be able to understand the complexities associated with management of human resources in the organizations and integrate the learning in handling these complexities.
CO_4	Be able to understand the importance of planning and forecasting in the decision making process of a given organization.
CO_5	Be able to understand the management principles and management Theories.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1			*		*
CO_2				*	*
CO_3					*
CO_4		*		*	*
CO_5		*	*		

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed

1	FUNDAMENTALS OF MANAGEMENT	Management –Introduction, Evolution of management, Meaning, Nature and Characteristics of management, Schools of Management, Scope and functional areas of management, Management as a science art or profession, Management & administration, Principles of management, Social responsibility of management and ethics. Branches of management-FM, CM, HRM.	14	COGNITIVE SKILL
2.	PLANNING AND DECISION MAKING	Management Process – Introduction; Planning –Nature, Importance and Purpose of planning, Planning process, Objectives, Types of plans (meaning only); Decision making steps and process; MBO – Meaning and Importance	12	ANALYTICAL SKILLS
3	ORGANIZING	Organization -Purpose of organization, Principles of organization, Types of organization. Line and staff authority-departmentalisation, Delegation of Authority-Centralisation Vs Decentralisation, Span of control. TQM, Kaizen – Meaning, Objectives and Importance in Management	9	TRANSFERABLE SKILLS
4	COMMUNICATION AND CONTROL	Communication-Meaning and Importance, Barriers to communication, Types of communication; Controlling - Meaning and Steps in controlling, Essentials of a sound control system.	8	EMPLOYABLE SKILLS

5	MANAGEMENT OF CHANGE	Concept, nature, process of planned change, Reasons for change, Resistance to change, Factors affecting resistance to change, Overcoming resistance to change, Emerging horizons of management in a changing environment – Green management – Meaning, Importance, Stress management – Meaning, Types, Causes.	10	LIFE SKILLS
6	MOTIVATION AND LEADERSHIP	Motivation Theories -Maslow's Need Hierarchy Theory, Herzberg's Two Factor Theory, McGregor's X & Y theory; Leadership Styles – Autocratic Style, Democratic Style, Bureaucratic Style, Laissez Faire Leadership Style, Transactional Leadership, Transformational Leadership and Charismatic Leadership	7	TRANSFERABLE SKILLS

Books for Reference:

- Appaniah& Reddy. (1998). Essentials of Management. New Delhi: Himalaya Publishing House.
- Aswathappa, K. (2011). Human Resource Management. New Delhi: Tata McGraw Hill Education Pvt Ltd.
- Rao, Subba. (2013). Human Resources Management. New Delhi: Himalaya Publishing House.
- Srinivasan & Chunawalla. (1995). Management Principles and Practice. New Delhi: Himalaya Publishing House.
- Tripathi& Reddy. (2011). Principles of Management. New Delhi: Tata McGraw Hill Education Pvt Ltd.

Web Resources:

<https://www.mindtools.com/pages/article/henri-fayol.htm>

<https://www.classcentral.com/course/swayam-principles-of-management-19977>

<https://2012books.lardbucket.org/books/management-principles-v1.0/s05-introduction-to-principles-of-.html>

<https://www.businessnewsdaily.com/10618-resources-learning-management-skills.html>

<https://courses.lumenlearning.com/suny-principlesmanagement/>

Journals:

<https://hbr.org/>

<https://online.hbs.edu/blog/post/leadership-vs-management>

<https://hbsp.harvard.edu/product/10296-PDF-ENG?itemFindingMethod=Catalog>

BCM 1.4 : Basic Excel Technique
Total Teaching Hours: 42No. of Hours a Week: 3

CObj_ID	Course Objectives
CObj_1	To impart excel formulas to students and application of the same.
CObj_2	To equip students with the knowledge on how to debug and audit the advanced formulas
CObj_3	To make the students meet the industry requirements.

CO_ID	Course Outcomes
CO_1	Examine spreadsheet concepts and explore the Microsoft office Excel environment.
CO_2	Understand and apply basic principles of laying out excel models for decision making.
CO_3	Use excel functions to summarize quantitative data graphically using pivot tables and charts.
CO_4	Apply formulas to lay data in readiness for analysis.
CO_5	Evaluate the financial impact of investments.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*			

CO_2	*	*			
CO_3		*	*		
CO_4		*	*		
CO_5		*		*	*

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Create Worksheets & Workbook	Create of Workbook, Navigation within the Workbook (Clipboard), Import Data from De Limited Text Files, Add the Worksheet for the Existing workbook. Navigating using GOTO Special.	3	Employable Skills
2	References & Table Format	Type of References : Absolute Reference , Mixed References, Relative References, Apply the Different Table Format. (Working with 2 Case Studies)	3	Employable Skills
3	Summarize data by using Functions / Statistical Functions.	Define Name, Perform Calculations by using the SUM, SUMIF, SUMIFS, COUNT, COUNTA, COUNTIF, COUNTIFS, COUNT BLANK, AVERAGE, AVERAGEIF, MAX, MIN RANK FUNCTIONS ETC (Working with 2 Case Studies)	3	Employable Skills
4		VLOOKUP, HLOOKUP, Index, Match, & If error. (Working with 2 Case Studies)	3	Employable Skills

	Lookup & Reference Section.			
5	Create & Format Charts	New Chart, Data Series, Switch b/w Rows & Columns, Analyses data by using Quick Analysis, Resize Charts & Add & Modify The Chart Elements, Layouts & Styles, Move Chart to Chart Sheets (Working with 1 Case Studies)	3	Employable Skills
6	Format & Modify Text by using Functions.	Format Text by using RIGHT, LEFT, MID, UPPER, LOWER, PROPER, Concatenate, TRIM, Clean, Char, TEXT JOIN, LEN, FIND, Search, Replace & Substitute. (Working with 1 Case Studies)	3	Employable Skills
7	Create Advanced Tables & Charts	Create & Manage Pivot Tables, Create & Manage Pivot Charts , Working Slices , Timeline Filters , Sorting Options, Designing the PIVOT Tables ETC. (Working with 2 Case Studies)	3	Employable Skills
8	DATE Functions	Working the Date Formats, Working the Various Date Functions Like DATE, TODAY,NOW, EOMONTH, WORKDAY, WORKDAY.INTL, NETWORKDAY, NETWORKDAY.INTL. ETC. . (Working with 1 Case Studies)	3	Employable Skills
9	Logical Functions	Working the Various Logical Functions like IF, IFS, AND, OR, SWITCH , TRUE or False . (Working with 1 Case Studies)	3	Employable Skills
10	Financial Functions	PMT, IPMT, CUMIPMT,RATE, NPER, FV. (Working with 1 Case Studies)	3	Employable Skills

11	Data Analytics Tools	Working with Custom Sort & Advanced Filter, Text to Columns, Remove Duplicates, Data Validation, Consolidation, what if Analysis (Scenario Manager, Goal Seek FORCAST, FORCAST.ETS, FORCAST.CONFINT, FRCAST.ETS.SESONALIOTY, FORCAST.ETS.STAT, FORCAST &	3	Employable Skills

		Data Table), FORECASTING.LINEAR) (Working with 1 Case Studies)		
12	Creating for Dynamic Charts using Functions.	An Excel Dashboard provides insight, analysis and alerts. They're fully interactive and dynamic and can help with project management, customer service, retail management, financial forecasting and much more. (Working with 1 Case Studies)	3	Employable Skills
13	Power Pivot Table	Advanced Pivot Table, Working with Relationship, Introduction of DAX Functions, Data Modelling, Queries & Connections, Designing Pivot Chart & Table . (Working with 1 Case Studies)	3	Employable Skills
14	Working with Addons	Working Various Addons Analytics Tool Pack, Power Maps, Solver Add in.	3	Employable Skills

Books for Reference:

- Microsoft Excel 2019 Bible: The Comprehensive Tutorial Resource
- Excel: Quickstart Guide from Beginner to Expert
- Excel 2019: All-In-One for Dummies
- Microsoft Excel Dashboards and Reports
- Ctrl+Shift+Enter Mastering Excel Array Formulas
- Excel for Beginners
- Microsoft Excel 2019 Formulas and Functions

Web Resources:

- <https://youtube.com/c/edurekaIN>
- <https://openoregon.pressbooks.pub/beginningexcel19/>
- <https://corporatefinanceinstitute.com/resources/ebooks/excel-book-pdf/>
- <https://doc.lagout.org/operating%20system%20/Windows/Excel/Microsoft%20Excel%202010%20Step%20by%20Step.pdf>
- https://www.dit.ie/media/ittraining/msoffice/MOAC_Excel_2016_Core.pdf
- <https://www.linkedin.com/learning/excel>
 - <https://www.youtube.com/channel/UCVLbzhxVTiTLiVK>

BCM1.5 –FINANCIAL LITERACY

Total Teaching Hours: 42 No. Of Hours a Week: 3

CObj_ID	Course Objectives
CObj_1	To provide an understanding of the knowledge of financial literacy and to create awareness of the same.
CObj_2	To familiarize with the basic concepts of banking, accounting and insurance sectors.
CObj_3	To provide an awareness on managing personal finance in day-to- day life.

CO_ID	Course Outcomes
CO_1	Understand the importance of financial literacy and its implementation of day-to day life.
CO_2	Learn the basic accounting, banking and insurance concepts and their usage in daily life transactions.
CO_3	Demonstrate an understanding of the different types of banking operations available for customers.
CO_4	Recognize and understand the procedure involved in managing personal finance.
CO_5	Explain the role of insurance and its importance including benefits.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1		*			*
CO_2	*				

CO_3			*	
CO_4		*		
CO_5		*		

Course Content

SL. NO	Module title	Module Content	Number of Hours	Skills Developed
1	INTRODUCTION TO FINANCIAL LITERACY	Meaning, objectives, importance and scope of financial literacy; Prerequisites of Financial Literacy – level of education, numerical and communication ability, financial knowledge, financial attitude, financial culture, financial behaviour ,financial inclusion, financial planning, financial wellbeing	06	Cognitive Skills
2	BASICS OF ACCOUNTING	Introduction – Meaning and Definition – Objectives of Accounting – Functions of Accounting –Accounting basic terminologies ,Users of Accounting Information – Limitations of Accounting – Accounting Principles – financial statement-importance-users-Social accounting & green accounting concepts	06	Analytical Skills

3	BANKING OPERATIONS	Types of banks; Banking Products and Services – Various services offered by banks; Types of bank deposit accounts – Savings Bank Account, Term Deposit, Current Account, Recurring Deposit, PPF, NSC etc.; Formalities to open various types of bank accounts, PAN Card, Address proof, KYC norm; Various types of loans – short term, medium term, long term, micro finance, agricultural etc. and related interest rates offered by various nationalized banks and post office; Cashless banking, e-banking, Check Counterfeit Currency; CIBIL, ATM, Debit and Credit Card, RTGS, NEFT and APP based Payment system; Banking complaints and Ombudsman. Institutions dealings in gold loans.	12	Employable Skills

4	MANAGING PERSONAL FINANCE	Meaning of personal finance, objectives ,need, importance ,Dos and don'ts in managing income ,expenditure and savings, Mutual funds-meaning,objectives,scope,p rocess – types of mutual funds. Gold loans-process to	06	Analytical Skills

5	INSURANCE BUSINESS IN INDIA	Meaning, definition ,objectives, types of insurance –Life insurance : meaning ,objectives, progress of life insurance types of life insurance , policy, claims, endowment, life insurance contact, parties in the life insurance. General insurance-meaning ,objectives. Health insurance –meaning ,objectives, need, types of health insurance-catastrophe insurance-growth of health insurance –future of health insurance. Liability and vehicle insurance concepts.	12	Cognitive Skills

Books for Reference:

1. SP Iyengar (2005), Advanced Accounting, Sultan Chand & Sons, Vol. 1.
2. Robert N Anthony, David Hawkins, Kenneth A. Merchant, (2017) Accounting: Text and Cases, McGraw-Hill Education, 13th Edition
3. Charles T. Horngren and Donna Philbrick, (2013) Introduction to Financial Accounting, Pearson Education, 11th Edition.
4. B.S. Raman (2008), Financial Accounting Vol. I & II, United Publishers & Distributors
5. P. Perya Swamy ;Principles and Practice of Life Insurance
6. Dr. Alice Mani: Banking Law and Operation, SBH.
7. Shashi K. Gupta, R.K. Sharma, Kalyani Banking and Insurance

Web Resources:

<https://www.accountingcoach.com/links>

<https://libguides.utt Tyler.edu/c.php?g=948323&p=6838173>

<https://corporatefinanceinstitute.com/resources/knowledge/accounting/>

<https://online.hbs.edu/courses/financial-accounting/>

Journals:

1. <https://journals.sagepub.com/home/jaf>
2. <https://www.abacademies.org/journals/academy-of-accounting-and-financial-studies-journal-home.html>
3. <https://www.insurancejournal.com/magazines/>
4. <https://www.mdpi.com/journal/ijfs>

SEMESTER – II
BCM 2.1 ADVANCED FINANCIAL ACCOUNTING

Total Teaching Hours: 60No. Of Hours a Week: 4.

CObj_ID	Course Objectives
CObj_1	To provide students conceptual knowledge of accounting.
CObj_2	To review and understand the accounting tools and techniques influencing business organizations.
CObj_3	To effectively analyze, interpret and use financial statements.

CO_ID	Course Outcomes
CO_1	To acquire conceptual knowledge of basics of fire insurance claims.
CO_2	To develop the skill of recording the Consignment transactions in the books of Consignor and Consignee and ascertain Profit.
CO_3	To identify and analyse the concepts of Joint venture and prepare different set of accounts on Joint Venture
CO_4	To familiarize the concept of Branch account and its system.
CO_5	To equip with the knowledge of accounting process and preparation of final accounts.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*				
CO_2				*	
CO_3		*			
CO_4			*		
CO_5					

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	INSURANCE CLAIMS	Introduction – Need – Loss of Stock Policy – Fire insurance premium calculation Steps for ascertaining Fire insurance claim – Treatment of Salvage – Average Clause – Treatment of Abnormal Items – Computation of Fire insurance claims. Insurance of loss of profit	14	Analytical Skills
2	CONSIGNMENT ACCOUNTS	Introduction – Meaning – Consignor – Consignee – Goods Invoiced at Cost Price – Goods Invoiced at Selling Price – Normal Loss – Abnormal Loss – Valuation of Stock – Stock Reserve – Journal Entries– Ledger Accounts in the books of Consignor and Consignee.	14	Cognitive Skills
3	ACCOUNTING FOR JOINT VENTURES	Introduction – Meaning – Objectives – Distinction between joint venture and consignment – Distinction between joint venture and partnership – maintenance of accounts in the books of co-ventures– maintaining separate books for joint venture – preparation of memorandum joint venture -problems.	12	Employable Skills

	BRANCH ACCOUNTS	Introduction – Meaning – Objectives – Types of Branches - Dependent Branches – Features – Supply of Goods at Cost Price - Invoice Price – Branch Account in the books of Head Office (Debtors System Only).	10	Transferrable Skills
5	FINAL ACCOUNTS OF A PROPRIETARY CONCERN	Meaning, Objectives and importance of Final Accounts. Preparation of Trading Account, Preparation of Profit and Loss Account, Preparation of Balance sheet- Problems	10	Employable Skills

Books for Reference:

Anil Kumar, V. Rajesh Kumar, B. Mariyappa(2017).Advanced Financial Accounting. New Delhi.Himalaya Publishing House.

Girish.V,Anand.R(2018-Revised).Advanced Financial Accounting.Bangalore .Skyward Publishers.

Arulanandam & Raman (2017).Advanced Financial Accounting. New Delhi. Himalaya Publishing House.

Dr. SN.Maheshwari.(2016) Advanced Financial Accounting.Bangalore.Vikas Publications.

S.P.Jain & K.L.Narang.(2018) Advanced Financial Accounting.Mumbai. Kalyani Publications

Radha swamy & R.L.Gupta(2017) Advanced Accounting.Chennai. Sultan Chand Publications.

Web Resources:

<https://www.studocu.com/in/document/anna-university/accounting/bcom-second-semester-advanced-financial-accounting-notes/7546747>

<https://www.tppl.org.in/2020/second-sem/1872-advanced-financial-accounting-9789351633709.html>

<https://www.studynama.com/community/threads/advanced-financial-accounting-ebook- handout-pdf-download-bcom-second-sem-students.1307/>

Journals: https://www.academia.edu/Documents/in/Advanced_Financial_Accounting

<https://www.cribfb.com/journal/index.php/ijafr>

<https://goodwoodpub.com/index.php/ijfam>

BCM 2.2- Quantitative Analysis for Business Decisions I**Total Teaching Hours: 60No. Of Hours a Week: 4.**

CObj_ID	Course Objectives
CObj_1	To understand the basic concepts of Mathematics.
CObj_2	To have a proper understanding of mathematical application in commerce
CObj_3	To Develop abstract, logical and critical thinking and the ability to reflect critically upon their work and the work of others.
CO_ID	Course Outcomes
CO_1	Explain the concepts and use equations, formulae, and mathematical expressions and relationships in a variety of contexts
CO_2	Apply the knowledge in mathematics (, matrices, calculus) in solving business problems
CO_3	Ability to solve problems on Matrices and execute the laws of indices, law of and evaluate them.
CO_4	Analyse and demonstrate mathematical skills required in mathematically intensive areas in Economics and business.
CO_5	Ability to solve problems on Arithmetic progression, Geometric progression and construct logical application of these concepts.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1		*			
CO_2		*			
CO_3			*		
CO_4			*		
CO_5			*		

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	NUMBER SYSTEM	Introduction - Natural numbers - Even numbers – Odd numbers – Integers – Prime numbers – Rational & Irrational numbers, Real numbers, HCF & LCM (Simple problems).	06	Cognitive Skills
2	THEORY OF EQUATIONS	Introduction – Meaning – BODMAS -Types of Equations – Simple/ Linear Equations and Simultaneous Equations (only two variables), Elimination and Substitution Methods only. Quadratic Equation - Factorization and Formula Method ($ax^2 + bx + c = 0$ form only). Simple problems	12	Cognitive Skills
3	MATRICES, DETERMINANT AND INDICES	Meaning – types – operation on matrices – additions – subtractions and multiplication of two matrices – transpose – determinants – minor of an element – co-factor of an element –inverse – crammers rule in two variables – problems. Indices: Meaning- Basic Laws of Indices and their application for simplification.	16	Transferable Skills
4	COMMERCIAL ARITHMETIC	Simple Interest, Compound Interest including yearly and half yearly calculations, Annuities, Percentages, Bills Discounting, Ratios and proportions, duplicate-triplicate and sub-duplicate of a ratio. Rule of 72 and 69 .Proportions: third, fourth and inverse proportion - problems.	16	Transferable Skills
5	PROGRESSIONS	PROGRESSIONS: Arithmetic Progression – Finding the 'nth ' term of AP and Sum to 'nth ' term of AP. Insertion of Arithmetic Mean, Geometric Progression – Finding the 'nth ' term of GP and sum to 'nth ' term of GP and insertion of Geometric Mean.	10	Analytical Skills

Books for Reference:

- 1.. Khan, S.M. (2012). A textbook of Business Mathematics. Viva Books Private Limited.
2. Sancheti, D.C. and Kapoor, V.K. (2014). Business Mathematics. S. Chand & Sons.
3. Soper, J. (2004) Mathematics for Economics and business: An Interactive Introduction. Wiley-Blackwell.
4. Schultheis, R.A. and Kaczmariski, R.M. (2005) Business Math. Cengage South Western.

Web Resources:

- ***WebMath***
- ***Wolfram Mathworld***

Journals:

- https://icmai.in/upload/Students/Syllabus-2012/Study_Material_New/Foundation-Paper4-Revised.pdf
- https://icmai.in/upload/Students/Syllabus-2012/Study_Material_New/Foundation-Paper4-Revised.pdf

Course code : 2.2 COST ACCOUNTING

Total Teaching Hours: 60No. Of Hours a Week: 4.

CObj_ID	Course Objectives
CObj_1	To Provide an understanding of basic techniques of cost accounting and to develop the skills necessary to apply those techniques
CObj_2	To provide an understanding of the use of cost accounting techniques in planning, control & decision making.
CObj_3	To provide an understanding of proper recording, presentation of cost data to management for measuring efficiency in cost control & cost reduction.

CO_ID	Course Outcomes
CO_1	To explain relevant cost concepts & classification of costs used in the manufacturing / service sector.
CO_2	To explain the purposes of cost accounting
CO_3	To apply costing principles in the decision making process.
CO_4	To prepare the production cost statement & cost of goods sold statement.
CO_5	To explain the relationship between cost & financial accounting.

CO-PO Mapping

	PO _1	PO_ 2	PO_ 3	PO_ 4	PO_ 5
CO_1	*		*		
CO_2		*	*		
CO_ 3	*	*			
CO_ 4				*	
CO_ 5					*

Course Content

Sl. No	Module title	Module Content	Number of Hours	Skills Developed
1.	INTRODUCTION TO COST ACCOUNTING	Introduction – Meaning & Definition of Cost, Costing and Cost Accounting – Objectives of Costing - Comparison between Financial Accounting and Cost Accounting –Cost Concepts - Classification of Costs – Cost Unit – Cost Center – Elements of Cost – Preparation of Cost Sheet – Tenders and Quotations	10Hrs	Cognitive Skills
2.	MATERIAL MANAGEMENT & COST CONTROL	Meaning – Types: Direct Material, Indirect Material. Material Control – Purchasing Procedure – Store Keeping – Techniques of Inventory Control –Levels settings– EOQ – Numerical examples - ABC Analysis – VED Analysis – Just In-Time – Perpetual Inventory System – Theoretical concepts - -Methods of Pricing Material Issues: FIFO, LIFO, Weighted Average Price Method and Simple Average Price Method – valuation of Closing stock.	12Hrs	Employable Skills
3.	LABOUR COST CONTROL	Meaning – Types: Direct Labour, Indirect Labour - Timekeeping – Time booking – Idle Time – Overtime – Labour Turnover. Methods of Labour Remuneration: Time Rate System, Piece Rate System, Incentive Systems (Halsey plan, Rowan Plan & Taylor's differential Piece Rate System) – Numerical examples	10Hrs	Employable Skills

4.	OVERHEAD COST CONTROL	Meaning and Definition – Classification of Overheads – Procedure for Accounting and Control of Overheads – Allocation of Overheads – Apportionment of Overheads – Primary Overhead Distribution Summary – Secondary Overhead Distribution Summary – Repeated Distribution Method and Simultaneous Equations Method – Absorption of Factory Overheads — Machine Hour Rate – Numerical examples on Machine Hour Rate.	14Hrs	Evaluation and Synthesis
5.	COST VOLUME PROFIT ANALYSIS	Introduction to cost volume profit analysis (CVP) - Break even point (BEP)- Calculation of BEP in value & volume – Contribution to sales ratio- Numerical examples	7 HRS	Analytical Skills
6.	RECONCILIATION OF COST AND FINANCIAL ACCOUNT	Need for Reconciliation – Reasons for differences in Profit or Loss shown by Cost Accounts and Profit or Loss shown by Financial Accounts – Preparation of Reconciliation Statement and Memorandum Reconciliation Account. Numerical examples	7 HRS	Cognitive Skills

Books for Reference:

- *J Made Gowda - 2018-Cost & Management Accounting, HPH*
- *M V Shukla - 2017- Cost & Management Accounting HPH*
- *N K Prasad - 2018- Cost Accounting, Books Syndicate Pvt. Ltd.*
- *Nigam & Sharma - 2016- Cost Accounting, HPH*
- *Khanna Pandey Ahuja - 2013 - S. Chand and Company Private Limited, New Delhi (An ISO 9001:2008 Company Practical Costing,*
- *P.K. Sinha- 2015- Accounting & Cost for Managers- skyward publishing*
- *S. Anil kumar, V. Rajesh kumar, B. Mariyappa - 2019- Himalaya publishing house*

Web Resources:

google.com

<https://www.hbsp.harvard.edu/product/105039-PDF-ENG>

<https://www.accountingaccidentally.com/cost-accounting-you-tube-links/>

<https://www.udemy.com/course/cost-accounting-a-comprehensive-study/>

<https://www.deskera.com/blog/cost-accounting/>

Journals:

<http://icmai-rnj.in/>

<https://www.hbsp.harvard.edu/product/105039-PDF-ENG>

<https://www.jstage.jst.go.jp/browse/jcar>

<https://www.researchgate.net/journal/Journal-of-Cost-Management-1092-8057>

BCM 2.6 INVESTING IN STOCK MARKET

Total Teaching Hours: 42No. Of Hours a Week: 3.

CObj_ID	Course Objectives
CObj_1	Introduce students to monetary and financial markets in India and examine their structure, operations and products.
CObj_2	Enable the students with a conceptual framework of stock markets and commodity markets
CObj_3	Develop an understanding of the principles of Investments in securities markets and provide the knowledge and skills required to undertake investments in stock market

CO_ID	Course Outcomes
CO_1	To identify and compare different investment options available for individual investors and to effectively manage their personal finances/investments.
CO_2	Understand & interpret the mechanism of investing, investment process and market indices.
CO_3	Explain role and nature of stock market and range of services provided by these for individual investors
CO_4	Demonstrate an understanding of mutual fund investments, their advantages and disadvantages.
CO_5	.Understand & interpret the mechanism of investing, investment process and market indices.

CO-PO Mapping

	PO_ 1	PO_ 2	PO_ 3	PO_ 4	PO_ 5
CO_ 1	*		*		
CO_ 2		*	*		
CO_ 3	*	*			
CO_ 4				*	
CO_ 5					*

Course Content

Sl. No	Module title	Module Content	Number of Hours	Skills Developed
1.	An Overview of Capital Market	Introduction, Meaning of capital Market, Primary market, Secondary market, Stock Market: Meaning, objectives, Functions, , issue mechanism, Types of companies issuing shares, Depositories, Player in in new issues market	8	Cognitive Skills
2.	Indian Stock Market	Market Participants: Players of Indian stock market, Investor, Clearing House, Stock Exchanges. Role of stock exchange, Governing body, Stock exchanges in India- BSE, NSE. Market Indices: Nifty-50, Sensex, Trading in securities: Demat trading, Dematerialization and	10	Employable Skills

		Rematerialization process.		

3.	Regulatory Institution	SEBI: Introduction, objectives, functions & powers, regulatory measures & Guideline: IPO, Debenture: Issues & redemption	8	Employable Skills
4.	Basics of Investing	Basics of Investment - Investment Environment. Risk and Return, Avenues of Investment ,Equity shares, IPO FPO, Preference shares, Bonds & Debentures, Insurance Schemes,Mutual Funds in details,and IndexFunds, ETFs	10	Evaluation and Synthesis
5.	Investment in Real Estate	Introduction to REI,Meaning, Role of REIT, Basics of REI Niches, Types of Private equityReal Estate strategies, Sources of Raising fund, Real estate private equity vs Real estate investment trust vs Real estate operating companies	6	Analytical Skills

Books for Reference:

- Publisher Simon & Schuster (Kindle); Penguin Books (Paperback) Author name : Peter Lynch & John Rothchild;
 - Publisher :Buzzingstock Publishing House
 - Author name : Ravi Patel
 - Publisher:Buzzingstock Publishing House
 - Authors: Ankit Gala,Jitendra Gala
- WebResources: <https://tradebrains.in/must-know-websites-for-indian-stock-market-investors/>
<https://www.moneycrashers.com/best-stock-market-investment-news-analysis-research-sites/>

Course code : Tally Prime Essentials

Total Teaching Hours: 42No. Of Hours a Week: 3.

CObj_ID	Course Objectives
CObj_1	Expose the students to digitally apply the accounting concepts and conventions.
CObj_2	To introduce the students to the Basic of Accounts and the usage of Tally for accounting purposes.
CObj_3	Develop the students' ability to use various tools in measuring and evaluating the performance of an entity
CO_ID	Course Outcomes
CO_1	Students learn the basics of tally and importance of tally in today's computerized environment.
CO_2	Students learn to prepare final accounts in tally along with cash flow statements and inventory analysis reports.
CO_3	The course assist students to become job ready and opens up diversified career options.
CO_4	Reconcile bank statement with relevant subsidiary books of accounts.
CO_5	Possess required skill to be employed as a data entry operator

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*				
CO_2	*				
CO_3	*				*

CO_4					*
CO_5		*			

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Maintaining Chart of Accounts in Tally Prime	Introduction – Getting Started with Tally Prime, Mouse/Keyboard conventions, company Creation, Shut a Company, Select a Company, Alter CompanyDetails, Company Features and Configurations, Company Features, F12: Configuration, Chart of Accounts, Ledger, Group, Ledger Creation, Single Ledger Creation, Multi ledger creation, Altering and Displaying ledgers, Group creation, single Group creation and ledgers, Key Takeaways, shortcut keys, practice Exercises	4 hrs	Employable Skills
2	Fundamentals of Inventory Management –	– Introduction, Inventory Management, Terms Used in Inventory Masters, Creation of Stock Group, Creation of Units of Measure, Creation of stock item, creation of Godown, Defining of stock opening balance in Tally Prime, Stock category, Reports, key takeaways, shortcut keys practice Exercise.	2hrs	Employable Skills
3	Maintaining Stock keeping units (SKU)	Introduction, Inventory masters in Tally Prime , creating inventory masters, creation of stock group, Creation of units of measure, Creation of Stock Item, Creation of Godown, Defining of Stock Opening Balance in Tally Prime, Stock Category, Reports, key takeaways, Shortcut keys, practice Exercises.	4 hr	Employable Skills

4	Chapter 4: Recording Day-to-Day transactions in Tally Prime	Business Transactions, Source Document for Voucher, Recording Transactions in Tally Prime, Accounting Vouchers, Receipt Voucher (F6), payment voucher (F5), Purchase Voucher (F9), Sales Voucher (F8), Debit Note Voucher, credit Note (Ctrl+F8), Journal Voucher (F7), Receipt Note voucher, Delivery Note Voucher, Rejection in Voucher, Rejection out Voucher Stock journal Voucher, Physical Verification of Stocks, Conclusion, Key Takeaways, Shortcut keys, Practice Exercises.	3hr	Employable Skills

5	Accounts Receivable and payable management	Introduction, Accounts Payable and Receivable, Maintaining Bill – wise Details, Activation of Maintaining Bill-wise Details Feature, New Reference, Against Reference, Advance Reference on Account, Credit Limit, Activate Credit Limit, Setting Credit Limit, Setting Credit limits, Exceeding Credit Limits, Exception to credits limits payment performance of debtors, changing the Financial year in Tally Prime, Conclusion, Key Takeaways, Shortcut keys, Practice Exercises.	3hr	Employable Skills
	Banking	Introduction, Banking Payments, Setting up Banking Features, Cheque	4hr	Employable Skills
6		Management, Cheque printing, Single Cheque Printing, Multi cheque printing, Cheque Register, Cancelled Cheque, Blank cheque, Bank Reconciliation, Manual Bank Reconciliation, Auto Bank Reconciliation, Auto Bank Reconciliation, Deposit Slip, Cash Deposit Slip, Cheque Deposit slip, Payments Report, Exporting e-payment Transactions from e-payments Report, Sending payment instructions to Bank, updating the Bank Details Instantly in Tally Prime, Conclusion, Key Takeaways, shortcut keys, Practice Exercises.		
7	Allocation and Tracking of Expenses and Incomes –	Cost Centre and Cost Categories, Activation of Cost Category and Cost Centre, Allocation of Expenses and incomes using Cost Centre, Allocation Of Expenses and incomes using Cost Centre with Cost Category, Allocation of Expenses to multiple cost centers and cost categories, Automation of Cost Centre and Cost Categories while recording transactions cost center classes, Cost Centre, Reports Category summary, Cost Centre Break up, Ledger Break up Group Break up , Conclusion, Shortcut keys, Practice Exercises.	4hrs	Employable Skills

8	MIS Reports	Advantages of management Information Systems, Types of MIS Reports in Tally Prime, MIS Reports in Tally Prime, Trial Balance, Balance Sheet, Profit and loss account, Cash flow statement, Funds flow statement, Ratio Analysis, Books and Accounting Reports, Day Book Receipts and Payments, Purchase Register, Bills Receivable And Bills Payable, Stock summary, stock transfer, movement Analysis, Ageing Analysis, Key takeaways, Shortcut keys, Practice Exercises.	4hrs	Analytical Skills
9	Storage and Classification of Inventory	Introduction, Godown management, Activating Godown, Creating a Godown Allocation of Stock to Particular Godown While Defining Opening Balance, Recording of purchase, Sales and Stock Transfers with Godown Details, Purchase of Inventory, Recording Stock Transfer entry using stock journal , sale of Inventory, Maintaining Damaged Goods, Analyzing Godown summary and Stock Movements Reports, Stock Category, Activation of Stock Categories, Creating Stock Categories, Recording Of Transactions, Movements of Goods in Batches/Lots – Batch wise details, Activating Batch wise Details in Tally Prime, Using Batch wise Details in purchase Invoice, Using Batch wise Details in Sales Invoice, Expired Batch/Stock Transfer Batch Reports, Batch Vouchers Report, Batch summary Report, Transfer Analysis report, stock Valuation methods, Configuration of on FIFO perpetual method, conclusion, Key takeaways, Shortcut keys	4 hrs	Employable Skills
10	Management of purchase and sales cycles	purchase order processing, activating order processing in Tally Prime , Sales order processing, Viewing order Details, Display columnar orders & stock Details, Sales order outstanding, per-closure of order, Reorder level, Display reorder status, conclusion, Key takeaways shortcut keys, practice Exercises.	4 hrs	Employable Skills
11	Price Levels and Price Lists	Activating price Lists and Defining of Price Levels, Creation of Price List, Using Price List Revise Price List, Conclusion, Key Takeaways, Shortcut keys, practice Exercises.	4 hrs	Employable Skills

12	Manufacturing process	Activating of bill of materials, Auto listing of components using bill of materials, Accounting of Manufacturing process of Tally Prime, Transferring of Manufactured Goods from Storehouse to Showroom, Reports, Stock journal Register, Transfer Analysis, Cost Estimation, Stock Ageing Analysis, Conclusion, Key Takeaways, Shortcut keys, Practice Exercises.	2 hrs	Analytical Skills

Books for Reference:

- 1)Vidhu(2018).Tally ERP 9 theory and practical.Asian Publishers.
- 2)Gaurav(2021).Learn Tally prime.Digital Muneem Ji Publishers.
- 3)Ragnesh(2021).Learning Tally prime.H K Publishers.
- 4)Ashok(2018).Simplest book for learning Tally.ERP 9.BPB Publishers 5)Tally educations private limited(2019).Tally GURU.Sahaj Enterprises

Web Resources:

www.tallysolutions.com

<https://www.youtube.com/watch?v=h9croue2uRo>

Journals:

www.worldwidejournals.com

BCM-N3.1 Corporate Accounting

Total Teaching Hours:56 No. of Hours per Week:04 [4 Credits]

CObj_ID	Course Objectives The course aims:
CObj_1	To develop analytical skills required in preparation of consolidated financial statements of a Joint Stock Company and various methods of valuation of shares, liquidators final statement.
CObj_2	To provide an understanding of the provisions of the Companies Act, 2013 including the updated provisions with reference to corporate mergers, acquisitions and other Accounting Standards
CObj_3	To provide conceptual understanding of corporate accounting and the framework within which the accounting standards underlying the accounting procedures are used to measure business performance.

CO_ID	Course Outcomes After completion of this course, the students should be
CO1	Able to demonstrate knowledge and skills in preparation of Financial Statements of a company according to the latest provisions.
CO2	Be able to apply various methods for valuation of shares and identify factors affecting it and apply the relevant provisions followed during the liquidation of companies and prepare the liquidator's final statement.
CO3	Apply various standards and principles in a given scenario with the detailed concepts of internal reconstruction, Financial situation and results of operations in an organization.
CO4	Able to develop an ability to apply appropriate standards with reference to corporate mergers and acquisitions for any given situation.
CO5	Be able to apply various methods of purchase considerations for corporate mergers, acquisitions and incorporate in the books of new company.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	*		*		
CO2	*		*		
CO3		*	*		
CO4	*	*		*	*
CO5	*	*	*	*	

Course Content

Sl. No.	Unit title	Content	Number of Hours	Skills Developed
1.	COMPANY FINAL ACCOUNTS	Statutory Provisions regarding preparation of Company Final Accounts –Treatment of Special Items –Tax deducted at source – Advance payment of Tax – Provision for Tax – Depreciation – Interest on debentures – Dividends – Rules regarding payment of dividends – Transfer to Reserves – Preparation of Income Statement and Balance Sheet in vertical form (As per 2013 revised format)	16	Employability
2.	VALUATION OF SHARES	Meaning – Need for Valuation – Factors affecting Valuation – Methods of Valuation: Intrinsic Value Method, Yield Method, Earning Capacity Method and Fair Value of shares - Rights Issue and Valuation of Rights Issue - Problems.	10	Analytical
3.	INTERNAL RECONSTRUCTION	Meaning – Objective – Procedure – Form of Reduction –Passing of Journal Entries – Preparation of Reconstruction accounts – Preparation of Balance Sheet after Reconstruction. (Vertical Format) Problems.	10	Evaluation and synthesis

4.	MERGERS AND ACQUISITIONS	Meaning of Amalgamation and Acquisition – Types of Amalgamation – Amalgamation in the nature of Merger – Amalgamation in the nature of Purchase - Methods of Purchase Consideration – Calculation of Purchase Consideration (Ind AS103) (Old AS14), Net asset Method - Net Payment Method, Accounting for Amalgamation - Entries and Ledger Accounts in the Books of Transferor Company and Transferee Company – Preparation of new Balance sheet. (Vertical Format)	15	Transferrable
5.	LIQUIDATION OF COMPANIES	Meaning–Types of Liquidation – Order of Payment - Calculation of Liquidator's Remuneration – Preparation of Liquidators Final Statement of Account.	10	Analytical

Books for Reference:

- Anil Kumar, V. Rajesh Kumar, B. Mariyappa, Corporate Accounting, 2017 Himalaya Publishing House, New Delhi
- Anil Kumar, V. Rajesh Kumar, B. Mariyappa, .Advanced Corporate Accounting , 2018. Himalaya Publishing House, ,New Delhi
- Arulanandam & Raman Corporate Accounting-II, 2017, Himalaya Publishing House, ,New Delhi
- CA Shibarama Tripath, Roadmap to IFRS and Indian Accounting Standards, 2016 Edition
- S.N. Maheswari , Financial Accounting, 2018, Vision Publishing House.
- Soundarajan A & K. Venkataramana,, Advanced Corporate Accounting, 2019, SHBP.
- RL Gupta , Advanced Accountancy, 2017 Sultan Chand
- Shukla and Grewal , Advanced Accountancy , 2017, Sultan Chand
- Srinivas Putty, Advanced Corporate Accounting, 2019, Himalaya Publishing House, New Delhi

Web Resources:

- The Economist(economist.com/topics/corporate-accounting)
- Accounting Coach (accountingcoach.com)
- <https://testbook.com/learn/corporate-accounting/>
- <https://onlinemasters.ohio.edu/blog/corporate-accounting/>

- https://wikieducator.org/Corporate_Accounting
<https://www.oreilly.com/library/view/corporate-accounting/>
- https://www.drnishikantjha.com/booksCollection/advanced_corporate_accounting_.pdf
- <https://web.thisisbeast.com/advanced-corporate-accounting-problems-and-solutions-pdf>

Journals:

<https://www.emerald.com/insight/publication/issn/1030->

966 <https://www.cribfb.com/journal/index.php/ijafr>

<https://journals.indexcopernicus.com/journal/69134>

BCM - N 3.2 Quantitative Analysis for Business Decisions**II Total Teaching Hours: 60****No. of Hours per****Week:04 [4 Credits]**

CObj	Course Objectives The course aims to
CObj_1	Provide an understanding of statistics to describe, classify and summarize the data in commerce and business.
CObj_2	Provide the knowledge and skills that are required in the application and analysis of descriptive and inferential statistics and interpret the results in the context of business decisions.
CObj_3	Introduce the basic concepts of probability and sampling techniques and its importance in business decisions

CO	Course Outcomes After completion of the course, students should
CO1	Be able to describe, classify and summarize in commerce and business.
CO2	Be able to apply appropriate descriptive and inferential statistical tools to analyze data and interpret the results.
CO3	Be able to comprehend their understanding and apply laws of probability, sampling techniques to solve business problems in appropriate contexts.
CO4	Be able to apprehend the basics of data analysis and forecasting techniques used in economics and business decisions.
CO5	Be able to draw statistical inferences and communicate the same in quantitative and qualitative terms that aid in decision making.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	*				
CO2			*		
CO3				*	
CO4					*
CO5		*			

Course Content

Sl. No.	Unit title	Content	Number of Hours	Skills Developed
1	INTRODUCTION TO STATISTICS	Meaning and Definition – Functions – Scope – Limitations. Collection of data – census, sample and sampling techniques- Probability and Non-Probability sampling - Classification of data, preparation of frequency distribution and tabulation of data(Only Complex table)	5	Numerical
2	DESCRIPTIVE STATISTICS	Meaning and Definition-Types of averages – Calculation of Arithmetic Mean, Median, Mode (excluding missing frequency and grouping method problems) - Meaning & Definition -Range, Quartile Deviation, Standard Deviation and Coefficient of Variation. Skewness- Meaning, uses, and problems on Karl Pearson's Co-efficient of skewness.(Direct Method only)	20	Analytical
3	INFERENTIAL STATISTICS	Correlation- Meaning and Definition - Uses – Types – Karl Pearson's coefficient of correlation –probable error, Spearman's Rank Correlation Coefficient. Regression- Meaning- Uses -Regression lines- Regression Equations, Correlation Coefficient through Regression Coefficient.	20	Research & Analytical

4	INDEX NUMBER & TIME SERIES	Index Number: Meaning, simple problems on Laspeyres, Paschel, Fishers's index number. Time Series: Meaning – Uses – Components of Time Series – Fitting a straight line trend by the method of least squares and Computation of Trend Values (when $\Sigma X = 0$) including Graphical presentation of trend values – Problems.	10	Analytical
5	THEORY OF PROBABILITY	Meaning and Importance of Probability- Experiment, Event and types of events, Addition Theory of probability (Simple Problems on addition theorem only)	5	Research & Analytical

Books for Reference:

- Akhilesh K. B. and Balasubrahmanyam S, Mathematics and statistics for Management, 2008, 1st Edition, Delhi, Vikas Publishing
- Gupta S.P., Statistical Methods, 2014, 43rd Edition, New Delhi, Sultan Chand & Sons
- J K Sharma – Business Statistics.
- Dorai Raj- Business Mathematics and Statistics, United publishers.

Web Resources:

- <https://www.edx.org/learn/statistics>
- <https://und.edu/academics/online/enrollanytime/econ210.html>
- <https://www.udemy.com/course/business-statistics-fundamentals/>

Journals:

- Whitley E, Ball J: Statistics review 1: Presenting and summarising data. *Crit Care* 2002, 6:66-71.
- Kirkwood BR, Sterne JAC: *Essential Medical Statistics*, 2003, 2nd ed. Oxford: Blackwell Science

**BCM-N 3.3 E-Commerce and
Digital Marketing**

Total Teaching Hours: 60

No. of Hours per Week:

04 [4 Credits]

CObj	Course Objectives
CObj_1	To provide an understanding of E-commerce framework including emerging technologies used in various Business Models
CObj_2	To familiarize students` with the knowledge of common ethical and legal issues involved in E-commerce
CObj_3	To provide an exposure to various Digital Marketing tools, theories and frameworks

CO	Course Outcomes After completing this course students should
CO1	Be able to understand the basic concepts and technologies used in E- commerce and Business Models
CO2	Be able to develop and awareness of Ethical , legal and other issues in Ecommerce and their implications on Business
CO3	Demonstrate an understanding of various Digital Marketing tools used in Ecommerce.
CO4	Demonstrate an understanding of designing various revenue models for efficient E-Business operations.
CO5	Be able to apply various tools and techniques of digital marketing, e payment and other delivery mechanisms necessary to integrate IT Based solutions into the user environment.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1					
CO2		*			
CO3			*		
CO4			*		*
CO5				*	*

Course Content

Sl. No.	Unit title	Content	Number of Hours	Skills Developed
1	E-commerce business models and concepts,	Introduction to E commerce, difference between traditional and Ecom business models, Architectural framework of Electronic Commerce types - B2C, B2B, C2B C2C, online market place , major players in India in E commerce business	10	Analytical
2	Electronic Data Interchange:	Meaning and Benefits of EDI, EDI technology, EDI standards, EDI communications, EDI Implementation, EDI Agreements, EDI Security. Electronic Payment Systems, Need of Electronic Payment System: Study and examine the use of Electronic Payment system and the protocols used, Study of Electronic Fund Transfer and secure electronic transaction protocol for credit card payment.	12	Cognitive
3	Digital marketing	Meaning, and characteristics of digital marketing .types of digital marketing, SEO, SEM Pay-per-click (PPC), Google	12	Employability

		ads, you tube marketing, advertising, Content marketing, Social media marketing, influencer marketing, organic and inorganic search		
4	Ecosystem required for Ecommerce business	Web technologies – global publishing concept, hypertext, URLs, HTTPD, Servers, HTML, HTML Forms & CGI gateway services, Web system architecture, http, sttp, ftp, telenet, internet, hardwares & softwares , cloud systems and services , epayment types, logistics, Types of e-payment System; E-cash & currency servers, e-cheques, credit cards, smart cards, electronic purses & debit cards	15	Evaluation
5	Cyber laws	Security risks of e-commerce, type of threats, sources of threats, security tools & risk Importance of cyber laws, types of Cyber Crimes, Information Technology Act, 2000, Important features of IT Act Understanding Ethical, Social and Political issues in E-Commerce:	11	Evaluation and synthesis

Books for Reference:

1. Shivasharana, Divakara Reddy N, Ecommerce, 2013, Himalaya Publishing House
2. Simon Kingsnorth ,Digital Marketing Strategy: An Integrated Approach to Online Marketing,2016, Kogan Page Publishers,
3. Dr S R Myneni, Information technology law (cyber laws) , 2016, Asia Law House
4. Oturkar, Ebusiness , 2015, Everest Publishing House

5. Elias. M. Awad, " Electronic Commerce", Prentice-Hall of India Pvt Ltd.
6. RaviKalakota, Andrew B. Whinston, "Electronic Commerce-A Manager's guide", Addison- Wesley.
7. Efraim Turban, Jae Lee, David King, H.Michael Chung, "Electronic Commerce—A ManagerialPerspective", Addison-Wesley.
8. Elias M Award, "Electronic Commerce from Vision to Fulfilment", 3rd Edition, PHI, Judy Strauss,

Web Resources:

<https://www.investopedia.com/terms/b/business-ecosystem.asp>

www.marketo.com

www.vikaspedia.in

Journals:

<https://www.journals.elsevier.com> ›

Journals www.springer.com/journals

OEC 3.1 - Managing Personal Finance

Total Teaching Hours:
45 No. of Hours per
Week:03 [3 Credits]

CObj	Course Objectives The course aims to
CObj_1	Provide an understanding of basic principles of investments, its importance in managing personal finance.
CObj_2	Provide the knowledge and skills that are required in financial planning and decision making.
CObj_3	Provide an understanding on various options available for Investing, Creating and Managing personal portfolios.

CO	Course Outcomes After completing the course students must be able to
CO1	Compare and Evaluate various options available for investments in terms of their risk and returns..
CO2	Develop appropriate financial decisions in terms of planning personnel budgets, retirement, real estate and insurance plans.
CO3	Apply financial principles to demonstrate practical decision making and understand, manage and plan for personnel saving, expenditure and tax planning.
CO4	Analyze basic economic information in terms of various types of borrowings and examine the risk associated with them
CO5	Plan for the retirement and creating provisions to meet personal contingencies, such as health and other risks.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1					
CO2	*		*		
CO3				*	
CO4		*			
CO5					*

Course Content

Sl. No.	Unit title	Content	Number of Hours	Skills Developed
1.	Introduction to Personal Finance	Aspects of personal finance, importance of managing personal finance, principles of managing personal finance, objectives, Planning and Budgeting, do's and don'ts of personal finance	8	Cognitive
2.	Earnings – sources of income, core income, creating additional income.	Money earned from employment or Business, Dividends, Capital Gains, Rental Income derived from property ownership and profit sharing from businesses.	8	Analytical

3.	Spending, Saving & tax planning,	Understanding essential and non-essential Expenditure Elizabeth Warren Rule, Savings, Investments.	12	Employability

		Real estate, Bullion, FDs, Recurring deposits, Mutual Funds (types), stocks etc. Tax Deductible Investment Schemes, Create an Emergency Fund Procedures to invest in shares(KYC), Mutual Funds and other Avenues		
4.	Investments, Borrowings & Insurance planning	Effect of Inflation and interest rates on personal finance, EMI planning, vehicle loans, Student loans, Importance of diversification, Limit borrowings, Home loans. Evaluating various insurance schemes (Life, General & Health) to hedge risks and create funds, Improving credit worthiness, understanding CIBIL scores.	12	Research
5.	Retirement planning	Planning for retirement, Pension plans available in India, Analysis of important pension schemes in India.	5	Evaluation & Analytical

Books for Reference:

Subramanyam P. V , 2019, . Retire Rich 350 pages, TV18
Broadcast ltdMonika Halanis , 2018 ,Let's Talk Money 204 pages ,
Harper Business

Manish Chauhan , 2014, How to be your own financial planner in 10 steps” 236 pages
, Network 18 publications

AnujSuneja ,2021,Casual Finance – A Millennial’s Guide to Personal
Finance’ 108 pages, Evince publisher

Web Resources:

www.learnvest.com

www.thebirdy.com

www.dailyworth.com

Journals

http://timesofindia.indiatimes.com/articleshow/83752164.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

http://timesofindia.indiatimes.com/articleshow/83752164.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

BCM-N 4.1 Financial Statement Analysis

Total Teaching Hours:

60 No. of Hours per

Week:04 [4 Credits]

CObj	Course Objectives
	The main objectives of this course is
CObj_1	To provide an understanding of the key elements of financial statements, importance, and types of analysis of financial statements
CObj_2	To provide different Tools and Techniques used for analysis and evaluation of financial statements of listed Companies, predict corporate bankruptcy and prepare reports for decision making.
CObj_3	To familiarize students with various models for assessing credit risk, cash flow statements, off-balance sheet analysis and reporting for business decisions.

CO_ID	Course Outcomes
	After completion of the course students should be able to
CO_1	Demonstrate their understanding on various items of financial statements, their importance and types of analysis used in evaluating financial performance of a company.
CO_2	Apply, interpret, and analyze the published financial statements, in various decision- making contexts using common size statement analysis, trend analysis, ratio analysis, Du-pont analysis and be able to communicate the results to appropriate authorities.
CO_3	Prepare and interpret segmental analysis and inter-firm comparisons through application of appropriate ratios and clearly interpret the result

CO_4	Apply various models such as Altman Z score, credit risk assessment models and predict probable corporate bankruptcy and report the same for further decision making.
CO_5	Interpret annual reports and accompany notes in addition to management discussion and analysis to assess the financial performance and efficiency of operations of a company.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	*				
CO2	*	*			
CO3		*			
CO4	*				
CO5		*			*

Course Content

Sl. No.	Unit title	Content	Number of Hours	Skills Developed
1.	UNIT 1: INTRODUCTION TO FINANCIAL STATEMENTS & ANALYSIS	Introduction – Meaning and Definition – Objectives – Types of Financial Statements–Users of Financial Statements: Internal & External – Limitations of Financial Statements – Basics of Income Statement & Statement of Financial Position- Methods in financial Analysis – Comparative Statement – Common -size Statement – Trend Analysis.	14	Transferrable
		Ratio Analysis : Introduction – Meaning – Objectives - Types	14	Cognitive

2.	UNIT 2: RATIO ANALYSIS	– Problems on calculating Ratios - Preparation of financial statements with the help of Accounting Ratios- Dupont and Altman Z Score Analysis.		
3.	UNIT 3: CASH FLOW STATEMENT ANALYSIS	Cash Flow Statement: Meaning- Definition— Concept of Cash and Cash Equivalents-Uses–Limitations– Provisions of AS-3 – Procedure of Cash Flow Statement Cash Flow from Operating Activities – Cash Flow from Investing Activities and Cash Flow from Financing Activities (Only Analysis)	12	Employability
4.	UNIT 4: CREDIT RISK ANALYSIS AND OFF BALANCE SHEET	Credit risk analysis- meaning- Types of credit risk: concentration risk- Institutional risk, commercial credit analysis- Assessing Credit risk- purpose of credit analysis, Probability of Default- Credit Analysis process- Credit Analyst role-credit rating analysis. Off Balance Sheet- Meaning- Benefits- Balance Sheet items- Lease and Buy back agreement.	12	Analytical
5.	UNIT 5: MANAGEMENT REPORTING	Meaning of Management Reporting – Requisites of a Good Reporting System – Principles of Good Reporting System – Kinds of Reports – Drafting of Reports under different Situations.	8	Evaluation Analytical

Books for Reference:

- A. A. Gopal krishnan, Understanding Financial Statements - Interpretation and Analysis, 1992, Global business press.
- Erich A. Helfert, Techniques of Financial Analysis, 1992, Tata McGraw Hill
- Prasanna Chandra , Financial Management , 2017, FMcGrow hill
- I.M. Pandey, Financial Management, 2016 Vikas publications
- Dr. S.N. Maheshwari , Management Accounting, 2016, vikas publishing
- Sudhindra Bhat, Management Accounting, 2016, Excel books

Web Resources:

- Icai.bos
- Google.com

Journals:

- <https://www.resurchify.com/ed/iccabm-2019-international-conference-on-current-research/2779>
- <https://regulationbodyofknowledge.org/financial-analysis/statement-regulation/>
- <https://www.emerald.com/insight/content/doi/10.1108/AJAR-05-2019-0037/full/html>

**BCM-N 4.2 Financial
Management Total Teaching**

Hours: 60

No. of Hours per

Week:04 [4 Credits]

CObj	The main Objectives of the course are
CObj_1	To develop conceptual understanding of financial management, objective, functions, goals and structure of organization.
CObj_2	To provide in depth knowledge of capital structure, investment and dividend decision and familiarize with the required tools to evaluate the same.
CObj_3	To provide an understanding of working capital management, analytical skills to compute the working capital requirements of an organization.

CO	Course Outcomes
	After completing the course students should be able to
CO 1	To be able to demonstrate the conceptual understanding of capital structure and analyze its impact on earnings of the company
CO 2	Be able to identify various source of short term finance and apply different techniques in managing working capital requirements
CO 3	Be able to demonstrate their understanding on dividends decisions and its impact on earning of their company
CO 4	Be able to evaluate the different methods of working capital management
CO 5	Be able to compare and contrast different valuation methods and strategies for corporate restructuring of the organization

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	*				
CO2		*	*		*
CO3			*		
CO4		*			
CO5		*	*	*	*

Course Content

Sl. No.	Unit title	Content	Number of Hours	Skills Developed
1.	Introduction	Financial Management - Meaning, Objectives, Functions and Goals of Financial Management Capital Structure – Factors influencing Capital Structure – Optimum Capital Structure – Theories of Capital Structure -Net Income, Net Operating Income, Computation and Analysis of EBIT, EBT, and EPS. Operating and Financial Leverage. Simple Problems.	14	Analytical
2	Financing Decision	Cost of Capital and Financing Decision, Sources of long-term financing, components of cost of capital. Methods for Calculating cost of equity capital, Cost of Retained Earnings, Cost of Debt and Cost of Preference Capital, Weighted Average cost of capital (WACC) and Marginal cost of capital	10	Cognitive
3.	Investment Decision		16	

		Time value of money - Meaning & Definition – Need – Future Value-Single Flow – Uneven Flow & Annuity. Present Value -Single Flow – Uneven Flow & Annuity. Doubling Period –Rule of 69, Concept of Valuation: Valuation of Bonds, Debentures and shares - Simple Problems .The Capital Budgeting Process - Payback Period Method, Accounting Rate of Return, Net Present Value (NPV), Internal Rate of Return (IRR) Profitability Index - Simple Problems		Evaluation
4.	Working Capital Decisions	Concepts of working capital, the risk-return trade off, Sources of short-term finance, Computation of working capital- simple problems, policies of working capital, cash management-theory, inventory management, EOQ - Problems	12	Employability
5.	Dividend Decisions	Meaning and Definition of Dividend- Factors determining dividend policy- Types of dividends-Dividend policies in practice, Dividend theories – Relevance and Irrelevance theory, Modigliani and Miller theory.	8	Analytical

Books for Reference:

1. James C. Van Horne and Sanjay Dhamija ,Financial Management and Policy, 2011, Pearson Education.
2. Levy H. and M. Sarnat, Principles of Financial Management, 1988 ,Pearson Education.
3. Joy, O.M, Introduction to Financial Management, 1980,McGraw Hill Education.

4. Brigham and Houston, Fundamentals of Financial Management, 2005, Cengage Learning
5. Khan and Jain, Basic Financial Management, 2017, McGraw Hill Education
6. Chandra P, Fundamentals of Financial Management, 2017, McGraw Hill Education
7. Rustagi, 16th Edition R.P. Fundamentals of Financial Management, 2021, Taxmann Publication Pvt. Ltd.
8. Pandey I.M. Financial Management, 2016, Vikas Publications.

Web references

www.investopedia.com
www.khanacademy.org
www.corporatefinanceinstitute.com

Journals

<https://ijefm.co.in>
<https://www.journals.elsevier.com/journal-of-multinational-financial-management>
<https://www.longdom.org/peer-reviewed-journals/financial-management-45336.html>

**BCM-N 4.3 Financial Systems &
Services Total Teaching Hours: 60
No. of Hours per
Week:04 [4 Credits]**

CObj	Course Objectives
CO 1	To provide an understanding of various products & services offered by banks and financial institutions
CO 2	To create an awareness of regulatory frameworks with reference to financial sector in India
CO 3	To provide an understanding of capital market operations in India

CO	Course Outcomes After completing the course students should be able to
CO 1	Demonstrate an understanding of the dynamics and framework within which the financial institutions operate in India.
CO 2	Recognize the importance and functions of regulatory framework with reference to financial institutions in India
CO 3	Demonstrate an understanding of capital markets and their operations in the Indian context.
CO 4	Compare and contrast various financial services available in Indian financial system.
CO 5	Appreciate the role played by technology in financial systems and services in India

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1	*		*		
CO2		*			
CO3					
CO4			*		
CO5			*		*

Course Content

Sl. No.	Unit title	Content	Number of Hours	Skills Developed
1.	Introduction	Nature and Functions of financial systems, role played by financial systems and services in economic development, Financial Inclusion and Economic Growth.	8	Cognitive
2	Participants in FS&S	Financial Institutions, Intermediaries, Stock, Commodity and Currency exchanges, Primary and Secondary markets for equity and debt, capital market, money market. Rating agencies, Leasing Companies – Housing Finance Institutions – , Asset Reconstruction Companies	12	Research

3.	Financial products and services	Financial instruments, Venture capital funds, types of loans , Fintech companies, Microfinance companies, fund based and non-fund based activities , Concept of Cashless Economy, Tele-banking , mutual funds Ebanking , Rupay ,Pay tm , BHIM app,	14	Employability
4.	Regulatory Bodies for FSS	RBI, SEBI, IRDA, PFRDA, AMFI, MCA – important functions and structure of these organizations	12	Evaluation and Synthesis
5.	Analysis of Financial Institutions in India	Analysis of Top companies in various Financial sectors based on Revenue, market capitalization, profits and number of employees. Five financial sectors for analysis - Banking, Insurance, Mutual funds , NBFC , gold loan companies.	14	Analytical

Books for Reference:

1. M Y Khan, “Financial Services”, TMH, 7th edition
2. Ravi M. Kishore, “Financial Management”, Taxmann’s, 6th edition.
3. Bhole. L.M. and JitendraMahakud “Financial Institutions & Markets – Structure, Growth & Innovations”, TMH 5th edition.
4. Anthony Saunders & Marcia Millon Cornett, “ Financial Markets & Institutions”, TMH,
5. E Gardon& K Natarajan: Financial Markets & Services, HPH, 7th Edition, Mumbai
6. VasantDesai : Financial Markets & Financial Services , Himalaya Publishing House, 1 st Edition Mumbai
7. V.A. Avadhani : Financial Services in India, 2009, HPH, 1st Edition

Web Resources:

www.intehnic.com

[www.corporatefinanceinstitute.co](http://www.corporatefinanceinstitute.com)

[m www.financialservices.gov.in](http://mwww.financialservices.gov.in)

Journals:

<https://economictimes.indiatimes.com/defaultinterstitial.cm>

[s https://www.financialexpress.com/](https://www.financialexpress.com/)

**OEC 4.1 - Open Elective (Business
Entrepreneurship)**

**Total Teaching Hours:
45 No. of Hours per
Week:03 [3 Credits]**

CObj	Course Objectives
CObj_1	To provide basic knowledge & skills required to encourage entrepreneurial success in a variety of settings and explain concepts of entrepreneurship in situations in which entrepreneurs act.
CObj_2	To familiarize students with various concepts used in understanding processes involved in entrepreneurship and business formation and development and to develop a positive attitude towards starting up new business ventures with an appreciation of risk & rewards in startups.
CObj_3	To provide an understanding of startups and the stages of the entrepreneurial process, opportunities and the resources needed for the successful development of entrepreneurial ventures and Government Initiatives in India.

CO	Course Outcome
	After completion of this course, students should be
CO1	Able to identify risks & rewards associated with entrepreneurship and the types of entrepreneurs and the steps involved in an entrepreneurial venture.
CO2	Able to apply basic knowledge & skills required in starting a venture, running startups, planning & executing new and creative startups including the marketing strategies.
CO3	Able to identify key factors and apply the entrepreneurial process, command and control, calculated risk-taking and opportunity recognition for business development and tackle the Financial Issues of Startups.
CO4	Able to demonstrate their understanding of the legal and financial conditions for starting a business venture, and Government Initiatives for Startups in India.
CO5	Able to develop their personal creativity and entrepreneurial initiative and take up Entrepreneurship as a Profession,

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5
CO1		*			*
CO2		*	*		*
CO3		*			*
CO4			*		*
CO5				*	*

Course Content

Sl. No.	Unit title	Content	Number of Hours	Skills Developed
1.	FUNDAMENTALS OF ENTREPRENEURSHIP	Introduction – Conceptual understanding of Entrepreneurship, –Functions of Entrepreneur - Pros and Cons of being an Entrepreneur – Qualities of an Entrepreneur – Types of Entrepreneurs-Women Entrepreneurs, Agro Entrepreneurs, Business Entrepreneurs, Social Entrepreneurs, Technopreneurship	10	EMPLOYABILITY
2.	PREPARING THE BUSINESS PLAN	Meaning – importance – basics of preparing Business Plan(BP) –BP format: Various dimensions of a Business Plan, Financial aspects of BP, Marketing aspects of BP, Human Resource aspects of BP, Technical aspects of BP, Social aspects of BP. Common pitfalls to be avoided in preparation of a BP.	12	ENTREPRENEURSHIP
3	STARTUPS & IT's FINANCIAL ISSUES	Introduction- Meaning – Features – Ideation – Design Thinking, 3 Pillars to Initiate startup-Handholding, Funding & Incubation. Startup Financial issues: Feasibility Analysis - The cost & Process of Raising capital – Unique Funding issues of a High tech Ventures – Funding with equity – Financing	12	MANAGERIAL ABILITY

		with debt – Funding strategies with bootstrapping – Crowd funding – Venture Capital- Creativity & innovation in India,		
4	GOVERNMENT INITIATIVES FOR STARTUPS IN INDIA	Government Initiatives – Startup India Initiative, Seed Fund – ASPIRE –SAMRIDDHI Scheme – Mudra Scheme -Sishu, Kishore & Tarun – ATAL Innovation Mission – MSME Multiplier Grants Scheme – Credit Guarantee Fund Trust for micro & small business – Software Technology Park – Venture Capital Assistance Scheme – Single Point Registration scheme – M-SIPS – Self Employment & Talent Utilization (SETU)	11	OPPORTUNITY IDENTIFICATION, AND NEGOTIATION

Books for reference:

Varun Agarwal , How I Braved Anu Aunty and Co-founded a Million Dollar Company, 2012 , Rupa publications

Rohit Prasad ,Start-Up Sutra, 2013, Hachette India

Rashmi Bansal , Connect the Dots, 2020 Bushfire Publishers

Web resources

<https://www.econlib.org/library/Enc/Entrepreneurship.html>

Corporate Finance Institute. 2022. Make-or-Buy Decision. [Online] Available at: <<https://corporatefinanceinstitute.com/resources/knowledge/strategy/make-or-buy-decision/>>

WallStreetMojo. 2022. Cash Budget. [Online] Available at: <<https://www.wallstreetmojo.com/cash-budget/>> [Accessed 13 April 2022].

Journals

<https://www.resurchify.com/impact/details/2110084014>

9 <https://www.inderscience.com/jhome.php?jcode=jibed>



BSc (Electronics, Computer Science) Degree/BSc Hons in Electronics/Computer Science

PROGRAMME MATRIX (I SEM to VIII SEM)

AND SYLLABUS

FOR

I, II, III AND IV SEMESTER ELECTRONICS

For the Programme

B.Sc (Electronics & Computer Sciences)

Programme (Basic and Honours Degree)

(NEP 2021 ONWARDS)

PEO_ID	Programme Educational Objectives
PEO1	To instill a strong foundation of fundamental concepts in electronics and computer science and demonstrate an independent thinking ability and knowledge to apply in various domains
PEO2	To impart knowledge on analyzing complex scientific problems and develop solutions using the principles of electronics and computer science
PEO3	To develop robust communication skills as well as social, ethical and professional values and collaborate effectively with team members belonging to various domains

PEO4	To inculcate strong interest in research and focus on solving problems with the methods imbibed from various disciplines of study
PEO5	To develop entrepreneurs and electronics professionals by inculcating the practice of life-long learning for continuous personal enrichment and professional development
PO_ID	Programme Outcomes
PO1	Scientific knowledge: Apply the knowledge of electronics and computer science to solve problems in various fields of science both in industry and research
PO2	Problem analysis: Identify, formulate and analyze complex scientific problems and develop substantiated solutions using the principles of electronics and computer science
PO3	Ethics, Individual and team work: Acquire strong oral and written communication skills and function effectively as an individual, and as a member or leader in diverse teams in multidisciplinary scenarios by maintaining professional ethics, responsibilities and norms of scientific practice
PO4	Research interest: Apply the techniques embraced from various disciplines and develop solutions to the research problems which would benefit mankind
PO5	Life-long learning: Become competent to engage in independent and life-long learning and become successful entrepreneurs or electronics professionals
PO_ID	Programme Specific Outcomes
PSO1	Ability to apply knowledge of logic thinking and basic science for solving electronics related problems
PSO2	Ability to perform electronics experiments, as well as to analyse and interpret data.
PSO3	Ability to design and manage electronic systems or processes that conforms to a given specification within ethical and economic constraints.
PSO4	Develop core competency to design, implement and evaluate a computational system to meet desired needs within realistic constraints
PSO5	Apply the computing and mathematical knowledge as well as standard software engineering practices and strategies to develop applications in various domains
PSO6	Apply research methods including design of experiments, analysis, interpretation of data, synthesis of information, developing GUI applications to provide valid conclusions

ELECTRONICS

SYLLABUS

SEMESTER–I

ELECT1: ELECTRONIC DEVICES AND CIRCUITS

Total Teaching Hours: **60**

No. of Hours / Week: **04**

CObj_ID	Course Objectives
CObj_1	To understand various fundamental principles of network analysis
CObj_2	To understand number systems and Boolean algebra and become familiar with the basic operation of electronic devices
CObj_3	To design electronic circuits, devices and gadgets

CO_ID	Course Outcomes
CO_1	Study and analyze basic networks using network theorems in a systematic manner
CO_2	Build simple electronic circuits used in various applications.
CO_3	Describe the behaviour of basic semiconductor devices and reproduce the I-V characteristics of diode/BJT devices
CO_4	Apply standard device models to explain/calculate critical internal parameters of semiconductor devices.
CO_5	Understand the basic knowledge of digital system building blocks, effectively can construct simple digital designs with the knowledge of Boolean algebra

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	*					*	*			
CO_2						*		*		
CO_3		*				*				
CO_4				*	*	*				*
CO_5					*	*				

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1.	Electronic Components Network Theorems PN junction diode Rectifiers	Electronic passive and active components, types and their properties, Concept of Voltage and Current Sources, electric energy and power.(Qualitative only) Superposition, Thevenin's, Norton's, Maximum Power Transfer, and Reciprocity Theorems.DC and AC analysis of RC and RL circuits, RLC series and parallel Resonant Circuits. Ideal and practical diodes, Formation of Depletion Layer, Diode Equation and I-V characteristics. Idea of static and dynamic resistance, Zener diode, Reverse saturation current, Zener and avalanche breakdown. Half wave and Full wave (center tap and bridge) rectifiers, expressions for output voltage, ripple factor and efficiency (mention only), Shunt capacitor filter. (Numerical examples wherever applicable). Testing of PN junction diodes using Multimeter.	15	Cognitive Cognitive Cognitive Cognitive, Employable
2.	Voltage regulator Bipolar Junction Transistor	Block diagram of regulated power supply, Line and Load regulation, Zener diode as voltage regulator – circuit diagram, load and line regulation, disadvantages. Fixed and Variable IC Voltage Regulators (78xx, 79xx, LM317), Clippers (shunt type) and clampers(Qualitative analysis only), Voltage Multipliers. Construction, types, CE,CB and CC configurations (mention only), VI characteristics of a transistor in CE mode, Regions of operation (active, cut off and saturation), leakage currents (mention only), Current gains α , β and and their inter-relations, dc load line and Q point. Applications of transistor as amplifier and switch - circuit and working. (Numerical examples wherever applicable), Testing of bipolar junction transistors using Multimeter.	15	Cognitive, Employable Cognitive, Employable
	Transistor biasing and Stabilization circuits Amplifier Special semiconductor diodes	Fixed Bias and Voltage Divider Bias. Thermal runaway, stability and stability factor. Transistor as a two-port network, h-parameter equivalent circuit. Small signal analysis of single stage CE amplifier using h-parameters. Input and Output impedances, Current and Voltage gains. Advantages of CC amplifier. Class A, B and C Amplifiers (qualitative).Types of coupling, Two stage RC Coupled Amplifier – circuit, working and its Frequency Response, loading effect, GBW product, Darlington transistor, Current gain. Varactor diode, Schottky diode, Tunnel diode, - construction, characteristics, working, symbol, and applications for each.LED, LCD and solar cell – construction, operation and applications, 7-segment display, concept of common anode and common cathode types.(Numerical problems, wherever applicable), Testing of Special semiconductor diodes using Multimeter.	15	Cognitive, Employable Cognitive, Employable Cognitive, Employable, Analytical
4.		Decimal, Binary, Octal and Hexadecimal number systems, base conversions. Representation of signed	15	Cognitive, Analytical

	Number System	and unsigned numbers, Binary arithmetic; addition, subtraction by 1's and 2's complement method, BCD code (8421, 2421, Excess-3), Gray code, error checking and correction codes (Only parity check).		
	Boolean Algebra	Constants, variables, operators, basic logic gates- AND, OR, NOT, Positive and negative logic, Boolean laws, Duality Theorem, De Morgan's Theorem, simplification of Boolean expressions using Boolean laws. Derived logic gates (NAND, NOR, XOR & XNOR). Universal property of NOR and NAND gates. (Numerical examples wherever applicable)		Cognitive, Employable, Analytical

Reference Books:

1. Robert L Boylestad, "Introductory circuit analysis", 5th edition., Universal Book 2003.
2. R.S.Sedha, "A Text book of Applied Electronics", 7th edition., S. Chand and Company Ltd. 2011
3. A.P. Malvino, "Principles of Electronics", 7th edition .TMH, 2011.
4. Electronic devices and circuit theory by Boylestad, Robert Nashelsky
5. David A. Bell " Electronic Devices and Circuits", 5th Edition, Oxford Uni.ress, 2015
6. Thomas L. Floyd, Digital Fundamentals, Pearson Education Asia (1994)
7. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
8. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
9. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
10. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning.
11. M. Nahvi& J. Edminister, "Electrical Circuits", Schaum's Outline SeriesTMGH2005
12. S. A. Nasar," Electrical Circuits", Schaum's outline series, Tata McGraw Hill, 2004
13. J. Millman and C. C. Halkias, "Integrated Electronics", Tata McGraw Hill, 2001

B.Sc. I Semester Practical Semester Examination S21E1.2: Practical Electronics - I

List of Experiments

Practical: ELECP1: Electronic Devices and Circuits – Lab

(Hardware and Circuit Simulation Software)

Total Teaching hours: **30** No. of Hours / Week: **03**

S. No	Module title	Number of Hours	Skills Developed
1.	Verification of Thevenin's and Maximum Power Transfer Theorem.	3	Cognitive, Analytical
2.	Verification of Superposition Theorem	3	Cognitive, Analytical
3.	Study of the I-V Characteristics of (a) p-n junction Diode, and (b) Zener diode.	3	Cognitive, Analytical

4.	Study of the I-V Characteristics of LEDs of two different colours and 7-segment display.	3	Cognitive, Analytical
5.	Study of Half wave rectifier without and with shunt capacitor filter– ripple factor for different values of filter capacitors.	3	Cognitive, Employable, Analytical
6.	Study of full wave bridge rectifier without and with shunt capacitor filter –ripple factor for different values of filter capacitors.	3	Cognitive, Employable, Analytical
7.	Study of Zener diode as a Voltage Regulator using bridge rectifier with shunt capacitor filter [Load and line regulation].	3	Cognitive, Employable, Analytical
8.	Study of Clipping, Clamping and Voltage Multiplier circuits.	3	Cognitive, Employable, Analytical
9.	Designing and testing of fixed positive and negative voltage regulators using 78xx and 79xx series ICs (Using bridge rectifier and shunt capacitor filter).	3	Cognitive, Employable, Analytical
10.	Designing and testing of variable voltage regulator using IC LM317 (Using bridge rectifier and shunt capacitor filter).	3	Cognitive, Employable, Analytical
11.	Study of Transistor characteristics in CE configuration – determination of h parameters.	3	Cognitive, Employable, Analytical
12.	Study of Fixed Bias and Voltage divider bias circuits – comparison for different β values.	3	Cognitive, Employable, Analytical
13.	Study of single stage CE amplifier (frequency response, input and output impedances in mid-band)	3	Cognitive, Employable, Analytical

14.	Study of two-stage RC-coupled CE amplifier (A_{V1} , A_{V2} , A_V) at mid-band frequency.	3	Cognitive, Employable, Analytical
15.	Study of Series and Parallel Resonance circuits – determination of its (a) Resonant frequency (b) Impedance at resonance (c) Bandwidth (d) Quality Factor	3	Cognitive, Analytical
16.	Verification of truth tables of OR, AND, NOT, NAND, NOR, XOR and XNOR gates using respective ICs. Realization of XOR and XNOR using basic gates.	3	Cognitive, Employable, Analytical

17.	Universal property of NAND and NOR gates.	3	Cognitive, Employable, Analytical

***Minimum of TEN Experiments to be performed excluding demonstration experiments**

SEMESTER–II

S21EI2.1: ANALOG AND DIGITAL ELECTRONICS

Total Teaching Hours: **60**

No. of Hours / Week: **04**

CObj_ID	Course Objectives
CObj_1	To recognize the various working principles of widely used electronic devices, linear and digital ICs
CObj_2	The students will learn the design and working of BJT, JFET, MOSFET
CObj_3	The students will learn arithmetic circuits, multiplexing and demultiplexing operations and a few logic families,

CO_ID	Course Outcomes
CO_1	Able to explain the behavior and characteristics of power devices such as UJT, SCR, Diac, Triac etc.
CO_2	Able to calculate various device parameters' values from their IV characteristics
CO_3	Able to understand op-amp and its applications
CO_4	Able to understand basic logic gates, concepts of Boolean algebra and techniques to reduce/simplify Boolean expressions
CO_5	Able to analyze combinatorial and sequential circuits

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	*					*		*		
CO_2		*					*			
CO_3										
CO_4					*	*		*		*
CO_5					*					

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1.	JFET MOSFET UJT SCR	Types - p-channel and n-channel, working and I-V characteristics - n-channel JFET, parameters and their relationships, Comparison of BJT and JFET. E – MOSFET, D – MOSFET – n-channel and p-channel, Construction, working, symbols, biasing, drain and transfer characteristics, VMOS, UMOS Power MOSFETs, handling, MOS logic, symbols and switching action of MOS, NMOS inverter, CMOS logic, CMOS – inverter, circuit and working, CMOS characteristics, IGBT construction and working Basic construction, working, equivalent circuit and I-V characteristics, intrinsic stand-off ratio, relaxation oscillator Construction, VI characteristics, working, symbol, and applications – HWR and FWR. (Numerical examples wherever applicable)Diac and Triac-construction, working, characteristics, applications,	16	Cognitive, Employable Cognitive, Employable Cognitive, Employable Cognitive, Employable
2.	Op-Amp Applications of op-amps Filters Oscillators IC 555Timer	Differential Amplifier, Block diagram of Op-Amp, Characteristics of an Ideal and Practical Op-Amp, Open and closed loop configuration, Frequency Response, CMRR, Slew Rate and concept of Virtual Ground. Concept of feedback, negative and positive feedback, advantages of negative feedback (Qualitative Study). Inverting and non-inverting amplifiers, Summing and Difference Amplifier, Differentiator, Integrator, Comparator and Zero-crossing detector First and second order active low pass, high pass and bandpass Butterworth filters. Barkhausen criterion for sustained oscillations, Colpitt's oscillator and crystal oscillators using transistor, Phase Shift oscillator, Wien-bridge oscillator – (no derivation for each) Introduction, Block diagram, Astable and Monostable multivibrator circuits. (Numerical Examples wherever applicable)	16	Cognitive, Employable, Analytical Cognitive, Employable Cognitive, Employable Cognitive, Employable Cognitive, Employable
	Logic Families Combinational Logic Circuits	Pulse characteristics, Logic Families-classification of digital ICs. Characteristics of logic families, circuit description of TTL NAND gate with totem pole and open collector. TTL IC terminology. CMOS NAND, comparison of TTL and CMOS families. Minimisation techniques using K-maps - SOP and POS, Minterm, Maxterm, SSOP, SPOS, Simplification of Boolean expressions, KMap for 3 and 4 variable. Digital to Analog converter- DAC with binary weighted resistor and R-2R resistor ladder network. Analog to Digital converter: Successive approximation methodperformance characteristics. Design of Arithmetic logic circuits:Half Adder, Full Adder, Half Subtractor, Full Subtractor. 4-bit parallel binary adder, 2-bit and 4-bitmagnitude comparator.Encoder, decimal to BCD priority encoder. Decoder, 2:4 decoder using AND gates, 3:8 decoder using NAND gates, BCD to decimal decoder, BCD to 7-Segment decoder, Multiplexer - 4:1 and 8:1 multiplexer, Demultiplexer - 1:4 and 1:8 demultiplexer - logic diagram and truth table of each, Realization of Full adder	16	Cognitive, Employable Cognitive, Employable, Analytical

		and Full subtractor using Mux and Decoder.		
4.	Sequential Logic Circuits	Flip-Flops - SR Latch, RS, D and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Racearound conditions in JK Flip-Flop. Master- Slave JK and T Flip-Flops. Applications of Flip-Flops in semiconductor memories, RAM, ROM and types.	16	Cognitive, Employable, Analytical
	Registers and Counters	Types of Shift Registers, Serial-in-Serial-out, Serial-inParallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits), applications. Ring counter, Johnson counter applications. Asynchronous Counters: Logic diagram, Truth table and timing diagrams of 4 bit ripple counter, modulo-n counters, 4bit Up-Down counter, Synchronous Counter: 4-bit counter, Design of Mod 3, Mod 5 and decade Counters using K-maps.		Cognitive, Employable, Analytical

Reference Books:

1. Electronic devices and circuit theory by Boylestad, Robert Nashelsky
2. Electronic Devices Conventional Current Version by Thomas L. Floyd
3. David A. Bell “ Electronic Devices and Circuits”, 5th Edition, Oxford Uni.Press, 2015
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edn, 2000, Prentice Hall
5. Operational Amplifiers and Linear ICs, David A. Bell, 3rd Edition, 2011, Oxford University Press.
6. R.S.Sedha, “A Text book of Applied Electronics”, 7th edition., S.Chand and Company Ltd. 2011
7. Thomas L. Floyd, Digital Fundamentals, Pearson Education Asia (1994)
8. Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th, Ed., 2011, Tata McGraw
9. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
10. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
11. Digital Systems: Principles & Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learning.
12. (12) R. L. Tokheim, Digital Principles, Schaum’s Outline Series, Tata McGraw- Hill (1994)
13. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill

Practical: S21EL2.2: ANALOG AND DIGITAL ELECTRONICS LAB

List of the Experiments

S. No	Module title	Number of Hours	Skills Developed
Part-A(Any FIVE)			
1.	Study of JFET/MOSFET characteristics – determination of parameters.	3	Cognitive, Analytical
2.	Study of single stage JFET amplifier.(frequency response and band width)	3	Cognitive, Analytical

3.	UJT characteristics and relaxation oscillator	3	Cognitive, Analytical
4.	SCR characteristics – determination of IH and firing voltage for different gate currents.	3	Cognitive, Analytical
5.	Design of inverting and non-inverting amplifier using Op-amp & study of frequency response.	3	Cognitive, Analytical
6.	Op-amp inverting and non-inverting adder, subtractor and averaging amplifier.	3	Cognitive, Analytical
7.	Study of the zero-crossing detector and comparator.	3	Cognitive, Analytical
8.	Design and study of differentiator and integrator using op-amp for different input waveforms.	3	Cognitive, Analytical
9.	Design and study of Wien bridge and RC phase shift oscillator using op-amp.	3	Cognitive, Analytical
10.	Design and study of first order high-pass and low-pass filters using op-amp.	3	Cognitive, Analytical
11.	Study of Colpitt's and crystal oscillator using transistor.	3	Cognitive, Analytical
12.	Astablemultivibrator using IC555 timer.	3	Cognitive, Analytical
13.	Monostable multivibrator using IC555 timer.	3	Cognitive, Employable, Analytical
Part- B (Any SEVEN)			
14.	Half Adderand Full Adder using (a) logic gates (b) using only NAND gates.	3	Cognitive, Analytical
15.	HalfSubtractor and Full Subtractor(a) logic gates (b) using only NAND gates.	3	Cognitive, Analytical
16.	4 bit parallel binary adder and subtractor using IC7485.	3	Cognitive, Analytical
17.	Study of BCD to decimal decoder using IC7447		Cognitive, Analytical
18.	Study of the Encoders and priority encoders.		Cognitive, Analytical

19.	Study of Multiplexer and Demultiplexer using ICs.		Cognitive, Analytical

20.	Study of 2-bit and 4-bit magnitude comparators.	Cognitive, Analytical
21.	Study of Clocked RS, D and JK Flip-Flops using NAND gates.	Cognitive, Analytical
22.	Study of 4-bit asynchronous counter using JK Flip-Flop IC7476, modify to decade counter and study their timing diagrams.	Cognitive, Analytical
23.	Study of 4-bit Shift Register – SISO, modification to ring counter using IC 7495.	Cognitive, Analytical
24.	Digital to Analog converter using binary weighted resistor method, determination of resolution, accuracy and linearity error	Cognitive, Analytical

***Minimum of TEN Experiments to be performed excluding demonstration experiments**

SEMESTER–III

ELECT3: DIGITAL DESIGN USING VERILOG AND VHDL PROGRAMMING

Total Teaching Hours: **60**

No. of Hours / Week: **04**

CObj_ID	Course Objectives
CObj_1	To familiarize with the concepts of programming using Verilog and VHDL
CObj_2	To identify language elements and keywords used in Verilog and VHDL
CObj_3	To write the Verilog programs in structural and dataflow modelling levels of Abstraction

CO_ID	Course Outcomes
CO_1	Able to understand the concept of programming using Verilog and VHDL
CO_2	Able to identify the language elements and keywords used in Verilog and VHDL

CO_3	Able to write Verilog programs in structural and dataflow modelling levels of Abstraction
CO_4	Able to write Verilog programs in behavioural modelling levels of Abstraction
CO_5	Able to write VHDL programs in behavioural modelling levels of Abstraction

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		*			*	*	*	*		
CO_2	*		*	*					*	*
CO_3		*			*	*	*	*		*
CO_4		*			*		*	*		*
CO_5		*			*		*	*	*	*

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1.	Overview of Digital Design with Verilog HDL	Evolution of CAD, emergence of HDLs, typical HDL-flow, why Verilog HDL? Trends in HDLs. Hierarchical Modeling Concepts - Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block. Verilog- Module, Delays, brief description - data flow style, behavioral style, structural style, mixed style.	12	Cognitive, Employable, Analytical
2.	Introduction to Gate level Modeling	Language Elements-Introduction, Keywords, Identifiers, White space characters, integers, data types, net types, register types and parameter; Expressions - Operands, Operators and types of expressions. Gate level Modeling - Introduction, built in primitive gates, multiple input gates, Tristate gates, pull gates, MOS switches, bidirectional switches, gate delay-illustrative examples.	12	Cognitive, Employable, Analytical
3.	Introduction to Data Flow Modeling and Behavioral Modeling	Data flow modeling - Continuous assignment, net declaration assignments, delays, net delays - illustrative examples Behavioral Modeling - Procedural constructs, timing controls, conditional statement, loop statement, Procedural continuous assignment, illustrative examples	12	Cognitive, Employable, Analytical
4.	Introduction to VHDL	What is VHDL? History, capabilities, hardware abstraction, basic terminology, entity declaration, Architecture body, Configuration declaration, Package declaration, Package body, Model analysis. Language Elements-Introduction, Identifiers, keywords, data objects, data types, Composite types,	12	Cognitive, Employable, Analytical

		Operators. OOPS concept-features, class, objects, instances, attributes. (Concept only)		
5.	Introduction to Modeling methods	Structural modeling: Component declaration, Component instantiation, Examples. Dataflow Modeling: Concurrent signal assignment statement, Sequential signal assignment statement, Delta delay revisited, multiple drivers, Block statement. Examples. Behavioral Modeling: Entity declaration, Architecture body, Process statement, Variable assignment statement, Signal assignment statement, Wait statement, If statement, Case statement, Null statement, Loop statement, Exit statement, Next statement, Examples.	12	Cognitive, Employable, Analytical

TEXT BOOKS:

1. Bhasker. J.(2008).A Verilog HDL Primer, BS Publications
2. Bhasker. J (2011) A VHDLPrimer. PHI Learning Private Limited, 3rd edition

Reference Books:

1. Samir Palnitkar, —Verilog HDL: A Guide to Digital Design and Synthesis”, Pearson Education, Second Edition.
2. Kevin Skahill, —VHDL for Programmable Logic, PHI/Pearson education, 2006.
3. Donald E. Thomas, Philip R. Moorby, —The Verilog Hardware Description Language, Springer Science+Business Media, LLC, Fifth edition.
4. Michael D. Ciletti, —Advanced Digital Design with the Verilog HDL, Pearson (Prentice Hall), Second edition.
5. Padmanabhan, Tripura Sundari, —Design through Verilog HDL, Wiley, 2016 or earlier.

Practical: S2 EL3.2: Digital Design Using Verilog and VHDL Programming lab

Total Teaching hours: 60

No. of Hours / Week: **04**

S. No	Module title	Number of Hours	Skills Developed
Part-A(Any Five)			
1.	Write a Verilog code to realize basic and derived logic gates	4	Cognitive, Analytical
2.	Write a Verilog code to realize the universal property of NAND and NOR gates	4	Cognitive, Analytical
3.	Write a Verilog code to realize Half adder using basic and derived gates	4	Cognitive, Analytical
4.	Write a Verilog code to realize Full adder using basic gates.	4	Cognitive, Analytical
5.	Write a Verilog code to realize Half subtractor using basic gates and derived gates	4	Cognitive, Employable, Analytical
6.	Write a Verilog code to realize 4:1 Decoders	4	Cognitive, Employable, Analytical
7.	Write a Verilog code to realize Code converters (Binary to Gray and vice versa)	4	Cognitive, Employable, Analytical
Part-B (Any Five)			
8.	Write a VHDL code to realize basic and derived logic gates	4	Cognitive, Employable, Analytical
9.	Write a VHDL code to realize the universal property of NAND and NOR gates	4	Cognitive, Employable, Analytical
10.	Write a VHDL code to realize Half adder using basic and derived gates	4	Cognitive, Employable, Analytical
11.	Write a VHDL code to realize Full adder using basic gates	4	Cognitive, Employable, Analytical
12.	Write a VHDL code to realize Half subtractor using basic gates and derived gates	4	Cognitive, Employable, Analytical
13.	Write a VHDL code to realize 4:1 Decoders	4	Cognitive, Employable, Analytical
14.	Write a VHDL code to realize Code converters (Binary to Gray and vice versa)	4	Cognitive, Employable, Analytical

***Minimum of TEN Experiments to be performed excluding demonstration experiments**

SEMESTER-IV

S21 EL 4.1: Electronic Communications – I

Total Teaching Hours: 60

No. of Hours / Week: **04**

CObj_ID	Course Objectives
CObj_1	To understand the analog communication system and its applications.
CObj_2	To demonstrate analog modulation techniques-AM & FM
CObj_3	To illustrate the concept of resonant and non-resonant antennas

CO_ID	Course Outcomes
CO_1	Able to describe the noise, transmission and radio wave propagation
CO_2	Able to demonstrate analog modulation techniques-AM & FM
CO_3	Able to explain AM & FM receiving function of analog modulation techniques
CO_4	Gain knowledge on the concept of resonant and non-resonant antennas
CO_5	Able to summarize the block diagram of monochrome and color televisions.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5

CO_1	*	*		*	*	*	*	*		*
CO_2		*		*	*		*	*	*	*
CO_3	*		*		*	*	*	*		
CO_4	*			*	*	*	*	*		
CO_5	*	*	*	*	*			*	*	*

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1.	Noise and Transmission lines	Noise-Introduction, internal- Thermal Noise, white noise, Shot noise, partition noise, external noises- Atmospheric noise, extraterrestrial noise, industrial noise, signal to noise ratio and noise figure, equivalent noise temperature-numerical examples. Transmission lines - types and equivalent circuit of T-lines, primary and secondary constants. Reflection co-efficient, VSWR and CSWR-numerical examples. Ionosphere and its effects, Propagation of waves-ground wave, sky wave and space wave propagations, Multi-hop Propagation.	12	Cognitive, Employable
2.	Analog Modulation techniques	Block diagram of electronic communication system. modulation-need for modulation, types of modulation-AM, FM & PM. Amplitude modulation – representation, modulation index, expression for instantaneous voltage(Derivation), power relations in AM, frequency spectrum, DSBFC, DSBSC and SSBSC (mention only), AM collector modulator, balanced modulator using diodes, Limitations of AM, Numerical examples on AM. FM - definition, modulation index, FM-waveforms, expression for instantaneous voltage (expression only), frequency spectrum diagram, bandwidth requirements, frequency deviation and carrier swing, FM generator-varactor diode modulator. Block diagram of AM transmitter and FM transmitter with AFC, qualitative study of pre-emphasis. Comparison of AM and FM, numerical examples on FM.	12	Cognitive, Employable, Analytical
3.	Radio	Demodulation- AM detection – principles of detection, linear diode and Transistor detector-circuits, principle of working and waveforms. FM detector – principle, slope detector-circuit, working. Introduction to radio receiver, tuned radio frequency		Cognitive,

	Receivers	receiver, super heterodyne receiver, mixer, local oscillator, intermediate frequency amplifier, automatic gain control, automatic frequency control, AM super heterodyne receiver– principle, block diagram, function of each stage with waveform. FM super heterodyne receiver– principle, block diagram, function of each stage with waveform, qualitative study of de-emphasis. Characteristics of radio receivers-qualitative study of sensitivity, selectivity, signal to noise ratio, fidelity, stability, image frequency and its rejection.	12	Employable, Analytical
4.	Antennas	Introduction, Basic Antenna Parameters - gain, directive gain, power gain, bandwidth, beam width, polarization, efficiency, radiation resistance, total effective resistance, beam Area, Radiation Intensity, Directivity, Resolution, Antenna Apertures, Effective Height-numerical examples. Radiation mechanism in antenna, resonant antennas-radiation pattern and current distribution for different lengths, non - resonant antenna, derivation for the power radiated by antenna and expression for radiation resistance-numerical examples. Ungrounded and grounded antennas, effect of antenna height. Folded dipole, Qualitative study of yagi-uda antenna, parabolic antenna, helical antenna and loop antenna, micro strip antenna.	12	Cognitive, Employable, Analytical
5.	Television	Introduction To Basic Television Systems, Characteristics of Human Eye, Brightness, Perception, Persistence of Vision Scanning, Aspect Ratio, Flicker, The Keel Factor, Resolution Horizontal And Vertical Resolution. Scanning-sequential scanning, interlaced scanning, T.V. camera tube (vidicon), composite video signal – blanking and synchronizing pulses, vestigial side band transmission, TV systems and standards – comparison between American and European systems-numerical examples. Block diagrams of monochrome TV transmitter and receiver. Basic principles of colour TV, primary and secondary colours, Colour combinations, chromo and	12	Cognitive, Employable, Analytical

		luminance processing as per PAL system. Colour TV receiver (PAL), Qualitative study of Flat Panel Display TV, LCD TV, LED TV, HDTV, 3D TV, OLED TV, Plasma Screen TV, New Era Projection TV.		

Text Books:

1. Electronic Communication, George Kennedy, 3rd edition, TMH.
2. Electronic Communication, Roddy and Coolen, 4th edition, PHI.
3. Communication Systems, Simon Haykin, 2nd edition, Wiley Eastern, India.
4. Principles of Communication Systems, Taub and schilling, Tata McGraw Hill, India
5. Modern Television Practice, R.R.Gulati, 4th revised edition, New Age International Publishers.

Reference Books:

1. Electronics Communications Systems, Wayne Thomasi, 5th edition, PearsonEd.
2. Digital Communication System, Ronald J.Tocci. 3. Communication Systems, R.P. Singh, SP Sapre, TMH.
3. Fundamentals of Communication Systems, John G. Proakis, Masond, Salehi PEA.

Practical: S21 EL 4.2: Electronic Communications – I Lab

Total Teaching hours: 60

No. of Hours / Week: **04**

S. No	Module title	Number of Hours	Skills Developed
1.	Amplitude modulator & demodulator	4	Cognitive, Analytical
2.	FM modulator using IC 8038	4	Cognitive, Analytical
3.	Pre emphasis & de emphasis	4	Cognitive, Analytical
4.	Three way audio cross over network	4	Cognitive, Analytical
5.	IF amplifier	4	Cognitive, Analytical
6.	Frequency mixer	4	Cognitive, Analytical
7.	Frequency multiplier	4	Cognitive, Analytical
8.	Study of sensitivity, selectivity & Fidelity of an AM radio receiver	4	Cognitive, Analytical
9.	Class C tuned amplifier	4	Cognitive, Analytical
10.	Time division Multiplexing	4	Cognitive, Analytical

***Minimum of Eight Experiments to be performed excluding demonstration experiments**

OPEN ELECTIVE

SEMESTER-I

ELEOE1.1: Domestic Equipment Maintenance

Total Teaching Hours: **48** No. of Hours / Week: **03**

CObj_ID	Course Objectives
CObj_1	To understand the working and parts of Geyser and cooker
CObj_2	To gain the knowledge on micro oven and refrigerator
CObj_3	To know about the working process of AC and general faults

CO_ID	Course Outcomes
CO_1	Gain the knowledge on Geyser, micro oven, AC, refrigerator and cooker
CO_2	Able to understand the common faults and their troubleshooting in cooker, refrigerator, Geyser and micro oven,
CO_3	Able to understand the manufacturing process of air conditioner, refrigerator, Geyser and micro oven,
CO_4	Able to understand the electrical wiring diagram
CO_5	Ability to repair/replace the components of Geyser, micro oven, AC, refrigerator and cooker

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1.	Geyser Common faults and their troubleshooting	Construction and working, parts and manufacturing process, types. Common faults and their troubleshooting: Dripping geyser overflow, overheating, steam or hot water escaping from overflow, water leaking through the ceiling, no hot water, water not hot enough, poor hot water pressure. Induction cooker: Construction and working, parts and manufacturing process, types. Cooker fuse blown, cooker buttons not working, cooktop shuts off while cooking, food not get cooked or heated properly, overheating and uneven heating, display keep flashing, weird noises–crackling, fan noise, humming sound, clicking.	16	Cognitive, Employable Cognitive, Employable
2.	Microwave Oven Refrigerator	Working, raw material and manufacturing process, types, Common faults and their troubleshooting: Microwave does not heat, runs then stops, buttons do not work, plate do not spin, bulb does not turn ON during operation, sparking inside, shuts OFF after few seconds Working, raw material and manufacturing process, electrical wiring diagram, types of refrigerator. Common faults and their troubleshooting: fridge not cooling, fridge not defrosting, leaking water, freezing food light not working, freezer is cooled but fridge stays warm, dead refrigerator, not enough cooling, keeps running, leakage, makes noise. Replacement procedure for: seal (gasket), evaporator fan motor, PTC relay, thermostat, compressor, and bulb.	16	Cognitive, Employable Cognitive, Employable
3.	Air Conditioner General faults Demonstration Experiments	Working, raw material and manufacturing process, electrical wiring diagram, types. Common Faults and their troubleshooting: Faults in following parts of AC: Filter, thermostat, refrigerant leaks, breakers, capacitors, compressor, evaporator coils, condenser coils, warm contactor. AC unit has an odour, shuts ON and OFF repeatedly, does not blow cold air, repeatedly tripping a circuit breaker, indoor unit is leaking water inside the room, outdoor unit is making an unusually loud sound, room is not getting cold enough, AC not turning ON. a) Working of Air Conditioner b) Working of Refrigerator c) Working of Geyser	16	Cognitive, Employable Cognitive, Employable,

		d) Working of Microwave Oven e) Working of Induction Cooker		Evaluation and Synthesis

References:

1. Electronic instruments and systems: Principles, maintenance and troubleshooting by R. G. Gupta
Tata McGraw Hill
2. Modern electronic equipment: Troubleshooting, repair and maintenance by Khandpur, Tata
McGraw Hill
3. Electronic fault diagnosis by G. C. Loveday, A. H. Wheeler publishing

OPEN ELECTIVE

SEMESTER–II

ELE-OE2.1: Consumer Electronics

Total Teaching Hours: **48** No. of Hours / Week: **03**

CObj_ID	Course Objectives
CObj_1	To understand the audio systems of Microphones, Amplifier, Loudspeakers, Radio Receivers, AM/FM, Audio Recording, and reproduction, Installation of Audio/Video systems – site preparation, electrical requirements, cables and connectors.

OPEN ELECTIVE

SEMESTER–III

ELEOE 3.1: Medical Electronics

Total Teaching Hours: **45**

No. of Hours / Week: **03**

CObj_ID	Course Objectives
CObj_1	To understand the electro-physiology and bio-potential recording
CObj_2	To describe the bio-chemical and non electrical parameter measurement
CObj_3	To discuss the various recent trends in medical instrumentation

CO_ID	Course Outcomes

CO_1	Able to understand the electro-physiology and bio-potential recording
CO_2	Able to describe the bio-chemical and non electrical parameter measurement
CO_3	Able to outline the different types of assist devices
CO_4	Able to describe the concepts of physical medicine and biotelemetry.
CO_5	Able to discuss the various recent trends in medical instrumentation

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1.	Electro-Physiology And Bio-Potential Recording	The origin of Bio-potentials; bio potential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, lead systems and recording methods, typical waveforms and signal characteristics.	15	Cognitive, Employable
2.	Bio-Chemical And Non Electrical Parameter Measurement Assist Devices	pH, PO ₂ , PCO ₂ , colorimeter, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood Cell Counters. Cardiac pacemakers, DC Defibrillator, Dialyser, Heart lung machine.	15	Cognitive, Employable
3.	Physical Medicine and Biotelemetry Recent Trends In Medical Instrumentation	Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy Telemetry principles, frequency selection, biotelemetry, electrical safety Thermograph, endoscopy unit, Laser in medicine, cryogenic application, Introduction to telemedicine.	15	Cognitive, Employable

Text Books:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007.
2. John G. Webster, "Medical Instrumentation Application and Design", 3rd Edition, Wiley India Edition, 2007

Reference Books

1. Khandpur, R.S., "Handbook of Biomedical Instrumentation", TATA McGraw-Hill, New Delhi, 2014.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley and Sons, New York, 2004.

OPEN ELECTIVE

SEMESTER-IV

ELE-OE2.1: MOBILE APPLICATION DEVELOPMENT

Total Teaching Hours: **45**

No. of Hours / Week: **03**

CObj_ID	Course Objectives
CObj_1	To learn the characteristics of mobile applications
CObj_2	To learn the characteristics of mobile applications
CObj_3	To study about the design aspects of mobile application

CO_ID	Course Outcomes
CO_1	Able to understand the characteristics of mobile applications
CO_2	Able to design and implement the user interfaces for mobile applications
CO_3	Able to design the mobile applications that is aware of the resource constraints of mobile devices
CO_4	Able to develop advanced mobile applications that accesses the databases and the web
CO_5	Able to develop useful mobile applications in the current scenario using Google Android Studio

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1.	Introduction	Mobile Applications – Characteristics and Benefits – Frameworks and Tools – Introduction to Java – Classes and Objects – Inheritance – Packages and Interfaces – Strings – I/O – Event handling.	9	Cognitive, Employable
2.	User Interface	Generic UI Development – Multimodal and Multichannel UI – Designing the right UI– Introduction to XML –XML basics – Attributes – DTD - XML schema – Screen Elements and Layouts.	9	Cognitive, Employable
3.	Tools	Google Android Platform – Android Application Architecture – Android Studio – Android Widgets and Menus – Event handling – Packaging and Deployment - Apple iPhone Platform	9	Cognitive, Employable
4.	Application Design	Memory Management – Design patterns for limited memory – Work flow for Application. Development – Techniques for composing Applications – Intents and Services – Fragments – Graphics – Animation.	9	Cognitive, Employable
5.	Application Development	Storing and Retrieving data – Communication via the Web – Notification and Alarms – Telephony – Location based services – Apps with Firebase Real Time Database – Project on respective Discipline.	9	Cognitive, Employable

Text books:

1. Jeff Friesen, “Learn Java for Android Development: Java 8 and Android” 5th Edition Paperback – 2014
2. Share Conder, Lauren Darcey, "Android Wireless Application Development" Pearson 3rd Edition.

References:

1. Zigurd Mednieks, Laird Dornin, G, Blake Meike and Masumi Nakamura, —Programming Android, O’Reilly, 2011.

2. Professional mobile Application Development paperback,2012 Jeff Mcherter (Author),Scott Gowell (Author), Wiley India Private Limited
3. Reto Meier, Wrox Wiley, —Professional Android 2 Application Developmentll, 2010.
4. Alasdair Allan, —iPhone Programmingll, O'Reilly, 2010.
5. Wei-Meng Lee, —Beginning iPhone SDK Programming with Objective-Cl, Wrox Wiley, 2010.
6. Stefan Poslad, —Ubiquitous Computing: Smart Devices, Environments and interactionsll, Wiley, 2009.
7. Pro iOS Table Views: for iPhone, iPad and iPod Touch Paperback,2012, Tim Duckett, Apress
8. iOS Programming: The Big Nerd Ranch Guide Paperback, 2014, Joe COnway, Aaron Hilegass, Christian Keur.



MATRIX AND SYLLABUS

For the Programme B.Sc. (Mathematics/ Computer Science)

Mathematics

NEP Based Curriculum (2021 onwards)

III Semester

NEP- Curriculum Framework for Approval

BSc (Mathematics, Computer Science) - Course Matrix for III Semester (w.e.f. 2022-23 Onwards)

III Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	S21KN 3.1/ S21HN 3.1/ S21AE 3.1	Language I (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	S21GE 3.1	Language II (Generic English)	60	3	1	-	3
DSC3	S21MA3.1	Ordinary Differential Equations and Real Analysis-I (Theory)	60	4	-	-	4
DSC3	S21MA 3.2	Ordinary Differential Equations and Real Analysis-I Lab using FOSS tools (Practical)	60	-	-	4	2
DSC3	S21CS3.1	Object Oriented Programming using Java (Theory)	60	4	-	-	4
DSC3	S21CS3.2	Java Lab (Practical)	60	-	-	4	2
OE-3	S21OE/ B21OE	Quantitative Mathematics-I/Computer Fundamentals and Programming Concepts in C	45	2	1	-	3
SEC- SB	21SBC 3 .1	Digital fluency-II	30	1	-	2	2
SEC-VB	21VBC 3.1	NCC/NSS/Cultural	30	-	-	2	1
SEC-VB	21VBC 3.2	Sports	30	-	-	2	1
Total							25

Note 1:

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii. Quiz / Presentation / Creating diagrams /charts / Classwork / Case study / Viva / Field work etc.	05		
iii. Classroom participation	05		
Total			40

S21 MA 3.1: ORDINARY DIFFERENTIAL EQUATIONS AND REAL ANALYSIS-I**THEORY****Total Teaching Hours: 60****No. of Hours per Week: 4****(4 credits)**

CObj	Course Objectives
CObj_1	To equip students with knowledge and insight in Differential equations and Real Analysis.
CObj_2	To provide basic subject knowledge of Mathematical applications in Differential equations and Real Analysis.
CObj_3	To develop the ability to use computer software as an aid and as a tool to study and solve problems in Mathematics.

CO	Course Outcomes
	After completion of the course, students will be able to
CO1	Remember and understand the concepts of Ordinary differential equations, sequences and series.
CO2	Analyse and use the relevant methods in solving the given problem on Ordinary differential equations, sequences and series.
CO3	Apply the concepts to solve problems on Ordinary differential equations, nature of sequences and series.
CO4	Evaluating the problem after analysing and applying suitable methods on Ordinary differential equations, sequences and series.
CO5	Give an appropriate conclusion for the given problem on Ordinary differential equations, sequences and series.

CO-PO Mapping (PSOs applicable for B.Sc. and B.A. Programmes)

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	*	*				*	*			
CO2	*	*	*			*	*	*		
CO3	*	*	*			*	*	*	*	
CO4	*	*	*	*		*	*	*	*	
CO5	*	*	*	*	*	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Differential Equations-I	Recapitulation of solution of a differential equation, variable separable method and reducible to variable separable methods. i) a) Linear equations- Bernoulli's equations and those reducible to these equations b) Exact equations and reducible to exact with standard integrating factors ii. Equations of first order and higher degree – nonlinear first order, higher degree solvable for p - solvable for y - solvable for x - Clairaut's equation singular solution - Geometric meaning. iii. Orthogonal trajectories in Cartesian and polar forms.	15Hrs	Transferrable/ Analytical Skills
2	Differential Equations-II	Second and higher order ordinary linear differential equations with constant coefficients complementary function-particular integrals (standard types)-Cauchy-Euler differential equation. Total and simultaneous differential equation. Solutions of second order ordinary linear differential equations with variable coefficients by the following methods: (i) When a part of complementary function is given	15Hrs	Transferrable/ Analytical Skills

		(ii) Changing the independent variable (iii) Changing the dependent variable (iv) Variation of parameters (v) When the equation is exact.		
3	Real Analysis-I	Sequences: Definition of a sequence, bounded sequences, limit of a sequence-algebra of limits. Convergent, divergent and oscillatory sequences, monotonic sequences and their properties. Cauchy's criterion, Nature of the sequences	15Hrs	Transferrable/ Analytical/ Cognitive Skills
4	Real Analysis-I	Series: Definition of Convergence-divergence-oscillation, properties of convergent Series, properties of convergent Series of positive terms, geometric series, Test for convergence of series - p-series -comparison tests, Cauchy root test, De'alembert's ratio test, Raabe's tests. - problems. Absolute-conditional convergence-De'alembert's test for absolute convergence-Alternating series (without proof) Summation of series - binomial, exponential and logarithmic series.	15 Hrs	Transferrable/ Analytical/ Cognitive Skills

Books for Reference:

1. M D Raisinghania, (2014), Ordinary and Partial Differential Equations, S Chand and Co. Pvt. Ltd.
2. F Ayres, (2010), Schaum's outline of theory and problems of Differential Equations, 1sted. USA: McGraw-Hill.
3. S Narayanan and T K Manicavachogam Pillay, (1981) Differential Equations: S V Publishers Private Ltd.
4. G F Simmons, (Oct 1991) Differential equation with Applications and historical notes: McGraw-Hill Publishing Company.
5. Richard R Goldberg, (1970), Methods of Real Analysis, Indian ed. New Delhi, India: Oxford and IBH Publishing Co.,
6. S.C. Malik and Savita Arora, (1992), Mathematical Analysis, 2nd ed. New Delhi, India: New Age international (P) Ltd.

Web Resources:

1. www.scilab.org.
2. wxmaxima.sourceforge.net
3. www.geogebra.org
4. <http://www.themathpage.com/>
5. <http://www.abstractmath.org/>
6. <http://www.fourier-series.com/>
7. <http://mathworld.wolfram.com/>
8. <http://www.princeton.edu/~rvdb>
9. <http://www.zweigmedia.com/RealWorld/Summary4.html>
10. <http://ocw.mit.edu/courses/mathematics/>
11. <http://planetmath.org/encyclopedia/TopicsOnCalculus.html>
12. <http://ocw.mit.edu/OcwWeb/Mathematics/18-01Fall-2005/CourseHome/index.htm>

13. <http://mathworld.wolfram.com/Calculus.html>
14. <http://ocw.mit.edu/courses/mathematics/>
15. <http://www.univie.ac.at/future.media/moe/galerie.html>
16. <http://tutorial.math.lamar.edu/classes/de/de.aspx>
17. <http://www.sosmath.com/diffeq/diffeq.html>
18. http://www.analyzemath.com/calculus/Differential_Equations/applications.html

S21 MA3.2: ORDINARY DIFFERENTIAL EQUATIONS AND REAL ANALYSIS-I LAB**PRACTICAL****Total Teaching Hours: 60****No. of Hours per Week: 4****(2 credits)**

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Differential Equations-I	1. Introduction to Scilab/Maxima for differential equations. 2. Solution of Differential equation using Scilab/Maxima and plotting the solution-I. 3. Solution of Differential equation using Scilab/Maxima and plotting the solution-II. 4. Solution of Differential equation using Scilab/Maxima and plotting the solution-III.	16Hrs	Analytical/Employable Skills
2	Differential Equations-II	5. Solution of Differential equation using Scilab/Maxima and plotting the solution-IV. 6. Finding complementary function and particular integral of constant coefficient second and higher order ordinary differential equations using Scilab/Maxima. 7. Finding complementary function and particular integral of constant coefficient second and higher order ordinary differential equations using Scilab/Maxima.	12Hrs	Cognitive /Analytical Skills
3	Real Analysis-I	8. Introduction to Scilab/Maxima for sequences and series 9. Illustration of convergent, divergent and oscillatory sequences using Scilab/Maxima. 10. Illustration of convergent, divergent and oscillatory series using Scilab/Maxima. 11. Scilab/Maxima programs to find the sum of the series and its radius of convergence 12. Using Cauchy's criterion to determine convergence of a sequence (simple examples). 13. Using D'Alembert's and Raabe's tests on the sequence of partial sums of the series to determine convergence of a series. 14. Testing the convergence of binomial,	28Hrs	Cognitive / Analytical Skills

		exponential and logarithmic series and finding the sum.		

S21 OE: QUANTITATIVE MATHEMATICS

THEORY

Total Teaching Hours: 45

No. of Hours per Week: 3

(3 credits)

CObj	Course Objectives
CObj_1	To equip students with knowledge and insight in Number system.
CObj_2	To provide basic knowledge of Time and work for competitive exams.
CObj_3	To develop the ability solving problems related to data interpretation.

CO	Course Outcomes Students will be able to
CO1	Understand the basic concepts of number system, time and work , data interpretation.
CO2	Demonstrate a working knowledge of number system, time and work , data interpretation.
CO3	Apply the concepts of number system, time and work , data interpretation. to real world problems.
CO4	The ability to analyze the real world problems
CO5	Solve the problems related to number system, time and work , data interpretation.

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	NumberSystem	Numbers Property – Simplification – Divisibility – HCF and LCM – Decimal Fractions – Square roots and Cube Roots – Logarithms – Antilogarithms - Surds and indices	10 Hrs	Transferrable/ Analytical /Employable Skills
2	Time & Work	Time and Work, Problems on ages, Calendar, Clock, Pipes and Cistern, Time and Distance, Problems of Train, Boats and Streams.	15Hrs	Transferrable/ Analytical /Employable Skills
3	Data Interpretation	Data interpretation-Tabulation-Bar graphs-Pie charts-Line graphs, odd man out series-number series-letter series, codes, relationships, classification, word analogy-applied analogy, verbal classification, reasoning, logical diagrams.	20 Hrs	Transferrable/ Analytical /Employable Skills

Books for Reference:

1. R.S. Aggarwal, 2012, Quantitative Aptitude, S. Chand & Company, New Delhi.
2. Arun Sharma, (2021)Quantitative Aptitude for CAT, 8th edition.
3. Survesh K Verma,(2023), Quantitative Aptitude Quantum CAT.



MATRIX AND SYLLABUS

For the Programme B.Sc. (Mathematics/ Computer Science)

Mathematics

NEP Based Curriculum (2021 onwards)

IV Semester

NEP- Curriculum Framework for Approval

BSc (Mathematics, Computer Science) - Course Matrix for IV Semester (w.e.f. 2022-23 Onwards)

IV Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	S21KN 4.1/ S21HN4.1/ S21AE 4.1	Language I (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	S21GE4.1	Language II (Generic English)	60	3	1	-	3
AECC	21SBC 4.1	Constitution of India	45	2	1	-	3
DSC4	S21MA 4.1	Partial Differential Equations and Integral Transform (Theory)	60	4	-	-	4
DSC4	S21MA 4.2	Partial Differential Equations and Integral Transform – Lab using FOSS tools (Practical)	60	-	-	4	2
DSC4	S21CS4.1	Operating Systems (Theory)	60	4	-	-	4
DSC4	S21CS4.2	UNIX Lab (Practical)	60	-	-	4	2
OE-4	S21OE/ B21OE	Quantitative Mathematics-II/Web Designing	45	3	-	-	3
SEC-VB	21VBC 4.1	Sports	30	-	-	2	1
SEC-VB	21VBC 4.2	NCC/NSS/Cultural	30	-	-	2	1
Total							26

Note 1:

AECC- Ability Enhancement Compulsory Course

DSC - Discipline-Specific Course

OE- Open elective (course offered by the department to students of other stream)

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii.Quiz / Presentation / Creating diagrams /charts / Classwork / Case study / Viva / Field work etc.	05		
iii. Classroom participation	05		
Total			40

**S21 MA4.1: PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORM
THEORY**

Total Teaching Hours: 60

No. of Hours per Week: 4

(4 credits)

CObj	Course Objectives
CObj_1	To master the ideas and techniques in Partial Differential equations, Fourier series, Fourier Transforms and Laplace transforms - its applications to differential equations.
CObj_2	To develop the mathematical skills of the students in the field of partial differential equations.
CObj_3	To develop the ability to utilize the Mathematical problem solving methods through FOSS tools in addressing practical issues.

CO	Course Outcomes
	After completion of the course, students will be able to
CO1	Remember and understand the concepts of Fourier series, Fourier transforms, Laplace transforms and Partial differential equations.
CO2	Analyse and use the relevant methods in solving the given problem on Fourier series, Fourier transforms, Laplace transforms and Partial differential equations.
CO3	Apply the concepts to solve problems on Fourier series, Fourier transforms, Laplace transforms and Partial differential equations
CO4	Evaluating the problems on Fourier series, Fourier transforms, Laplace transforms and Partial differential equations.
CO5	Give an appropriate conclusion for the given problem on Fourier series, Fourier transforms, Laplace transforms and Partial differential equations

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	*	*				*	*			
CO2	*	*	*			*	*	*		
CO3	*	*	*	*		*	*	*		
CO4	*	*	*	*	*	*	*	*	*	*
CO5	*	*	*	*	*	*	*	*	*	*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Integral Transforms: Fourier series	Trigonometric Fourier series of functions with period 2π and $2L$. Half range Fourier cosine and sine series.	08 Hrs	Transferrable/ Analytical Skills
2	Fourier Transforms	The Fourier integral, different forms of Fourier integral - problems, Complex Fourier transform, inverse transforms, self reciprocals, basic properties of Fourier transforms, linear, change of scale, shifting, modulation – Fourier transforms of derivative and the derivative of the transform – problems, Fourier sine and cosine transforms and inverse – self reciprocal – the derivatives (without theorems) – problems.	16 Hrs	Transferrable/ Analytical Skills
3	Laplace Transforms	Definition and basic properties-Laplace transforms of some common functions and standard results-Laplace transforms of periodic functions-Laplace transforms of derivatives and the integral of a function-Laplace transforms the Heaviside function and Dirac-delta function-convolution theorem (with proof)-Inverse Laplace transforms-Laplace transform method of solving ordinary linear differential equation of first and second orders with constant coefficients.	14 Hrs	Transferrable/ Analytical Skills

4	Partial Differential Equations	Total differential equations-Necessary condition for the equation $Pdx + Qdy + Rdz = 0$ to be integrable -Simultaneous equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$. Formation of partial differential equation. Equations of First Order Lagrange's linear equation – Charpit's method, Standard types of first order non-linear partial differential equation (By known substitution). Solution of second order linear partial differential equations in two variables with constant coefficients by finding complementary function and particular integral Solution of one – dimensional heat equations, Solution of one – dimensional wave equations using Fourier series.	22 Hrs	Transferrable/ Analytical / Research/ Skills Evaluation/ Synthesis

Books for Reference:

1. M D Raisinghania, (2014), Ordinary and Partial Differential Equations, S Chand and Co.Pvt. Ltd.
2. K SankaraRao,(2017), Introduction to Partial Differential Equations, third edition, PHI learning private limited.
3. Frank Ayres and Elliott Mendelson, (2008), Schaum's Outline of Calculus, (5th ed.) USA: Mc. Graw Hill.
4. E Spiegel, (2009), Schaum's Outline of AdvancedCalculus, (5th ed.) USA: Mc. Graw Hill.
5. M D Raisinghania, (2013), Advanced Differential Equations, S Chand and Co. Pvt. Ltd.
6. G F Simmons, (oct 1991), Differential equation with Applications and historical notes, 2nded.: McGraw-Hill Publishing Company.
7. Vairamanickham, K. Ratchagar, Nirmala P. Tamilselvan.S (2015). Transforms and Partial Differential Equations. (3rded.). Scitech Publications Pvt. Ltd.
8. Spiegel. Murray. R. (1974). Schaum's Outline of Advanced Calculus. Mc Graw Hill.

Web Resources:

1. www.scilab.org.
2. wxmaxima.sourceforge.net
3. www.geogebra.org
4. <http://www.themathpage.com/>
5. <http://www.abstractmath.org/>
6. <http://www.fourier-series.com/>
7. <http://mathworld.wolfram.com/>
8. <http://www.princeton.edu/~rvdb>
9. <http://www.zweigmedia.com/RealWorld/Summary4.html>
10. <http://ocw.mit.edu/courses/mathematics/>
11. <http://planetmath.org/encyclopedia/TopicsOnCalculus.html>
12. <http://ocw.mit.edu/OcwWeb/Mathematics/18-01Fall->

S21 MA4.2: PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORM LAB**PRACTICAL****Total Teaching Hours: 60****No. of Hours per Week: 4****(2 credits)**

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Integral Transforms: Fourier series	1. To plot periodic functions with period 2π and $2L$. 2. To find full range trigonometric Fourier series of some simple functions with period 2π and $2L$. 3. To find the half-range sine and cosine series of simple functions.	12Hrs	Analytical/Employable Skills
2	Fourier Transforms	4. Fourier integral of some standard functions. 5. Fourier Transforms of some standard functions.	8Hrs	Cognitive & Analytical Skills
3	Laplace Transforms	6. Finding the Laplace transforms of some standard functions. 7. Finding the inverse Laplace transform of simple functions. 8 Implementing Laplace transform method of solving ordinary linear differential equations of first and second order with constant coefficients.	12Hrs	Cognitive & Analytical Skills
4	Partial Differential Equations	9 Solutions to the problems on total and simultaneous differential equations. 10. Solutions to the problems on different types of Partial differential equations. 11. Solving second order linear partial differential equations in two variables with constant coefficient. 12. Solving some more second order linear partial differential equations in two variables with constant coefficient. 13. Solution of one dimensional heat equation using Fourier series. 14. Solution of one dimensional wave equation using Fourier series.	24Hrs	Cognitive & Analytical Skills

S21 OE: QUANTITATIVE MATHEMATICS-II**THEORY****Total Teaching Hours: 45****No. of Hours per Week: 3****(3 credits)**

CObj	Course Objectives
CObj_1	To equip students with knowledge and insight in Permutations and combinations.
CObj_2	To provide basic knowledge on Mensuration and set theory.
CObj_3	To develop the ability of solving problems related to bankers arithmetic.

CO	Course Outcomes
CO1	Understand the basic concepts of permutations, combinations, mensuration, set theory and bankers arithmetic.
CO2	Demonstrate a working knowledge of permutations, combinations, mensuration, set theory and bankers arithmetic.
CO3	Apply the concepts of permutations, combinations, mensuration, set theory and bankers arithmetic to real world problems.
CO4	Solve the problems related to permutations, combinations, mensuration, set theory and bankers arithmetic.
CO5	The ability to address the real world problems.

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Permutations& Combinations	Permutations and combinations (Without proof) problems on permutations and combinations, Application problems	10 Hrs	Transferrable/ Analytical / Employable Skills
2	Mensuration & Set Theory	Area – Volume and surface Areas – Heights and Distances. Set theory – representation – types, operations and Venn diagrams - problems	15 Hrs	Transferrable/ Analytical/ Employable Skills
3	Bankers Arithmetic	Simple Interest – Compound Interest – Stocks and Shares – True Discount – Banker's discount. Averages – Percentage – Profit and Loss - Ratio and Proposition – Partnership –Allegation and mixture – Chain rule.	20 Hrs	Transferrable/ Analytical/ Employable Skills

Books for Reference:

1. R.S. Aggarwal,(2012), Quantitative Aptitude, S. Chand & Company, New Delhi.
2. Arun Sharma, (2021)Quantitative Aptitude for CAT, 8th edition.
3. Survesh K Verma,(2023), Quantitative Aptitude Quantum CAT.
4. G KRanganath, (2018),Business Mathematics,3rd edition.
5. Eugene Don PhD, Joel Lerner PhD, (2019), Schaum's Outline, 2nd edition.
6. Abhijit Guha, (2016), Quantitative Aptitude for all competitions, 6th revised edition.

Department of Physical Sciences
Physics

MATRIX AND SYLLABUS

For the Programme B.Sc. (Physics/Computer Science)

Physics

NEP Based Curriculum (2021 onwards)

III Semester

NEP- Curriculum Framework for Approval

B.Sc. (Physics/Computer Science) - Matrix for III Semester (w.e.f. 2022-23 onwards)

III Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	S21KN 3.1/ S21HN 3.1/ S21AE 3.1	Language I (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	S21GE 3.1	Language II (Generic English)	60	3	1	-	3
DSC3	S21 PH 3.1	Wave Motion and Optics (Theory)	60	4	-	-	4
DSC3	S21 PH 3.2	Physics Practical Lab- III (Practical)	60	-	-	4	2
DSC3	S21CS3.1	Object Oriented Programming Using Java- (Theory)	60	4	-	-	4
DSC3	S21CS3.2	Java Lab– (Practical)	60	-	-	4	2
OE-3	S21OE/ B21OE	Sports Science / Computer Fundamentals and Programming Concepts in C	45	2	1	-	3
SEC-SB	21SBC 3 .1	Digital fluency-II	30	1	-	2	2
SEC-VB	21VBC 3.1	NCC/NSS/Cultural	30	-	-	2	1
SEC-VB	21VBC 3.2	Sports	30	-	-	2	1
Total							25

Note 1:

DSC - Discipline-Specific Course

DSE – Discipline-Specific Elective

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Note 2:

The DSE and Vocational courses are programme specific and may vary depending on programme offered.

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii.Quiz / Presentation / Creating diagrams /charts / Classwork / Case study / Viva / Field work etc.	05		
iii. Classroom participation	05		
Total			40

For Practical Courses

End Semester Examination: 50%

Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)

Activities	Total Marks
1. Lab Performance	10
2. Observation record	05
3. Internal exam	10
Total	25

S21 PH 3.1: WAVE MOTION AND OPTICS**THEORY****Total Teaching Hours: 60****No. of Hours per Week: 4****(4 credits)**

CObj	Course Objectives
CObj_1	To understand the importance and applications of harmonic oscillation and damped oscillation
CObj_2	To gain knowledge on transverse and longitudinal waves in matter
CObj_3	To understand the light phenomenon and its applications

CO	Course Outcomes
	After completion of this module, students should be able to
CO_1	Understand the concepts related to wave nature.
CO_2	Apply few fundamental aspects on Simple harmonic waves (SHO)'s, wave nature of light.
CO_3	Analyze on the deeper aspects SHO leading towards Fourier series and Fourier transforms.
CO_4	Evaluate on the aspects of fundamental aspects of wave mechanics.
CO_5	Design and Develop solutions related to optics and acoustics.

CO-PO Mapping

[illegible]

Course Content

S. No	Unit/chapter title	Content	Number of hours	Skills developed
1.	Unit-I Fundamentals of vibrations	Simple harmonic oscillator and solution of the differential equation, Physical characteristics of SHM, Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy consideration with undamped harmonic oscillator, logarithmic decrement, relaxation time, quality factor, differential equation of forced oscillator and its solution, amplitude resonance, velocity resonance.	12 Hrs	Cognitive
	Superposition of Harmonic motions	Addition of two simple harmonic motions with different frequencies and phases, addition of many simple harmonic motions, combination of two mutually perpendicular simple harmonic vibrations of same frequency and different frequencies, Lissajous figures.		Cognitive
	Fourier analysis of complex vibrations	Fourier series and evaluation of the Fourier coefficients, analysis of periodic functions square, triangular, saw-tooth functions.		Cognitive/Analytical Skills
	Topics for Self-study	Amplitude resonance, velocity resonance. Construct the saw-tooth waves by the use of Fourier series	01 Hr	
	Activity No. 1	1. Observe Lissajous figure patterns in CRO 2. Demonstrate resonance 3. Observe and create Fourier waves by using open simulation software - Phet Colorado University	02 Hrs	

2.	Unit-II Transverse and Longitudinal waves	Transverse wave propagation along a stretched string, general solution of the wave equation and its significance, modes of vibration of stretched string clamped at both ends, overtones, energy transport, transverse impedance. Reflection and transmission of waves. Longitudinal waves in air, solution of a differential equation, reflection and transmission of acoustic waves, Mach number. Longitudinal vibrations in bars – wave equation and its general solution. Special cases (i) bar fixed at both ends ii) bar fixed at the mid point iii) bar free at both ends iv) bar fixed at one end. Transverse vibrations in a bar – wave equation and its general solution. Boundary conditions, clamped free bar, free – free bar, bar supported at both ends, Tuning fork.	12 Hrs	Cognitive/Analytical Skills Cognitive/Analytical Skills Cognitive/Analytical Skills
	Topics for self study(If any)	Transverse vibrations in a bar – wave equation and its general solution. Boundary conditions, clamped-free bar, free – free bar, bar supported at both ends	02 Hrs	
	Activity No. 2	1. Observe vibrations in stretched string, with different tensions 2. Identify overtones 3. Longitudinal vibrations in spring	01 Hr	
3.	Unit-III Wave Optics	Huygen's wave theory of light: Huygen's principle, construction Huygen's wave front, Laws of reflection and refraction using spherical wavefront at a plane surface. Coherent sources and their production, Conditions for observing interference (mention), Conditions for constructive and destructive interference (mention). Coherent sources by division of amplitude: Interference at thin films - reflected and transmitted light, Colours of thin films, Theory of air wedge, Theory of Newton's rings (Only reflected System), and Determination of Refractive index of a liquid. Concept of Fresnel's half period zones, Theory of rectilinear propagation, Fresnel diffraction, Construction and working of Zone plate, Comparison of Zone plate with lens, Cylindrical wave front (Half period strips – qualitative)	12 Hrs	Cognitive/Analytical Skills
	Interference			Cognitive/Analytical Skills
	Fresnel diffraction			Cognitive/Analytical Skills

	Topics for self-study	Determination of Refractive index of a liquid	01 Hr	
	Activity No. 3	1. Form the interference film through soap bubbles & realize the interference pattern 2. Ways to explore refraction and reflection – Light refraction with water and light reflection from mirror 3. Realize diffraction of light - small bright flashlight bulb and a slit made with two pencils.	02 Hrs	
4.	Unit-IV Fraunhofer Diffraction	Theory of single slit diffraction, Theory of grating - normal and oblique incidence - Experimental determination of wavelength, Discussion of Dispersive power, Resolving power, Rayleigh's criterion, Expression for resolving power of grating and telescope, Comparison of prism and grating spectra.	12 Hrs	Cognitive/Analytical Skills
	Polarization	Review of plane polarized light and method of production, Double refraction at crystals, Huygens' explanation of double refraction, Theory of retarding plates - Quarter wave plates and Half wave plates, n, Production and detection of linearly, elliptically and circularly polarized light, Optical activity - Fresnel's explanation.		Cognitive/Analytical Skills
	Topics for self-study (If any)	Comparison of prism and grating spectra. Production and detection of linearly, elliptically and circularly polarized light	01 Hr	
	Activity No.4	1. Fraunhofer diffraction at a single slit 2. Realize the double refraction by using double refraction crystal and ink spot in plain paper 3. Realize the polarized light by glass, window glass, sun glass and lens	02 Hrs	

Books for References:

1. Bajaj, N. K. (1988). Physics of oscillations and waves. McGraw-Hill.
2. Buckley, R. (1985). *Oscillations and Waves*. CRC Press.
3. Chaudhury, R. N. (2010). Waves and Oscillations. New Age International.
4. Franklin, J. (2020). *Mathematical methods for oscillations and waves*. Cambridge University Press.
5. Fitzpatrick, R. (2013). Oscillations and Waves: An Introduction. CRC Press.
6. Garg, S. (2009). Oscillations and Waves. PHI Learning.
7. Kakani, S. L. (2018). Waves oscillations acoustics.
8. Mittal, P. K. (2013). Oscillations, Waves and Acoustics. I K International Publishing House.

9. Rabinovich, M. I., & Trubetskov, D. I. (2012). *Oscillations and waves: In linear and nonlinear systems* (1989th ed.). Springer.
10. Subrahmanyam, N. (1994). *Waves and Oscillations*. Vikas Publishing House.

S21 PH 3.2: PHYSICS PRACTICAL– LAB III**PRACTICAL****Total Teaching Hours: 60****No. of Hours per Week: 4****(2 credits)**

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1.	Module 1	Measurement of errors – simple Pendulum	04 Hrs	Research/ Analytical/ Employable Skills
2.	Module 2	Damping of an oscillating disc using logarithmic decrement in Air and Water	04 Hrs	Research/ Analytical/ Employable Skills
3.	Module 3	Calculate Y and n using oscillations of a mass under different combination of springs	04 Hrs	Research/ Analytical/ Employable Skills
4.	Module 4	Verification of Laws of stretched string	04 Hrs	Research/ Analytical/ Employable Skills
5.	Module 5	Determination of frequency of a Bar/tuning fork – Melde's experiment	04 Hrs	Research/ Analytical/ Employable Skills
6.	Module 6	Volume Resonator – determination of frequency of tuning fork	04 Hrs	Research/ Analytical/ Employable Skills
7.	Module 7	Focal length of combination of lenses separated by a distance	04 Hrs	Research/ Analytical/ Employable Skills
8.	Module 8	Air wedge - determination of thickness of object.	04 Hrs	Research/ Analytical/ Employable Skills
9.	Module 9	Newton's rings – determination of radius of curvature of lens surface.	04 Hrs	Research/ Analytical/ Employable Skills
10.	Module 10	Diffraction grating in minimum deviation position	04 Hrs	Research/ Analytical/ Employable Skills
11.	Module 11	Diffraction grating in normal incidence position	04 Hrs	Research/ Analytical/ Employable Skills
12.	Module 12	Resolving power of a grating	04 Hrs	Research/ Analytical/ Employable Skills
13.	Module 13	Verification of Malus law	04 Hrs	Research/ Analytical/ Employable Skills
14.	Module 14	Determination of specific rotation of sugar solution	04 Hrs	Research/ Analytical/ Employable Skills
15.	Module 15	Determination of resolving power of telescope	04 Hrs	Research/ Analytical/ Employable Skills

***Minimum of EIGHT Experiments to be performed excluding demonstration experiments**

S21 OE 3.1: SPORTS SCIENCE**THEORY****Total Teaching Hours: 45****No. of Hours per Week: 03****(3 credits)**

CObj	Course Objective
CObj_1	To understand the units and measurement of physical quantities
CObj_2	To know about mechanics involved in sports
CObj_3	To understand the food and nutrition required for sports

CO	Course outcomes
	After completion of this module, students should be able to
CO1	Understand the Newtonian mechanics in the sports.
CO2	Apply the fundamentals of physics in sports.
CO3	Analyze the role of food and nutrition in sports
CO4	Evaluate the causality in sports.
CO5	Correlate with the fundamental mechanics for every action in sport.

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit-I Measurement Newton's laws of motion	Physical quantities, Standards and Units, International system of Units, Standards of time, length and mass, Precision and significant figures Newton's first law. Force, mass. Newton's second law. Newton's third law, Mass and weight. Applications of Newton's laws	7 Hrs	Analytical Skills
2	Unit-II Projectile motion Conservation laws	Shooting a falling target, Physics behind Shooting, Javelin throw and Discus throw. Conservation of linear momentum, collisions – elastic and inelastic. Angular momentum. (Physics behind Carom, Billiards, Racing)	8 Hrs	Analytical Skills
3	Unit-III Center of mass Gravitation	Physics behind Cycling, Rock climbing, Skating Origin, Newton's law of gravitation, Buoyancy and Physics behind swimming	15 Hrs	Analytical skills
4	Unit-IV Food and Nutrition Energy Physical exercises	Proteins, Vitamins, Fat, Blood pressure. Problems due to the deficiency of vitamins. Different forms of Energy, Conservation of mass-energy Walking, Jogging and Running, Weight management.	15 Hrs	Cognitive Skills

Books for Reference

- Armenti, A. (Ed.). (1996). *The physics of sports* (1992nd ed.). American Institute of Physics.
- Lewin, W. H. G. (2012). *For the love of physics: From the end of the rainbow to the edge of time - A journey through the wonders of physics*. Free Press.
- Lisa, M. (2015). *The physics of sports*. McGraw-Hill Professional.
- Mooney, L., & Rivers, A. (1996). *Sports Science*. Longman.
- Perelman, Y. (2010). *Physics for Entertainment*. Createspace Independent Publishing Platform.
- Perelman, Y. (2014a). *Mechanics for Entertainment*. Prodinova.
- Perelman, Y. (2014b). *Physics Everywhere*. Nook Press.
- Rea, S. (2023). *Sports Science: A complete introduction*. John Murray Press.
- Solway, A. (2010). *Sports Science*. Heinemann Library.

10. Spathopoulos, V. M. (2013). *An introduction to the physics of sports*. Createspace Independent Publishing Platform.

MATRIX AND SYLLABUS

For the Programme B.Sc. (Physics/Computer Science)

Physics

NEP Based Curriculum (2021 onwards)

IV Semester

NEP- Curriculum Framework for Approval

B.Sc. (Physics/Computer Science) - Matrix for IV Semester (w.e.f. 2022-23 onwards)

IV Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	S21KN 4.1/ S21HN4.1/ S21AE4.1	Language I (Kannada/Hindi/Additional English)	45	3	1	-	3
AECC	S21GE4.1	Language II (Generic English)	60	3	1	-	3
AECC	21SBC 4.1	Constitution of India	45	2	1	-	3
DSC4	S21PH4.1	Thermal Physics and Electronics (Theory)	60	4	-	-	4
DSC4	S21PH4.2	Practical Physics Lab- IV (Practical)	60	-	-	4	2
DSC4	S21CS4.1	Operating System - (Theory)	60	4	-	-	4
DSC4	S21CS4.2	Unix Lab – (Practical)	60	-	-	4	2
OE-4	S21OE/ B21OE	Nanotechnology / Web Designing	45	3	-	-	3
SEC-VB	21VBC 4.1	Sports	30	-	-	2	1
SEC-VB	21VBC 4.2	NCC/NSS/Cultural	30	-	-	2	1
Total							26

Note 1:

DSC - Discipline-Specific Course

DSE – Discipline-Specific Elective

SEC - VB Skill Enhancement Course -Value Based

SEC - SB Skill Enhancement Course -Skill Based

Note 2:

The DSE and Vocational courses are programme specific and may vary depending on programme offered.

Continuous Internal Assessment – Scheme of Evaluation

For Theory Courses

End Semester Examination: 60%

Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		
ii.Quiz / Presentation / Creating diagrams /charts / Classwork / Case study / Viva / Field work etc.	05		
iii. Classroom participation	05		
Total			40

For Practical Courses

End Semester Examination: 50%

Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)

Activities	Total Marks
1. Lab Performance	10
2. Observation record	05
3. Internal exam	10
Total	25

S21 EL 4.1: THERMAL PHYSICS AND ELECTRONICS**THEORY****Total Teaching Hours: 60****No. of Hours per Week: 4****(4 credits)**

CObj	Course Objectives
CObj_1	To understand the relation between temperature, pressure, energy and volume by thermodynamic laws
CObj_2	To know the concept of kinetic theory of gases, transport phenomenon and low temperature producing devices
CObj_3	To recognize the semiconductor devices, PN junction diode, transistor and digital electronics devices

CO	Course Outcomes
CO_1	Understand the thermodynamics and fundamentals of electronics
CO_2	Apply a) the concepts of thermal physics to various thermal systems b) The concepts semiconductor diodes, transistors and IC's for real time applications
CO_3	Analyze a) The thermal aspects of materials b) The material aspects of semiconducting materials
CO_4	Evaluate a) The parameters related to Entropy and Enthalpy of Thermal systems b) The parameters related to Bandgap, Carrier Concentration, Mobility of semiconductors.
CO_5	Design and work on exergetic factors of thermodynamic systems. To Fabricate Semiconducting materials leading towards optoelectronics/ thermoelectric materials.

CO-PO Mapping

[illegible]

Course Content

S. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit-I Basic Concepts and the Zeroth law of thermodynamics	Macroscopic and microscopic descriptions of a system; Thermal Equilibrium - Zeroth Law of Thermodynamics; Concept of temperature; Thermodynamic equilibrium; Thermodynamic coordinates - extensive and intensive; Equations of state; Various processes - PV indicator diagrams	12 Hrs	Cognitive/Analytical Skills
	First Law of Thermodynamics	The first law of Thermodynamics; Sign convention for heat and work; Derivation of equation of state $PV^\gamma = \text{Const}$; Work done in an isothermal and adiabatic process for an ideal gas; Internal energy as a state function; Application of the first law for (i) Cyclic Process (ii) Adiabatic Process (iii) Isochoric Process (iv) Isobaric Process and (v) Isothermal Process		Cognitive/Analytical Skills
	Second Law of Thermodynamics	Reversible and irreversible processes; Carnot Engine; Carnot Cycle and its efficiency (with derivation); Second law of thermodynamics (Kelvin's & Clausius' statements and their equivalence); Carnot theorem (proof); Refrigerator-Coefficient of Performance		Cognitive/Analytical Skills
	Entropy	The concept of entropy; Entropy of an ideal gas; Entropy - reversible process, Entropy irreversible process; Entropy and the second law; Clausius inequality; Principle of increase of entropy; Entropy change in (i) adiabatic process (ii) free expansion (iii) cyclic process (iv) isobaric process; TdS diagram of a Carnot cycle; Entropy and disorder		Cognitive/Analytical Skills
	Topics for self-study	Practical internal combustion engines – Otto and Diesel Cycles (qualitative treatment)	01 Hr	
	Activity No. 1	1. Estimate the COP of a refrigerator 2. Demonstrating entropy with ice 3. Demonstrating various thermodynamic processes	02 Hrs	

2	Unit-II Kinetic Theory of Gasses	Basic assumptions of kinetic theory, Derivation of perfect gas equation, mean free path, Degrees of freedom and principle of equipartition of energy, Derivation of Specific heats of an ideal gas, atomicity of gases.	12 Hrs	Cognitive/Analytical Skills
	Transport Phenomena	Viscosity and thermal conduction in gases (with derivation), Relation between coefficient of viscosity and coefficient of thermal conductivity of a gas		Cognitive/Analytical Skills
	Low Temperature Physics	Methods of producing low temperatures: (i) JouleThomson (Joule Kelvin / Throttling / Porous plug) experiment, Joule Thomson Coefficient, inversion]temperature.		Cognitive/Analytical Skills
	Topics for self-study	Adiabatic demagnetization – working and theory.	01 Hr	
	Activity No. 2	1. Demonstration of Joule-Kelvin experiment with balloon 2. Demonstration of Brownian motion 3. Demonstration of viscosity in air	02 Hrs	
3	Unit-III Semiconductor Physics	Distinction between metals, semiconductors and insulators based on band theory. Intrinsic semiconductors: concept of holes, effective mass, expression for carrier concentration (derivation for holes) and electrical conductivity; Extrinsic semiconductors: mention of expressions for carrier concentrations and conductivity. Formation of P-N junction, depletion region, Biased P-N junction, variation of width of the depletion region, drift and diffusion current, expression for diode current.	12 Hrs	Cognitive/Analytical Skills
	Special Diodes Transistors	Zener diode: characteristics and its use as a voltage regulator. Photo diodes, Solar cells and LED (principle, working and applications). Transistor: modes and characteristics (CE mode), DC Biasing , Load line analysis (Operating Point, Fixed Bias: Forward bias of Base – Emitter, collector – emitter loop, transistor saturation, Load line analysis		Cognitive/Analytical Skills / Employability
	Topics for self-study	Principle and working of LED	01 Hr	

	Activity No. 3	1. To identify a diode, a LED, a transistor, an IC, a resistor and a capacitor from a mixed collection of such items. 2. Design on/off indicator using LED to understand how LEDs emit light when they are forward biased. Ex: TV, Set top box, Notification indicators in smartphones. 3. Identification of emitter, base and collector of a transistor	02 Hrs	
4	Unit-IV Op-amps Digital Electronics	Block Diagram of an OPAMP, Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Open loop configuration - Limitations, Gain Bandwidth Product, Frequency Response, CMRR, Slew Rate and concept of Virtual Ground. Feedback concepts, Advantages of feedback, types of feedback, Expression for Gain; OPAMP as a feedback amplifier – Non – Inverting and Inverting amplifier, Modification of input and output impedances with feedback ; Voltage follower; Differential amplifier with feedback. Frequency response of Low pass, high pass and band pass filters (first order), inverting summing amplifier, ideal Differentiator, Integrator. Positive Feedback concept - oscillator operation –Barkhausen Criterion; Types of oscillator circuits (Qualitative); Number Systems: binary, octal, hexadecimal (inter conversions); Number codes : BCD, Gray Code (conversions to other systems); Signed Numbers; Arithmetic using Radix and Radix -1 complement. Logic gates and truth tables: OR gate, AND gate; Inverter (the NOT function); NAND and NOR; exclusive OR; exclusive NOR. Boolean laws and De Morgan's theorem, Realization of AND, OR, NOT using universal gates NAND and NOR.	12 Hrs	Cognitive/Analytical Skills Cognitive/Analytical Skills
	Topics for self-study	Phase shift oscillator and Wien bridge oscillator	01 Hr	
	Activity No. 4	1. UltraSonic Alarm for Visually Impaired 2. Construct integrator and differentiator circuit and verify the mathematical integration and differentiation problems 3. Digital Fan Speed Regulator 4. Sensitive Intruder Alarm Circuit 5. Infrared Motion Detector Circuit	02 Hrs	

Books for References:

1. Blake, A. G. E. (1969). *Thermal Physics*. Hodder & Stoughton.
2. Finn, C. B. P. (1993). *Thermal Physics* (2nd ed.). Nelson Thornes.

3. Fitzpatrick, R. (2020). Thermodynamics and statistical mechanics. World Scientific Publishing.
4. Lal, B., & Subrahmaniam, N. (2008). Heat thermodynamics and statistical physics. S Chand.
5. Luscombe, J. (2020). *Thermodynamics*. CRC Press.
6. Panat, P. V. (2008). Thermodynamics and statistical mechanics. Alpha Science International.
7. Saxena, A. K. (2015). An introduction to thermodynamics and statistical mechanics 2016 (2nd ed.). Alpha Science International.
8. Seeger, K. (2004). *Semiconductor physics: An introduction* (9th ed.). Springer.
9. Sekerka, R. F. (2015). *Thermal physics: Thermodynamics and statistical mechanics for scientists and engineers*. Elsevier Science Publishing.
10. Somanathan Nair, B., & Deepa, S. R. (2009). Basic electronics (includes solved problems & MCQs). I K International Publishing House

S21 PH 4.2: PHYSICS PRACTICAL – LAB IV**PRACTICAL****Total Teaching Hours: 60****No. of Hours per Week: 4****(2 credits)**

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1.	Module 1	Verification of Clausius - Clapeyron equation using pressure cooker	04 Hrs	Research/ Analytical/ Employable Skills
2.	Module 2	Thermal conductivity by Forbes method	04 Hrs	Research/ Analytical/ Employable Skills
3.	Module 3	Thermal behavior of a torch filament	04 Hrs	Research/ Analytical/ Employable Skills
4.	Module 4	Determination specific heat of solid by Newton's law of cooling	04 Hrs	Research/ Analytical/ Employable Skills
5.	Module 5	Calibration of Thermistor for Temperature measurement	04 Hrs	Research/ Analytical/ Employable Skills
6.	Module 6	Calibration of thermocouple for Temperature measurement	04 Hrs	Research/ Analytical/ Employable Skills
7.	Module 7	Determination of energy gap of thermistor	04 Hrs	Research/ Analytical/ Employable Skills
8.	Module 8	Regulated power supply (using Zener diode)	04 Hrs	Research/ Analytical/ Employable Skills
9.	Module 9	Determination of transistor h-parameters	04 Hrs	Research/ Analytical/ Employable Skills
10.	Module 10	Transistor as a switch	04 Hrs	Research/ Analytical/ Employable Skills
11.	Module 11	Op-amp inverting and non – inverting amplifier – ac or dc	04 Hrs	Research/ Analytical/ Employable Skills
12.	Module 12	Op-amp-summing amplifier – ac or dc	04 Hrs	Research/ Analytical/ Employable Skills
13.	Module 13	Op-amp as integrator and differentiator	04 Hrs	Research/ Analytical/ Employable Skills
14.	Module 14	To verify and design AND, OR, NOT and XOR gates using NAND gates	04 Hrs	Research/ Analytical/ Employable Skills
15.	Module 15	To convert a Boolean Expression into Logic Gate Circuit and assemble it using logic gate ICs.	04 Hrs	Research/ Analytical/ Employable Skills

***Minimum of EIGHT Experiments to be performed excluding demonstration experiments**

S21 OE 4.1: NANOTECHNOLOGY

THEORY

Total Teaching Hours: 45

No. of Hours per Week: 03

(3 credits)

CObj	Course Objective
CObj_1	To understand the fundamentals of nanotechnology.
CObj_2	To understand the various characterization techniques.
CObj_3	To gain insights on properties of Nanomaterials.

CO	Course outcomes
	After completion of this module, students should be able to
CO1	Understand the elementary aspects of nanomaterials.
CO2	Describe the properties of Nanomaterials.
CO3	Gain a brief idea on synthesis and characterization techniques for Nanomaterials.
CO4	Discuss on the various technological applications related to nanosciences.
CO5	Evaluate on the design aspects of materials for photonics and optical storage.

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit-I Introduction to nanomaterials	Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation. Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences	15 Hrs	Analytical Skills
2	Unit-II Synthesis and Characterization of nanostructure materials	Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots..	8 Hrs	Analytical skills
3	Unit-III Characterization of nanostructure materials	X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy	7 Hrs	Analytical skills
4	Unit-IV Properties and applications of nanomaterials	Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasiparticles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructures and nanostructures. Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage.	15 Hrs	Cognitive Skills

Books for Reference:

1. Bertino, M. F. (2022). Introduction to nanotechnology. World Scientific Publishing.
2. Boisseau, P., Houdy, P., & Lahmani, M. (2009). *Nanoscience: Nanobiotechnology and Nanobiology* (Patrick Boisseau, P. Houdy, & M. Lahmani, Eds.). Springer. <https://doi.org/10.1007/978-3-540-88633-4>
3. Booker, R., & Boysen, E. (2005). Nanotechnology For Dummies. Hungry Minds.
4. Dupas, C., & Lahmani, M. (Eds.). (2016). *Nanoscience: Nanotechnologies and nanophysics*. Springer.
5. Prasad, R., Kumar, V., & Kumar, M. (Eds.). (2018). *Nanotechnology: Food and environmental paradigm*. Springer.
6. Rathinasamy, A., Parameswari, C., & Ponnuswami, V. (2020). An introduction to nanotechnology. New India Publishing Agency- Nipa.
7. Ratner, M. A., & Ratner, D. (2002). Nanotechnology: A gentle introduction to the next big idea. Prentice Hall.
8. Sindhu, R. K., Chitkara, M., & Sandhu, I. S. (2021). *Nanotechnology: Principles and applications* (R. K. Sindhu, M. Chitkara, & I. S. Sandhu, Eds.). Jenny Stanford Publishing.
9. Singh, N., & Shukla, N. K. (2022). *Nanotechnology: Device design and applications* (S. Birla, N. Singh, and N. K. Shukla, Eds.). CRC Press.
10. Zubry, B. (2019). Introduction to Nanotechnology. Independently Published.

Department of Lifescience

MATRIX AND SYLLABUS

For the Programme B.Sc

Microbiology

B.Sc. (Basic and Honours Degree)

NEP Based Curriculum

PEOs	Programme Educational Objectives
PEO1	To provide in-depth knowledge on core areas of biosciences in a wide-ranging context which involves the use of evolved and practicable skills for a lifelong learning.
PEO2	To make students competent in the field of biosciences and allied areas by providing them hands-on experience using multifarious tools and techniques.
PEO3	To inculcate, facilitate, motivate and promote knowledge to critically evaluate, and apply technical skills to validate and solve environmental, industrial and agricultural issues through core bio-scientific interventions.
PEO4	To develop graduates with a strong professional ethics and moral duties combined with enhanced vocabulary that will positively affect their profession, community, society and nation at large.
PEO5	To equip students so as to take up a suitable career in industry or research or from a multidisciplinary environment from the imbibed communicative, linguistic, analytical and bioinstrumentation competencies.

PO	Programme Outcomes
PO1	After completion in the core areas of biosciences program students are able to get exposed to strong theoretical and practical background in fundamental concepts.
PO2	Develop an ability to solve, analyze and interpret data generated from laboratory work and research activities that help to develop critical understanding of the latest development in the core areas of biosciences.
PO3	Students are able to use skills required for the extraction, separation, and synthesis of a variety of biomolecules utilized in clinical diagnosis, pharmaceutical, industrial, agricultural sector or in research laboratories.
PO4	Apply knowledge and understandings of Biological Science and skills to new and unfamiliar contexts to identify, analyze problems, issues and seek solutions to real-life problem
PO5	Able to undertake hands on laboratory work and activities that help to develop practical knowledge and skills that are required for pursuing career in clinical diagnosis, drug design, vaccine development, pharmaceutical industry, teaching, research and environmental monitoring

PO_ID	Programme Specific Outcomes
PSO1	At the end of the programme the student will understand and be able to explain concepts related to the domains of study.
PSO2	Students will be able to explain various applications of Microbiology such as in Environmental, Medical, Industrial, Agricultural and Food Microbiology.
PSO3	Students will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, Microbial Genetics, Environmental, Medical, Industrial, Agricultural and Food Microbiology.
PSO4	Students will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired and Acquire the knowledge to design the protocol to solve environmental, industrial, agricultural issues through evolved expertise.
PSO5	Students will be able to execute a research project incorporating techniques of Basic and Advanced fields of study under supervision.

NEP-2020

Programme Name- B.Sc. Microbiology (w.e.f. 2021-22 Onwards)

I Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	LAN 1.1	Kannada / other languages	45	2	1	-	3
AECC	LAN 1.2	English / Hindi	45	2	1	-	3
DSC - 1T	S21 MB1.1	General Microbiology	60		4	-	4
DSC - 1P	S21 MB 1.2	General Microbiology	45		-	4	3
DSC		Other Discipline - Theory	60		4	-	4
DSC		Other Discipline - Lab	45		-	4	3
OE-1T	MBL301	Microbial Technology for Human Welfare	45		3	-	3
SEC-1T	MBL701	Microbiological Methods and Analytical Techniques	15		1		1
SEC-1P	MBL701	Microbiological Methods and Analytical Techniques	45			3	2
SEC-3	VBC 1.2	Physical Education for fitness - Yoga				1	1
Total							25
II Semester							
AECC	LAN 2.1	Kannada / Functional Kannada	45	2	1	-	3
AECC	LAN 2.2	English / Hindi	45	2	1	-	3
AECC	EVS 2.1	Environmental Studies	30		2	-	2
DSC- 2T	MBL 102	Microbial Biochemistry and Physiology	60		4		4
DSC-2P	MBL 102	Microbial Biochemistry and Physiology	45			3	2
DSC		Other Discipline - Theory	60		4		4
DSC		Other Discipline - Lab	45			3	2
OE- 2T	MBL 302	Environmental and Health Microbiology	60		4		3
SEC-4	VBC 2.1	NCC/NSS/Cultural	30			1	1
SEC-5	VBC 2.2	Physical Education - Sports	30			1	1
Total							25

III Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
AECC	LAN 3.1	Kannada / Hindi	45	2	1	-	3
AECC	LAN 3.2	English / Hindi	45	2	1	-	3
DSC7	S21 MB 3.1	Microbial diversity - Theory	60		4	-	4
DSC8	S21 MB 3.2	Microbial diversity – Lab	60		-	4	2
DSC9		Other Discipline - Theory	60	3	1	-	4
DSC10		Other Discipline - Lab	60	-	-	2	2
OEC	OEC MB 3.1	Cosmetic Microbiology	45	-	3	-	3
SEC-6	SBC 3.1	Artificial Intelligence / Power Business Intelligence / Cyber Security	30	-	1	1	2
SEC-7	VBC 3.1	Sports	30	-	-	1	1
SEC-8	VBC 3.2	NCC/NSS/R&R/Cultural	30	-	-	1	1
Total							25
IV Semester							
AECC	LAN 4.1	Kannada / Functional Kannada	45	2	1	-	3
AECC	LAN 4.2	English / Hindi	45	2	1	-	3
AECC	EVS 4.3	Constitution of India	30	2	-	-	2
DSC11	S21 MB 4.1	Microbial Enzymology and Metabolism	60	4	-	-	4
DSC12	S21 MB 4.2	Microbial Enzymology and Metabolism	60	-	-	4	2
DSC13		Other Discipline - Theory	60	3	1	-	4
DSC14		Other Discipline - Lab	60	-	-	2	2
OEC	OEC MB 4.1	Microbial Biotechnology	45	2	1	-	3
SEC-9	VBC 4.1	Sports	30	-	-	1	1
SEC-10	VBC 4.2	NCC/NSS/YRCS/Cultural	30	-	-	1	1
Total							25

AECC- Ability Enhancement Compulsory Courses

DSC- Discipline Specific Course

VBC- Value-based Course

SEC- Skill Enhancement Course

DSE- Discipline Specific Elective

OE- Open Elective

V Semester							
Code	Course Code	Course	Teaching Hours	Course Components			Credits
				L	T	P	
DSC15	S21 MB 5.1	Microbial Genetics and Molecular Biology – Theory	60		4	-	4
DSC16	S21 MB 5.2	Microbial Genetics and Molecular Biology – Lab	60		-	4	2
DSC17	S21 MB 5.3	Immunology and Medical Microbiology – Theory	60	3	1	-	4
DSC18	S21 MB 5.4	Immunology and Medical Microbiology - Lab	60	-	-	4	2
DSC19		Other Discipline Theory	60	-	3	-	4
DSC20		Other Discipline Lab	30	-	1	1	2
DSC21		Other Discipline Theory	30	-	-	1	4
DSC22		Other Discipline Lab	30	-	-	1	2
SEC-11		R-Programming – A practical approach	30	1	-	2	2
Total							26
VI Semester							
DSC23	S21 MB 6.1	Food and Dairy Microbiology- Theory	60	4	-	-	4
DSC24	S21 MB 6.2	Food and Dairy Microbiology- Lab	60	-	-	4	2
DSC25	S21 MB 6.3	Industrial Microbiology and Bioprocess Technology - Theory	60	3	1	-	4
DSC26	S21 MB 6.4	Industrial Microbiology and Bioprocess Technology - Lab	60	-	-	4	2
DSC27		Other Discipline Theory	60	3	1	-	4
DSC28		Other Discipline Lab	60	-	-	2	2
DSC29		Other Discipline Theory	60	3	1	-	4
DSC30		Other Discipline Lab	60	-	-	2	2
SEC-12		Professional Communication	45	2	-	1	2
Total							

DSC- Discipline-Specific Course

SEC- Skill Enhancement Course

**Continuous Internal Assessment – Scheme of Evaluation
for Theory Courses**

End Semester Examination: 60%
Continuous Internal Assessment: 40%

Activities (CIA: 40 Marks)	Proposed and Approved Scheme		Total Marks (40)
	IA-1	IA-2	
Session Test Maximum Marks	30	30	
1. Weightage (Marks)	10	10	20
2. Assignment (Marks)	20		20
i. Writing	10		10
ii.Snap Quiz / Oral Viva Voce (T)/Reflective Essay	05		05
iii. Classroom participation	05		05
Total			40

**Continuous Internal Assessment – Scheme of Evaluation
For Practical Courses**

End-Semester Examination: 50%
Continuous Internal Assessment: 50%

CIA (25 marks) + End Semester Exam (25 marks)	
Maximum Marks (Internal Assessment)	25
1. Weightage (Marks)	15
2. Record work (Marks)	05
3. Quiz/Presentation/creating diagrams/charts/Lab work/	05
Total (Marks)	25

SEMESTER – I

S21 MB 1.1 : General Microbiology

Total Teaching Hours: 60 Hours

No. of Hours / Week: 4

CObj_ID	Course Objectives
CObj_1	The objective of the course is to Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae.
CObj_2	To Master aseptic techniques and be able to identify the unknown microorganisms.
CObj_3	To understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes.

CO_ID	Course Outcomes
CO_1	Comprehend the various methods for identification of unknown microorganisms.
CO_2	Apply practical skills in microscopy handling and staining techniques.
CO_3	Understand about the various physical and chemical means of sterilization.
CO_4	Understand the microbial transport systems and the modes and mechanisms of energy conservation in microbial metabolism.
CO_5	Knowledge about the microbial nutrition - Autotrophy and heterotrophy mode of nutrition.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	*					*				
CO_2		*				*				
CO_3	*					*				
CO_4			*					*		
CO_5			*				*			

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Historical development, major contributions, origin of microorganisms and microscopy	Historical development of microbiology - Theory of spontaneous generation, Biogenesis and Abiogenesis. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Edward Jenner, Alexander Fleming, Martinus Beijerinck, Sergei Winogradsky, Elei Metchnikoff. Contributions of Indian scientists in the field of Microbiology. Fossil evidences of microorganisms. Origin of life, primitive cells and evolution of microorganisms. Microscopy- working principle, construction and operation of simple and compound microscopes.	15 Hours	Analytical Skills
2	Staining, sterilization and preservation of microorganisms	Staining: Nature of strains, principles, mechanism, methods and types of staining- Simple, Differential-Gram staining, Acid fast staining, staining of capsule, cell wall, endospore, inclusion bodies. Sterilization: Principles, types and techniques, Physical, chemical, radiation and mechanical Preservation of microorganisms: Methods of preservation of microorganism, slant culture, stab culture, soil culture mineral oil overlaying, glycerol preservation.	15 Hours	Cognitive Skills

3	Types, structure, organisation and reproduction of prokaryotic microorganisms	Overview of Prokaryotic Cell Structure: Size, shape, arrangement. Diagram of Prokaryotic cell organisation, cell wall structure and Gram staining, cell membrane; Bacterial and Archaeal, Cytoplasmic matrix- Cytoskeleton, ribosome, inclusion granules: Composition and function. Nuclear Materials – Bacterial chromosomes structure (its differences with the Eukaryotic chromosome); Extra Chromosomal materials. Components external to cell wall- capsule, slime, s-layer, pilli, fimbriae, flagella; structure, motility, chemotaxis. Bacterial Endospore - Examples of spore forming organisms, habitats, function, formation and germination. Reproduction in bacteria and bacterial cell cycle.	15 Hours	Transferrable Skills
4	Types, structure, organisation and reproduction of eukaryotic microorganisms	Overview of eukaryotic cell structure: General structure and types of cells; External cell coverings and cell membrane. Structure and function of Cytoplasmic matrix- cytoskeleton: Structure and function; single Membrane organelles- Endoplasmic reticulum, Golgi complex, Lysosomes, Vesicles and Ribosomes; Double Membrane organelles- Nucleus, Mitochondrion and Chloroplast: Structure and Functions; Peroxisomes; Organelles of motility- Structure and movement of flagella and cilia.	15 Hours	Transferrable Skills

Text

Practical: S21 MB1.2 General Microbiology

Total Teaching Hours: 45

No. of Hours / Week: 3

S. No	Module title	Total Number of Hours	Skills Developed
1	Microbiological laboratory standards and safety protocols	3	Analytical Skills
2	Standard aseptic conditions of Microbiological laboratory	3	
3	Operation and working principles of Light/Compound microscope.	3	
4	Working principles and operations of basic equipments of microbiological laboratory (Autoclave, Oven, Incubator, pH meter, Spectrophotometer, Colorimeter, vortex, magnetic stirrer etc).	3	
5	Applications of basic microbiological tools (Pipettes, Micropipette, Bunsen burner, Inoculation loop, Spreader).	3	
6	Demonstration and observations of microorganisms from natural sources under light microscope (Algae, Yeast and Protozoa).	3	
7	Demonstration of bacterial motility by hanging drop method.	3	
8	Simple staining.	3	
9	Differential staining - Gram staining.	3	
10	Acid fast staining.	3	
11	Structural staining - Flagella and Capsule.	3	
12	Bacterial endospore staining.	3	
13	Staining of reserved food materials.	3	
14	Staining of fungi by Lactophenol cotton blue.	3	
15	Negative staining.	3	

Books for References

- Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.

- Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
- A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
- Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
- Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.
- General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
- Microbiology- Concepts and Applications, Pelczar Jr,Chan, Krieg, International ed, McGraw Hill.
- Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
- Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.
- Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
- Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Pub..Sudbury, 835 pp.
- Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655 pp.
- Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pte. Ltd., San Francisco. 958pp.

Course 2 : Theory: OE 1T, MBL 301, Microbial Technology for Human Welfare

Total Teaching Hours : 42

No. of Hours / Week: 3

CObj_ID	Course Objectives
CObj_1	The major objective of the course is to teach the strategies to develop fermented products
CObj_2	To know the importance of biofertilizers, biopesticides and Mushroom Cultivation.
CObj_3	To understand the strategies for development of microbial strains, process optimization, large scale production and product recovery by industrially relevant microbial products

CO_ID	Course Outcomes
CO_1	Create the knowledge about the microbial food products and agencies
CO_2	Make use of microorganisms in the production of bio fertilizer and biopesticide
CO_3	Learn techniques in commercial cultivation of mushroom and biogas production
CO_4	Get hands-on knowledge of disinfection, sterilization, microbial assays, pharmacopoeia standards and antimicrobial agents.
CO_5	Determine the recovery and purification of microbial products such as microbial drugs and antibiotic therapy vaccine

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	*						*			
CO_2			*				*			
CO_3		*						*		
CO_4				*					*	
CO_5				*						*

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Food and Fermentation Microbial Technology	Fermented Foods – Types, Nutritional Values, Advantages and Health Benefits Prebiotics, Probiotics, Synbiotics and Nutraceutical Foods. Fermented Products – Alcoholic and nonalcoholic beverages, fermented dairy products, Fruit fermented drinks.	14 Hours	Transferrable and Cognitive Skills
2	Agriculture Microbial Technology	Microbial Fertilizers, Microbial Pesticides, Mushroom Cultivation, Biogas Production	14 Hours	Analytical Skills
3	Pharmaceutical Microbial Technology	Microbial Drugs – Types and Development of Drug Resistance Antibiotics – Types, Functions and Antibiotic Therapy Vaccines – Types, Properties, Functions and Schedules	14 Hours	Evaluation and Synthesis

Text Books / References

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
4. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.
6. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
7. Microbiology- Concepts and Applications, Pelczar Jr,Chan, Krieg, International ed, McGraw Hill.
8. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
9. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.
10. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey

846 pp.

11. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Pub..Sudbury, 835 pp.
12. Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655 pp.
13. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pte. Ltd., San Francisco. 958pp.
14. Stanbury, P. F., A. Whitaker and S. Hall, *Principles of fermentation technology*.Elsevier Science B.V., Amsterdam, Netherlands, Aditya Books (P) Ltd, New Delhi.
15. Subbarao, N. S., *Soil Microorganisms and Plant Growth*.Oxford and IBH publishing Company, New Delhi.

SEMESTER – II

S21 MB 2.1: Microbial Biochemistry and Physiology

Total Teaching Hours: 60 Hours

No. of Hours / Week: 4

CObj_ID	Course Objectives
CObj_1	The major objective of the course is to develop a clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation.
CObj_2	To provide the core principles and specialized knowledge of Carbohydrates, Lipids, Proteins, Vitamins, Porphyrin, cellular transport, law of thermodynamics, Lipid and Nitrogen metabolism.
CObj_3	To acquaint various life processes like photosynthesis, respiration, fermentation and anaerobic respiration.

CO_ID	Course Outcomes
CO_1	Evaluate the metabolic process of microbial system
CO_2	Apply the knowledge of biomolecules in biochemistry
CO_3	Analysis of the mechanism of bioenergetics and photosynthesis.
CO_4	Analysis of the mechanism of fermentation and anaerobic respiration.
CO_5	Able to predict the intermediate product which can be used for industrial production processes.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	*					*				
CO_2		*					*			
CO_3			*					*		
CO_4				*				*		
CO_5					*				*	*

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Biochemical Concepts	Basic Biochemical Concepts: Major elements of life and their primary characteristics, atomic bonds and molecules – bonding properties of carbon, chemical bonds- covalent and non covalent, Hydrogen bonds and Vander Waal Forces. Biological Solvents: Structure and properties of water molecule, Water as an universal solvent, polarity, hydrophilic and hydrophobic interactions, properties of water, Acids, bases, electrolytes, hydrogen ion concentration, pH, buffers and physiological buffer system, Handerson – Hasselbatch equation.	15 Hours	Transferrable Skills
2	Macromolecules – Types, Structure and Properties	Carbohydrates: Definition, classification, structure and properties. Amino acids and proteins: Definition, structure, classification and properties of amino acids, Structure and classification of proteins. Lipids and Fats: Definition, classification, structure, properties and importance of lipids. Porphyrins and Vitamins: Definition, structure, properties and importance of chlorophyll, cytochrome and hemoglobin.	15 Hours	Cognitive Skills

3	Microbial Physiology	Microbial Growth: Definition of growth, Mathematical expression, Growth curve, phases of growth, calculation of generation time and specific growth rate. Synchronous growth, Continuous growth (chemostat and turbidostat), Diauxic growth. Measurement of Growth: Direct Microscopic count - Haemocytometer; Viable count, Membrane filtration; Electronic Counting; Measurement of cell mass; Turbidity measurements- Nephelometer and spectrophotometer techniques; Measurements of cell constituents. Growth Yield (definition of terms). Influence of environmental factors on growth. Microbial growth in natural environments. viable non-culturable organisms. Quorum sensing. Microbial Nutrition: Microbial nutrients, Classification of organisms based on carbon source, energy source and electron source, Macro and micronutrients. Membrane Transport: Structure and organization of biological membranes, Types of Cellular transport, Passive, Facilitated, Active, Group Translocation, Membrane bound and binding protein transport system, Carrier models, Liposomes, Ion transduction Na K^+, ATPase.	15 Hours	Analytical Skills
4	Microbial Physiology- Bioenergetics, Microbial Respiration, Microbial Photosynthesis	Bioenergetics: Free energy, Enthalpy, Entropy, Classification of high energy compounds, Oxidation reduction reactions, equilibrium constant, Redox potential, Law of thermodynamics. Microbial Respiration: Respiratory electron transport chain in bacteria, oxidation – reduction reactions, protein translocation, oxidative and substrate level phosphorylation – inhibitors and mechanism, chemiosmotic coupling. Fermentation reactions (homo and hetero) Microbial Photosynthesis: Light reaction: Light harvesting pigments Photophosphorylation, CO_2 fixation	15 Hours	Transferrable Skills

		pathways: Calvin cycle, CODH pathway, Reductive TCA pathway.		

Books for Reference:

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
4. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed.2008,Pearson Education.
6. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillaneducation limited.
7. Microbiology- Concepts and Applications, Pelczar Jr,Chan, Krieg, International ed, McGraw Hill.
8. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
9. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.
10. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
11. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Pub..Sudbury, 835 pp.
12. Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655pp.
13. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9 th ed. Pearson Education Ptv. Ltd., San Francisco. 958pp.

S21 MB2.1: Microbial Biochemistry and Physiology

Total Teaching Hours: 45Hours

No. of Hours / Week: 3

Course Content

S. No	Module title	Number of Hours	Skills Developed
1	Preparation of Solution: Normal and Molar solutions	3	Analytical Skills
2	Calibration of pH meter and determination of pH of natural samples	3	
3	Preparation of Buffer Solutions	3	
4	Qualitative determination and identification of Carbohydrates	3	
5	Qualitative determination and identification of Proteins	3	
6	Qualitative determination and identification of Amino Acids	3	
7	Qualitative determination and identification of Fatty Acids	3	
8	Quantitative estimation of Reducing Sugar by DNS method	3	

9	Quantitative estimation of Proteins by Biuret and Lowry's method	3	
10	Determination of lipid saponification values of fats and iodine number of fatty acids	3	
11	Determination of bacterial growth by spectrophotometric method & calculation of generation time	3	
12	Effect of pH, temperature and Salt concentration on bacterial growth	3	
13	Effect of Salt concentration on bacterial growth	3	
14	Effect of Temperature on bacterial growth	3	
15	Demonstration of aerobic and anaerobic respiration in microbes	3	

Books for Reference:

1. Felix Franks, 1993; Protein Biotechnology, Humana Press, New Jersey.
2. Stryer L, 1995; Biochemistry, Freeman and Company, New York.
3. Voet & Voet, 1995; Biochemistry, John Wiley and Sons, New York.
4. Nelson and Cox, 2000; Lehninger Principles of Biochemistry, Elsevier Publ.
5. Harper, 1999; Biochemistry, McGraw Hill, New York.
6. Palmer T. (2001), Biochemistry, Biotechnology and Clinical Chemistry, Harwood Publication, Chichester.
7. Boyer R. (2002), Concepts in Biochemistry 2nd Edition, Brook/ Cole, Australia.
8. Moat A. G., Foster J.W. Spector. (2004), Microbial Physiology 4th Edition Panama Book Distributors.
9. Caldwell, D. R. (1995) – Microbial Physiology and Metabolism. Brown Publishers.
10. Lodish H, T. Baltimore, A. Berck B.L. Zipursky, P. Mastysdaire and J. Darnell. (2004) –
11. Molecular Cell Biology, Scientific American Books, Inc. Newyork.

Course 2 : Theory: OE 1T, OE- 2T, MBL 302, Environmental and Health Microbiology

Total Teaching Hours : 42

No. of Hours / Week: 3

CObj_ID	Course Objectives
CObj_1	The major objective of the course is to give hands- on experience on isolation and characterization of microbes environmental samples(air water and soil).
CObj_2	To analyze the microbial assessment of water and potability test for water Microbiology
CObj_3	To survey and surveillance of microbial infections.

CO_ID	Course Outcomes
CO_1	Analyze the characteristics of microbes in air, water and soil

CO_2	Understand the role of microorganisms in soil
CO_3	Know the microbial analysis of drinking water
CO_4	Aware about airborne, waterborne and foodborne microbial infections
CO_5	Elaborate the epidemiology of microbial infections, their detection and control.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		*				*				
CO_2			*				*			
CO_3			*				*			
CO_4				*					*	
CO_5			*							*

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Soil and Air Microbiology	Soil and Air as a major component of environment. Types, properties and uses of soil and air. Distribution of microorganisms in soil and air. Major types of beneficial microorganisms in soil. Major types of harmful microorganisms in soil.	14 Hours	Transferrable and Cognitive Skills
2	Water Microbiology	Water as a major component of environment. Types, properties and uses of water. Microorganisms of different water bodies. Standard qualities of drinking water	14 Hours	Analytical Skills

3	Health Microbiology	Public health hygiene and communicable diseases. Survey and surveillance of microbial infections. Airborne microbial infections, waterborne microbial infections, Food borne microbial infections. Epidemiology of microbial infections, their detection and control.	14 Hours	Evaluation and Synthesis

Text Books / References

1. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.
2. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.
3. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.
4. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.
5. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.
6. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.
7. Microbiology- Concepts and Applications, Pelczar Jr,Chan, Krieg, International ed, McGraw Hill.
8. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
9. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.
10. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
11. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Pub..Sudbury, 835 pp.
12. Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655 pp.
13. Tortora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pte. Ltd., San Francisco. 958pp.
14. Hurst, C. J., *Environment Microbiology*.ASM Press, Washington D.C.
15. Anathanarayana and Paniker, *Textbook of Microbiology*.Orient and Longman, New Delhi.

SEMESTER – III

Course code & Title: S21 MB 3.1 - Microbial diversity

Total Teaching Hours: 60

No. of Hours / Week: 4

CObj	Course Objectives

CObj_1	To expand knowledge on evolution and microbial diversity.
CObj_2	To understand bacterial taxonomy.
CObj_3	To study various classes of fungi in terms of their characteristic features.

CO	Course Outcomes
CO1	To demonstrate an understanding of bacterial, fungal, cyanobacterial, viral and rickettsial classifications, culturing, reproduction and significance.
CO2	The student will learn the techniques of studying bacterial growth curve and factors affecting growth curve.
CO3	The students will gain knowledge about role of macronutrients and micronutrients in growth of microbes.
CO4	Develop an understanding of physiological and molecular diversity within a community of microbes.
CO5	Understand the principles and methods behind studying and identifying cultured and uncultured microorganisms.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	*					*				
CO2		*				*				
CO3	*					*				
CO4			*					*		
CO5			*				*			

(Note: This table is already available, kindly copy and paste it here)

Course Content

S. No	Unit title	Course Content	Number of Hours	Skills Developed
Unit 1	Introduction to Microbial Diversity	Biodiversity- Microbial evolution and types of diversity. Introduction and overview of microbial taxonomy, taxonomic ranks of microorganisms and classification systems (Phenetic, phylogenetic and polyphasic classification). Major characteristics used in taxonomy: classical and molecular characteristics. Introduction and overview of Metagenomics and its applications. Ecological niche of microorganisms	09 Hours	Transferrable Skills

Unit 2	Prokaryotic Diversity	Introduction and overview of Bergey's Manual, habitat and distinguishing features of Gram negative & positive bacteria. Aerobic/Microaerophilic, Gram negative bacteria: Motile, helical & vibrioid, Non-motile curved bacteria, Rods and cocci, Facultative anaerobic Gram negative bacteria: Rods, curved and helical bacteria, Dissimilatory Sulfate reducers, Anaerobic Gram negative bacteria: Anaerobic cocci, Phototrophic bacteria (Anoxygenic and oxygenic phototrophs), Gram positive bacteria –General features of: Endospore forming rods and cocci, Asporogenous rods and cocci, Mycobacteria and Actinomycetes.	18 Hours	Cognitive Skills

Unit 3	Diversity of unusual prokaryotes	Bacteria with unusual morphology. Budding and appendaged bacteria. Sheathed bacteria, Mycoplasma, Bacteria with gliding motility, Rickettsia and Chlamydia, Archaeobacteria. Introduction and general features of Archaea. Types of Extremophilic Microorganisms: Overview of Thermophiles, Halophiles, Acidophiles, Alkalophiles, Barophiles and Methanogens. Importance of prokaryotic microorganism.	15 Hours	Cognitive Skills
Unit 4	Eukaryotic Diversity	FUNGI: General Characteristics, Occurrence, Structure, Reproduction (Penicillium and Aspergillus) & “Marine and endophytic fungi” ALGAE: General Characteristics, Occurrence Structure, Reproduction (Anabaena, Spirulina) & Economic importance of Algae. PROTOZOA: General Characteristics, Occurrence, Structure, Reproduction (Plasmodium, Leishmania). VIRUSES: General Characteristics, Occurrence, Structure, Reproduction (T4, TMV).	18 Hours	Cognitive & Analytical Skill

Books for Reference:

1. Prescott, M.J., Harley, J.P., Klein, D.A. (2002). Microbiology, 5th Edition. New York: WCBMcGrawHill publication.
2. Pelczar, M.J., Chan E.C.S., Krieg, N.R., Microbiology, 5 Edition. Tata McGrawHill Publication Co.Ltd. New Delhi.
3. Salle, S.J. (1974).Fundamental Principals of Bacteriology, Tata McGraw Hill Publication Co. Ltd.NewDelhi.
4. Purohit, S.S.,Microbiology-Fundamentals and Applications-6thEdition,Agrobios Publications, Delhi.
5. Stainer, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, R.K. General Microbiology, 5th Edition.MacMillan Press Ltd., London.
6. Powar and Daginawala, General Microbiology Vol-II. Himalaya Publishing House, Mumbai.
7. Modi, H.A. Elementary Microbiology -Vol –I & II, Akta Prakashan, Nadiyad.
8. Tortora, Funke & Case. Microbiology-An Introduction, 8 Edition, Pearson Education, Delhi.
9. Ronald M. Atlas, Richard Bartha, Microbial Ecology, Fundamentals and Applications 2nd Edition, Milan Publishing Co.

SEMESTER III

Practical: S21 MB 3.2 - Microbial diversity

Total Teaching Hours: 45

No. of Hours / Week: 3

CObj	Course Objectives
CObj_1	To know various culture media and their applications.
CObj_2	To understand, learn and gain skills of isolation, culturing and maintenance of pure culture.
CObj_3	To train the students in advance microbial techniques.

CO	Course Outcomes
CO1	Student will be able to use the knowledge for isolation and identification of microorganisms from variety of sources.
CO2	Student will be able to understand evolution of microbial species.
CO3	Student will be able to classify the microorganisms based on classical and advanced methods.
CO4	Student will be able to understand microbial diversity, species and estimation of various microbial species from different sources.
CO5	Students gain knowledge of analytical methods in biological sciences.

S. No	Module title	Total Number of Hours	Skills Developed
1	Preparation of media, Sterilization and dispensing of media into plates, tubes, slants (NA, NB, PDA MRBA)	3	Analytical Skills
2	Isolation of bacteria from soil and water: a) preparation of serial dilutions b) Spread plate and pour plate technique	3	
3	Study of colony characteristics of bacteria	3	
4	Identification of bacteria by IMViC test	6	
5	Cultivation of anaerobic microorganisms –Pyrogallol method.	3	
6	Isolation of yeast from fruits.	3	
7	Isolation of Bacteriophage from sewage.	3	
8	Isolation of Protozoa from soil.	3	
9	Isolation of Actinomycetes from soil.	3	
10	Staining of Actinomycetes.	3	
11	Fungal slide culture technique.	3	
12	Preparation of Wet mount technique - fungi and algae.	3	
13	Study of <i>E.coli</i> / <i>Staphylococcus</i> / <i>Penicillium</i> / <i>Aspergillus</i> .	3	
14	Study of <i>Anabaena</i> / <i>Spirogyra</i> / <i>Plasmodium</i> / <i>Leishmania</i> .	3	

References Books

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

3. Prescott's Microbiology. 5th Edition. McGraw Hill International.

4. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

Open Elective: OEC MB 3.1 Cosmetic Microbiology

Total Teaching Hours: 42

No. of Hours / Week: 3

CObj	Course Objectives
CObj_1	To know scope and applications of microorganisms producing cosmetic products.
CObj_2	To understand, learn and gain skills of isolation, culturing and maintenance of microbial cultures producing cosmetic products.
CObj_3	To train students in techniques of cosmetic and anti- microbial importance.

CO	Course Outcomes
CO1	Student will be able to use the knowledge for isolation and identification of cosmetic products from microorganisms.
CO2	Student will be able to understand the microbial quality control measures used in cosmetology
CO3	Student will be able to relate and synthesize microbial products used in cosmetics
CO4	Student will be able to understand the mode of action of natural cosmetic products
CO5	Students gain knowledge of analytical methods in cosmetic sciences.

S. No	Unit title	Course Content	Number of Hours	Skills Developed

Unit 1	Microorganisms and cosmetics	Scope of cosmetic microbiology, - Role of microbes in cosmetics preparation. Microorganisms in cosmetics – Preservation of cosmetics – Mechanisms of action of Cosmetic preservatives –	14 Hours	Transferrable Skills and Analytical Skills

		Enzymes in cosmetics. Quality control measures in cosmetics preparation – Microbial resistance – Critical Control point.		
Unit 2	Antimicrobial properties of natural cosmetic products	Honey, Garlic, Neem, Turmeric, Aloe vera, tea tree, Tulsi, Green Tea, Chamomile, Neem, Rosemary, Sandalwood, lemon grass, avocado and shea butter	14 Hours	Cognitive Skills
Unit 3	Microbial Products in Cosmetics	Lactic acid, Astaxanthin, β -carrageenan, α - cyclodextrin, Ceramide, Hyaluronic acid, Surfactin – C, β - Carotene and Glutathione	14 Hours	Cognitive Skills

References Books:

Donald S. Orth. 2010. Insights into Cosmetic Microbiology. 1st Edition., Allured Pub Corp.

Donald S. Orth, Stephen P. Denyer, Jon J Kabara, S.K. Tan. 2006. Cosmetic and Drug Microbiology. 1st Edition., CRC Press.

Philip, A.G. 2006. Cosmetic Microbiology. A Practical approach. 2nd Edition., Taylor & Francis group.

Daniel K. Brannan. 1997, Cosmetic Microbiology: A practical handbook, CRC Press.

SEMESTER – IV

S21 MB 4.1: Microbial Enzymology and Metabolism

Total Teaching Hours: 60

No. of Hours / Week: 4

CObj	Course Objectives
CObj_1	To understand the mechanism of enzyme kinetics
CObj_2	To develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation
CObj_3	To provide the core principles and specialized knowledge of Carbohydrates, Lipids, Proteins metabolism
CO	Course Outcomes
CO1	The students will be able to make qualitative and quantitative description of the basic enzymatic phenomena and processes
CO2	Understand the importance of mathematical and statistical methods required for the description, interpretation of enzymatic phenomena and processes
CO3	Knows the basic concepts, terms and techniques used in enzymology
CO4	Understand the regulation of biochemical pathway and possible process modifications for improved control over microorganisms for microbial product synthesis.
CO5	Concepts of lipid and nitrogen metabolism, oxidation of fatty acid

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	*						*			
CO2			*				*			
CO3		*						*		
CO4				*					*	
CO5				*						*

S. No	Module title	Module Content	Number of Hours	Skills Developed
Unit-1	Basic concept in Enzymology	Terms involved in enzymology, Nomenclature of enzymes, Classification of enzymes, properties. Coenzyme- Structure and function, TPP, NAD, NADP, FAD, FMN. Enzyme specificity, Mechanism of	10 Hours	Cognitive & Analytical Skills
		enzyme action- Lock and Key model, Induced fit model.		
Unit 2	Enzyme Kinetics	Importance of kinetics, Concept of steady state and rapid Equilibrium kinetics. Factor affecting enzyme activity, temperature, pH, Concentration, Substrate. Derivation of Michaelis – Menton equation, LBplots. Unit of enzyme activity, Enzyme turnover number. Enzyme Regulation - Allosteric and Feed back inhibition. Reversible (competitive, noncompetitive and uncompetitive) and irreversible inhibitions. Method of purification of enzymes - Ammonium sulphate precipitation, dialysis, chromatography, solvent precipitation.	20 Hrs	Analytical Skills

Unit 3	Metabolism of Carbohydrates	Introduction to Metabolism, Catabolism, Anabolism, Amphibolic pathways, Intermediary metabolism, Types of Metabolic regulations. Break down of complex sugars, Glycolysis, TCA cycle and ATP production. Alternative pathways: HMP pathway, Gluconeogenesis, Glucuronic acid pathway and ED Pathway Energy production: Substrate level phosphorylation. Electron transport chain, Oxidative phosphorylation - Structure of ATPase complex, Chemiosmotic theory. Mitochondrial shuttle system.	15 Hrs	Transferrable Skills
Unit 4	Lipid, Protein & Nucleic acid Metabolism	Fatty acid oxidation – β oxidation. Biosynthesis of saturated and unsaturated fatty acids. Metabolism of Cholesterol, Triglycerides and ergosterols. General aspects of amino acid metabolism; Deamination, Transamination and Decarboxylation, Urea cycle. Biosynthesis of purine and	15 Hrs	Cognitive Skills
		pyrimidine nucleotides <i>denovo</i> and salvage pathway. Biosynthesis of Peptidoglycan.		

REFERENCES

1. Fundamentals of Biochemistry, J.L. Jain, S.Chand publications, 2004.
2. Lehninger's Principles of Biochemistry (2000) by Nelson, David I. and Cox, M.M. Macmillan / Worth, NY.
3. Harper's Biochemistry Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, 24th edition, Prentice Hall International. Inc.
4. Principles of Biochemistry, Geoffrey L. Zubay, 3rd edition William W. Parson, Dennis E. Vance, W.C. Brown Publishers, 1995.

5. Principles of Biochemistry, David L. Nelson, Michael M.Cox, Lehninger, 4th edition, W.H. Freeman and company.

6. Biochemistry, Lubert Stryer, 4th edition, W.H. Freeman & Co, 1995. 7.Fundamentals of Biochemistry (1999) by Donald Voet, Judith G.Voet and Charlotte WPratt, John Wiley & Sons, NY.

SEMESTER IV

Practical: S21 MB 4.2 Microbial Enzymology and Metabolism

Total Teaching Hours: 45

No. of Hours / Week: 3

CObj	Course Objectives
CObj _1	To learn and understand the fundamentals of cellular metabolism of carbohydrates, lipids, aminoacids, and nucleic acids
CObj _2	To learn the detection and estimation of biomolecules
CObj _3	To Study of enzyme kinetics, Km and Vmax

CO	Course Outcomes
CO1	The student will be able to learn Carbohydrate catabolism by fermentation
CO2	Learn about enzyme kinetics, effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions
CO3	The students will learn to perform assay of clinically important enzyme
CO4	Learn different immobilization techniques and Industrial scope of enzymes
CO5	The expertise gained by the student in this course can be useful in food industries ,pharma industries, clinical and microbiological labs

S.No	Module title	Total Number of Hours	Skills Developed
1	Carbohydrates Fermentation - Glucose, Fructose, Sucrose, Mannitol	3	Analytical Skills
2	Detection of proteins using spectrophotometry	3	
3	Estimation of DNA & RNA	6	
4	Determination of enzyme (Amylase/Protease/Invertase) activity at varied pH	3	
5	Determination of optimum temperature for enzyme activity.	3	
6	Isolation of lipolytic microbes from soil-plate method	3	
7	Separation of amino acids by paper chromatography.	6	
8	Immobilization techniques.	3	
9	Enzyme Assay of Amylase	3	
10	Study of protein secondary and tertiary structures with the help of models	3	
11	Study of enzyme kinetics, Km and Vmax	3	
12	Demonstration of and thin layer chromatography	6	

REFERENCE BOOKS:

1. Principles & Techniques Of Practical Biochemistry 5Th Edition. Keith Wilson, ISBN-10 0521799651, Academic Foundation
2. An Introduction to Practical Biochemistry | 3rd Edition. David Plummer. McGraw

Hill Education; 3rd edition, ISBN-13 : 978-0070994874. Publisher : McGraw Hill Education

3. Richard J. Simpson. (2005). Proteins and Proteomics: A Laboratory Manual. I.K. International Publishing House Ltd. New Delhi.
4. Alcamo, I.E. (2001). Laboratory fundamentals of Microbiology, Jones and Barlett.
5. Fundamentals of Biochemistry, J.L. Jain, S.Chand publications, 2004.
6. Lehninger's Principles of Biochemistry (2000) by Nelson, David I. and Cox, M.M. Macmillan / Worth, NY.
7. Harper's Biochemistry Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, 24th edition, Prentice Hall International. Inc.

OE MB 4.1: Microbial Biotechnology

Total Teaching Hours : 42

No. of Hours / Week: 3

CObj_ID	Course Objectives
CObj_1	To upraise the components and units of a bioprocess industry
CObj_2	To impart the knowledge on the various industrial bioproducts
CObj_3	To give an insight on the role of microorganism in food industries
CO_ID	Course Outcomes
CO_1	Students understand the microbial biotechnology through handling the microorganisms

CO_2	Creates knowledge about the Production of various industrial bioproducts from industrially relevant microbes in students
CO_3	Potential applications of bioprocessing in various fields involving microorganism are understood by students
CO_4	Students can explain the importance of different types of food in balanced diet and planning
CO_5	Students will be able to evaluate the microbial food products and their role in processing and consumption

Course Content

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Fermentation Technology	Introduction to Fermentation Technology, Isolation, Preservation and Maintenance of Industrial Microorganisms. Media for industrial fermentation; Sterilization. Fermentor part and components. Recovery of Fermentation products.	14 Hours	Transferrable and Cognitive Skills
2	Microbial Bioproducts	Microbial synthesis of organic acids (Citric acid), alcohol (ethanol), antibiotics production (penicillin), vitamin(B12) and amino acid(Tryptophan), beverage (wine), food flavourants and pigment.	14 Hours	Analytical Skills and Cognitive Skills
3	Food Technology	Microbes as direct food (Single cell protein and Baker's yeast). General principles in manufacture of Cheese and Yogurt; Fermented foods: Soy sauce and Miso; Fermented vegetables: Sauerkraut and pickles. Fermented sausages. Food processing aids through biotechnology.	14 Hours	Transferrable and Analytical Skills

Text Books / References

1. Peter F Stanbury, Allan Whitaker, Steohen J Hall, 2013, Principles of Fermentation Technology, Elsevier Science Ltd, Second Edition.
2. Arnold. L. Demain and Julian Davies, Manual of Industrial Microbiology and Biotechnology, III edition, ASM press, Washington DC, 2010.

3. Hui YH, Meunier-Goddick, Hansen AS, Josephsen J, Nip W, Stanfield PS and Toldrih F. 2011. Handbook of food & beverage fermentation technology. CRC Press.
4. Prescott and Dunn's. Industrial Microbiology, by Gerald Reed. 1983, 4th Edition, AVI Publishing Company Inc. Conneticut.
5. Frazier, Food Microbiology- 1987, Tata McGraw-Hill Education.
6. Adams M.R. and Moss M.O (2000) Food Microbiology. Royal Publishing Corporation.

SEMESTER V

Content of Course 5: Theory: S21 MB 5.1 – Microbial Genetics and Molecular Biology

CObj_ID	Course Objectives
CObj_1	The major objective of the course is to to understand how microorganisms can be used as tools to understand various biological phenomena.
CObj_2	To acquaint types of mutation, gene regulation and transposable element
CObj_3	To acquire in-depth study on structure and organization of chromosome, replication process, transcription process, translation process and mutagenesis.

CO_ID	Course Outcomes
CO_1	Outline the structure of the prokaryotic and eukaryotic genome and discuss the types mutation and DNA repair mechanism.
CO_2	Analyze the genetic recombination and the overview of bacterial genetic maps and interpret the gene transfer mechanism in bacteria.
CO_3	Understand the central dogma and regulation of gene expression.
CO_4	Evaluate the operon model and molecular techniques with different samples.
CO_5	Apply the recombinant DNA technology in the agricultural, medical and industrial and environmental field.

S. No	Module title	Module Content	Number of Hours	Skills Developed
Unit 1	Microbe Genome Organization and Mutation	Prokaryotic Genome - <i>E. coli</i> genome. Eukaryotic Genome – <i>Saccharomyces</i> , Structure of chromatin, types of histones, histone modifications- methylation, acetylation, phosphorylation and function of chromatin, karyotype and idiogram, Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Transposon mutagenesis, site directed mutagenesis; environmental mutagenesis; Ames test.	15 hours	Analytical Skills
Unit 2	Plasmids and Gene Transfer Mechanism	Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids and Cosmids. Lysogeny and lytic cycle in bacteriophages, Life cycle and their uses in microbial genetics. Lytic phages-T7 and T4, Lysogenic phages- Lamda, M13 and ΦX174. Transformation, Conjugation, Transduction and transfection mechanism and its applications.	15 hours	Transferable skills
Unit 3	DNA damage, repair mechanism and replication	Central dogma. Structure of DNA, DNA polymorphism (A, B, Z DNA). Structure and function of different types of RNA. Types of DNA damage –deamination, oxidative damage, alkylation, pyrimidine dimers; Repair pathways – photo-reactivation, excision repair, post replication repair, SOS repair, methyl directed mismatch repair, very short patch repair. DNA replication in prokaryotes and viruses (Rolling circle and M13 bacteriophages replication), Origin of replication, replication fork- leading and lagging strands, enzymes involved at different steps of replication.	15 hours	Cognitive skills
Unit 4	Transcription, Translation and regulation of gene expression	Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases. Initiation, elongation and termination. Polycistronic and monocistronic mRNA, post transcriptional	15 hours	Analytical skills

		modifications. Transcription in Eukaryotes Ribosome assembly, initiation factors and their regulation, formation of initiation complex, Initiation, elongation and termination of polypeptide chain, elongation factors and releasing factors, translational proof-reading, post-translational modification. Lac Operon concept, Tryptophan operon. Regulation of prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression. Transcriptional and post transcriptional gene silencing-RNAi pathway (siRNA and miRNA)		

References:

1. Robert F. Weaver. (2009). Molecular Biology, 4th Edition. McGraw-Hill.
2. B.B. Buchanan. (2007). Biochemistry and Molecular Biology of Plants. I.K. International Publishing House Ltd. New Delhi.
3. Chris. R. Callbine., Hallace. R. Bin. F. Leus. and Andrew, A. Travers. (2006) Understanding DNA (3rd Ed.). Academic Press.
4. Raymond F Gesteland. (2006). The RNA World, Third Edition. I.K. International Publishing House.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, (2002). Molecular Biology of the Cell. Garland Pub. 4th Ed.
6. Twyman R.M., (1998). Advanced Molecular Biology. 1st Ed. Viva Books Pvt Ltd., New Delhi.
7. Joset F., Michel G, (1993). Prokaryotic Genetics, Genome Organization, Transfer and Plasticity, Boston. Blackwell.
8. Adams R.L.P, (1992). DNA Replication. IPL Oxford, England.
9. Streips and Yasbin, (1991). Modern Microbial Genetics. Wiley Ltd.
10. Thomas D. Brock, (1990). The Emergence of Bacterial Genetics, CSH lab Press.
11. Mark Ptashne, (1986). A Genetic Switch. Gene Control and Phage λ . Cell Press

SEMESTER V

Practical: S21 MB 5.2 – Microbial Genetics and Molecular Biology

Total Teaching Hours: 45

No. of Hours / Week: 3

S. No	Module title	Total Number of Hours	Skills Developed
1	Demonstration of streaking plate using toothpicks	3	Analytical skills
2	Preparation of Master and Replica Plates	3	
3	Effect of UV radiation on microorganisms	3	
4	Isolation of streptomycin-resistant strain of bacteria by gradient plate method	3	
5	Isolation of genomic DNA from microorganisms	6	

	(Bacteria/Fungi/Algae) and separation by Gel electrophoresis		
6	Isolation of plasmid DNA from microorganisms (Bacteria/Fungi/Algae) and separation by Gel electrophoresis	6	
7	Demonstration of bacterial transformation by CaCl ₂ method	3	
8	Demonstration of Transduction in <i>E.coli</i>	3	
9	Ampicillin selection for the enrichment of auxotroph	3	
10	Isolation of Spheroplast and Protoplast from Bacteria	3	
11	Charts on genetic engineering – pBR 322, pUC 18 and 19, SV 40, Bacteriophages – Lambda, Gene cloning	3	
12	Restriction digestion of DNA	3	
13	Polymerase Chain reaction	3	

References

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
7. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
8. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
9. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
10. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
11. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
12. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
13. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers
14. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
15. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

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SEMESTER V

Content of Course 6: Theory: S21 MB 5.3 – Immunology and Medical Microbiology

	Objective
CObj_1	To develop students' understanding of medical microbiology with hand on experience in the isolation and identification of the microorganisms from different clinical samples
CObj_2	To strengthen the knowledge of students in immunology and immunodiagnostics
CObj_3	To explain the various pathological events during the progression of an infectious disease caused by common pathogenic microorganisms

	Outcome
CO1	Illustrate the cells, tissues, organs of the immune system and types of immunity.
CO2	Understand the properties, functions of Antigens, antibodies and complement system and antigen and antibody reactions
CO3	Analyze the symptoms, pathogenesis, laboratory diagnosis and control measures of bacterial, fungal, viral and protozoa
CO4	Elaborate the antimicrobial agents to handle microorganism in risk groups
CO5	Apply the immuno and molecular techniques for the diagnosis of disease.

S. No	Module title	Module Content	Number of Hours	Skills Developed
Unit 1	Immunobiology	Innate immunity & immunological barriers; The cellular players: Phagocytic cells, Lymphocytic cells, DCs; The innate immune response: Inflammation, Acute Phase Reaction; Molecular basis of diversity of immunoglobulin molecules; Autoimmunity and transplantation; Manipulations of the immune response.	15 Hours	Cognitive Skills
Unit 2	Histochemical and Immunotechniques And Public Health Management	Antibody generation; Detection of molecules using ELISA; RIA; western blot; immunoprecipitation; flow cytometry and immunofluorescence microscopy; detection of molecules in living cells; in situ localization by techniques such as FISH and GISH. Frequency measures; morbidity frequency measures; mortality frequency measures; natality (birth) measures; measures of	15 Hours	Analytical Skills

		association; measures of public health impact. Public health surveillance: Purpose and characteristics; identifying health problems for surveillance; collecting data for surveillance; analyzing and interpreting data; disseminating data and interpretation; evaluating and improving surveillance.		
Unit 3	Normal microflora of the human body and host pathogen interaction And Antimicrobial agents: General characteristics and mode of action	Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS. Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1	15 Hours	Cognitive Skills
Unit 4	Medical Microbiology	Detailed Study of following infections including Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab diagnosis, Prophylaxis, and Treatment: - Polio, Herpes, Hepatitis, Dengue, Influenza, Chikungunya and Corona, <i>Streptococcus pyogenes</i> , <i>Staphylococcus aureus</i> , <i>Mycobacterium tuberculosis</i> , <i>Salmonella typhi</i> , <i>Vibrio cholera</i> , <i>Clostridium tetani</i> , Malaria, <i>Leishmania</i> , Epidermophyton, <i>Candida</i>	15 Hours	Transferable Skills

References Books

1. Abul K. Abbas, Andrew K. Lightman, Jordan S. Pober. (1998). Cellular and Molecular Immunology. Saunders College Pub.
2. Connie R Mahon. (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
3. Credric, A. Mims. (2004) Medical microbiology. (3rd Ed.). Moshy Inc.

4. Frank, Steven A. (2002). Immunology and Evolution of Infectious Disease. Princeton University Press.
5. Fritz H. Kayser. (2005). Medical microbiology. ThiemeVerlag.
6. Jenson, Wright, Robinson. (1997), Microbiology for the Health Sciences 4th edition, Prentice hall.
7. Klaus D. Elgert (1996). Immunology-understanding of the Immune system. Wiley-Liss. NY.
8. Kuby, J. (2006). Immunology 6th Edition. WH. Freeman and Company, New York.
9. Leslic Collier, John Oxford. (2000) Human virology: a textbook for students of medicine, dentistry & microbiology (2nd Ed.) Oxford University Press.
10. Mackie and McCarthey (1996), Medical microbiology vol 1, Microbial infection. vol 2, practical medical microbiology, Churchill Livingstone,
11. Marjorie Cowan, Kathleen Park Talaro. (2009). Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall, Anderson. (1998). Microbiology -A Human Perspective, 2nd edition, McGraw- Hill
13. Roitt, I.M. (2006). Essentials of Immunology. 7th Edition. Elsevier.
14. Topley & Wilson's (1995). Textbook on Principles of Bacteriology, Virology and Immunology, IX Edition (5 volumes) Edward Arnold, London.
15. Wadher, and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
16. Warren Levinson (2000) Medical Microbiology and Immunology: Examination and Board Review. 8th ed. McGraw Hill.

SEMESTER V

Practical: S21 MB 5.4 – Immunology and Medical Microbiology

Total Teaching Hours: 45

No. of Hours / Week: 3

S. No	Module title	Total Number of Hours	Skills Developed
1	Isolation and identification of clinically important microbes from clinical specimens: (throat swab, sputum, nasal swab, urine, blood, lesions)	9 Hours	Analytical Skills
2	Isolation and identification of dermatomycosis by wet mount	3 Hours	
3	Identification of pathogens on selective, differential and enrichment media	3 Hours	
4	Different staining techniques a) Ziehl-Neelsen method of AFB b) Leishman's staining c) Giemsa staining	3 Hours	

5	Special staining methods to demonstrate granules, capsules and endospores	3 Hours	
6	Determination of MIC by tube method	3 Hours	
7	Purification of antigens (bacterial, fungal)	3 Hours	
8	Induction and Purification of antibodies	3 Hours	
9	Precipitation reaction on gel (ODD, SRID)	3 Hours	
10	Agglutinations (slide) - WIDAL, RPR	3 Hours	
11	Blood grouping and Rh typing	3 Hours	
12	Determination of bactericidal activity of goat serum	3 Hours	
13	ELISA (dot)	3 Hours	

References Books

1. Credric, A. Mims. (2004) Medical microbiology. (3rd Ed.). Moshy Inc.
2. James H. Jorgensen, Manual of Clinical Microbiology, 11th 2015, ASM Press
3. Mackie and McCartney (1996), Medical microbiology vol 1, Microbial infection. vol 2, practical medical microbiology, Churchil Livingstone.
4. Patrick R. Murray, Manual of Clinical Microbiology: 1 & 2 Volume 2007, ASM Press
5. Wadher, and Bhoosreddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher

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As per NEP 2020 guidelines

SEMESTER VI

Content of Course 7: Theory: S21 MB 6.1 – Food and Dairy Microbiology

	Objective
CObj_1	To understand microbiology of fermented food commodities.
CObj_2	To describe the role of microorganisms in food spoilage and principles of food preservation.
CObj_3	To analyze the microbiological quality control, and quality schemes.

	Outcome
CO1	Analyze the character of microbes in food spoilage using various examination and evaluation of preservation techniques for food.
CO2	Evaluate the microbiology of fermented milk products.
CO3	Discuss the government regulatory practices and policies in food quality and safety.
CO4	Apply the techniques to assay the food borne infections and intoxication.
CO5	Create the knowledge about the microbial food products and determine the role of various agencies in food sanitation and control.

S. No	Module title	Module Content	Number of Hours	Skills Developed
Unit 1	History and Food as substrate for microorganisms	History, Development and Scope of food microbiology; Concept of food and nutrients; Physiochemical properties of food; Importance and types of microorganisms in food (bacteria, mold and yeast). Sources of contamination of microorganisms in foods, Factors influencing microbial growth in food - Extrinsic and intrinsic factors. Applications of food microbiology: Beneficial uses of microorganisms in food, Intestinal beneficial bacteria, Probiotics, Prebiotics –Definition, functional foods, types, importance and economic values, Recombinant foods, Biosensors in food industry	15	Cognitive Skills
Unit 2	Food-borne infections and spoilage	Food borne diseases. Bacterial and nonbacterial - with examples of infective and toxic types - <i>Brucella</i> , <i>Bacillus</i> , <i>Clostridium</i> , <i>Escherichia</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Staphylococcus</i> , <i>Vibrio</i> , <i>Yersinia</i> , Nematodes, protozoa, algae, fungi and viruses. Foodborne outbreaks-laboratory testing procedures. Spoilage of fruits, vegetables, meat, poultry, fish and seafood. Cereals, sugar products, vegetables, fruits, meat and meat products, Fish and sea foods-poultry-spoilage of Canned foods. Detection of spoilage and characterization	15	Transferrable Skills
Unit 3	Dairy microbiology and Dairy products	Sources of microorganisms in milk – Classification of microbes – Biochemical types, characteristics and pathology. Microflora of milk and milk products, Fermented milk and milk products: Sauerkraut, Buttermilk, Cream, Yogurt, Cheese, Kefir and Kumis. Microbes involved in fermentation: Starter lactic acid cultures. Spoilage of milk and milk products. Milk borne diseases –bacterial (Mastitis, Anthrax, Brucellosis, Diphtheria, Tetanus) and viral diseases (Food and mouth disease, Rinderpest, Cowpox, and Virus diarrhea) in cattle's – Control measures.	15	Analytical Skills
Unit 4	Preservation and sanitation	Principles and methods of food preservation-Physical (temperature, irradiation, drying, canning, processing for heat treatment) Chemical (Organic acids, food additives. Class I and Class II preservatives), Biopreservation (Lactic acid bacteria). Food Packaging- Types of packaging materials, properties and benefits. Good Hygiene Practices, Sanitation in	15	Transferrable Skills

		manufacture and retail trade; food control agencies and their regulation, hazard analysis and critical control points (HACCP); GMP, plant sanitation – employees' health standard, waste treatment, disposal, quality control. Sanitation of dairy processing plants, food control agencies and their regulations. Recent trends and development in food technologies in India		

REFERENCES:

1. Frazier WC and Westhoff DC. (1992). *Food Microbiology*. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
2. Adams MR and Moss MO. (1995). *Food Microbiology*. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
3. Banwart JM. (1987). *Basic Food Microbiology*. 1st edition. CBS Publishers and Distributors, Delhi, India
4. Dubey. R.C. and Maheswari. D.K. A Textbook of Microbiology, 1999. 1 ed.
5. Fundamentals of Dairy Microbiology by Prajapati.
6. James. M. Jay, 1992, Modern food microbiology 4ed.
7. B. C. Hobbs and D. Roberts. 1993. Food Poisoning and Food Hygiene. Edwards Arnold. London.
8. A. E. Yousef and C. Caristrom. 2003. Food Microbioigy - A Laboratory manual, Wiley Interscience.
9. J. M, Jay. 2000. Modern Food Microbiology. Aspen Publishers.
10. Robinson, R.K. 1990. Dairy Microbiology. Elsevier Applied Science. London

SEMESTER VI

Practical: S21 MB 6.2 – Food and Dairy Microbiology

Total Teaching Hours: 45

No. of Hours / Week: 3

S. No	Module title	Total Number of Hours	Skills Developed
1	Isolation and identification of microbes from fermented and stored foods	3	Analytical skills
2	Isolation and identification of microbes from infected fruits and vegetables	3	
3	Isolation of lipolytic organism from any spoiled dairy products	3	
4	Detection of number of bacteria in milk by SPC	3	
5	Detection of number of bacteria in milk by breed count	3	
6	Determination of quality of a milk sample by methylene blue reduction test	3	
7	Determination of quality of a milk sample by resazurin test	3	
8	Estimation of Fat content in milk by Gerber's method	3	

9	Estimation of Lactose in milk	3	
10	Estimation of Lactic acid in milk.	3	
11	Production of yogurt	3	
12	Role of yeasts in bread making	3	
13	Production and detection of Aflatoxins from fungi by thin layer chromatography (TLC)	3	
14	Study of foodborne pathogens - <i>Clostridium</i> , <i>E.coli</i> , <i>Staphylococcus</i> , <i>Shigella</i> and <i>Salmonella</i>	3	
15	Visit to food and dairy industry and report submission	3	

REFERENCES:

1. J.G. Cappuccino and N.Sherman. Microbiology – A lab manual. NewYork: Benjamin Cummins. 1996.
2. Kannan, N. Laboratory Manual in General Microbiology. Palani: Palani Paramount Publication, 1996.
3. Jayaraman, J. Laboratory Manual in Biochemistry. New Delhi: Wiley Eastern Ltd., 1985.
4. Plummer, D.T. An Introduction to Practical Biochemistry. New Delhi:Tata McGraw-Hill.. 1998. 5.
5. Harley Precott. Laboratory Exercises in Microbiology The MacGraw Hill companies. 5th edition. 2002.

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SEMESTER VI

Content of Course 8: Theory: S21 MB 6.3 – Industrial Microbiology and Bioprocess Technology

CObj_ID	Course Objectives
CObj_1	The major objective of the course is to provide the design of bioreactors, media formulations and factors affecting the industrial production of bio-chemicals along with approaches that can be used for enhanced production.
CObj_2	To analyze the role of micro-organism in production of organic acids, alcohols, wine, vinegar, enzymes, vitamins, antibiotics, amino-acids and steroids
CObj_3	To understand the strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant microbial products and therapeutic proteins

CO_ID	Course Outcomes
CO_1	General design of fermenter, media and the process of fermentation and optimization of fermentation process
CO_2	Isolation of industrially important microbial strains and fermentation media
CO_3	Students will be able to select industrially important microbes for economical use including protein products.
CO_4	Types of fermentation processes, bio-reactors and measurement of fermentation parameters
CO_5	Microbial production of industrial products (microorganisms involved, media, fermentation conditions, downstream processing and uses)

S. No	Module title	Module Content	Number of Hours	Skills Developed
Unit 1	Introduction to industrial microbiology and Upstream process	Scope and development of Industrial Microbiology; Industrially important microorganisms – Isolation methods and Screening Techniques- Primary and Secondary; Preservation of cultures; Strain improvement- protoplast fusion, rDNA technology, mutation; Development of	16 Hours	Analytical skills

		inoculum for various fermentation processes; Types of industrial fermentation processes: Batch, Continuous, Surface, Submerged and SSF; Fermentor: Basic structure, construction and various types-typical stirred aerated fermentor, tower fermentor, air lift and bubble cap fermentor; Media components and formulation, crude media components, antifoam agents, precursors, inducers and inhibitors and buffering agents; Process parameters-aeration, agitation, temperature regulation, foam regulation and pH regulation, Cell mass regulation		
Unit 2	Downstream process	Primary separation – removal of insoluble products/cell (centrifugation, filtration and sedimentation); Cell disruption (physical, chemical and enzymatic); Product isolation and separation – solvent extraction, adsorption, aqueous two-phase system and precipitation; Purification techniques (Chromatography - ion exchange, gel permeation and affinity); Membrane separation (micro-filtration, ultrafiltration and reverse phase electrophoresis); Product polishing (crystallization, drying) and packaging – diafiltration.	14 Hours	Analytical skills
Unit 3	Immobilization and biotransformation	Techniques and types of immobilizations- (1) non-covalent adsorption and deposition, (2) physical entrapment, (3) covalent attachment, and (4) bio-conjugation, industrial applications of immobilization: merits and demerits; Biotransformation of steroids	12 Hours	Technical skills
Unit 4	Microbially derived products	Industrial production of antibiotics (Penicillin and Streptomycin), amino acids (Glutamic acid and lysine), beverages (Wine, Whisky and Beer), biofuels (Biogas), enzymes (Amylase, Lipase, and Protease), hormones (insulin and gibberellic acid), organic acid (Citric acid and acetic acid), vitamins (Vit B12), SCP and recombinant vaccines	18 Hours	Technical skills

References Books

1. Richard H. Baltz, Julian E Davies and Arnold L. Demain Manual of Industrial Microbiology and Biotechnology. 3rd edition, ASM Press (2010).
2. Daniel Forciniti. Industrial Bioseparation: Principles and practice. 1st edition, Wiley Blackwell (2008).
3. Reed. G. Prescott and Dunn's Industrial Microbiology. CBS Publishers. (1999).
4. Demain, A. L. Industrial Microbiology and Biotechnology. 2nd Edition. (2001).
5. EL Mansi. E.M.T. Fermentation Microbiology and Biotechnology. 4ndEdition,CRC Taylor & Francis (2020).
6. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. Industrial Microbiology: An introduction. Blackwell Science Publishers (2002).
7. Casida LE, Industrial Microbiology, J. Wiley, (Reprint2008).

8. Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill(2021) Willey, Sherwood, Woolverton. Prescott, Harley, and Klein's Microbiology McGraw-Hill publication, 7th edition 2008
9. Tortora, Funke, 10th edition (2010). Microbiology. Pearson Benjamin Cummings.
10. JACQUELYN G. BLACK. Microbiology Principles and explorations. JOHN WILEY & SONS (2018)
11. Madigan, Martinko, Bender, Buckley, Stahl. Brock Biology of Microorganisms. Pearson 14th edition, 2015
12. Tom Besty, D.C Jim Koegh. Microbiology Demystified McGRAW-HILL, 2005.
13. Wulf Crueger. Cruegers Biotechnology: A Textbook of Industrial Microbiology 2017
14. Dr. R.C. Dubey, Dr. D.K. Maheswari 2012. Practical Microbiology
15. S. Ram Reddy and G. Ram reddy 2012. Practical Microbiology,

SEMESTER VI

Practical: S21 MB 6.4 - Industrial Microbiology and Bioprocess Technology

Total Teaching Hours: 45

No. of Hours / Week: 3

S. No		Module title	Total Number of Hours	Skills Developed
1	Isolation of amylase producing microbes and determination of enzyme activity		6 h	Analytical skills
2	Isolation of antibiotic producing microbes by crowded plate technique and determination of antibacterial activity		6 h	
3	Production of ethanol by fermentation, recovery and estimation by dichromate method		6 h	
4	Microbial fermentation for the organic acid production and estimation of organic acid by titrimetric method		6 h	
5	Immobilization of yeast cells, enzymes and evaluation of its efficiency		3 h	
6	Production of biofertilizer		3 h	
7	Production of wine using grapes		3 h	
8	Mushroom cultivation		3 h	
9	Microbial fermentation for the pigment production		3 h	
10	Production of biofuel using domestic wastes - Demonstration		3 h	
11	A visit to any educational institute/industry to see an industrial fermenter/bioreactor, and other downstream processing operations			

Reference:

1. Casida, L. E., *Industrial Microbiology*. Wiley, Eastern Ltd, New Delhi.
2. McNeil, B. and L. M. Harvey, *Fermentation, a practical approach*. IRL Press, New York.
3. Michael J Waites, Neil L Morgan, John S Rockey and G. Higton, *Industrial Microbiology: An Introduction*. Blackwell Science, New Delhi.
4. Prescott, S. C. and C. C. Dunn, *Industrial Microbiology*. Tata McGraw-Hill, New Delhi.
5. Stanbury, P. F., A. Whitaker and S. Hall, *Principles of fermentation technology*. Elsevier Science B.V., Amsterdam, Netherlands, Aditya Books (P) Ltd, New Delhi.

Department of Zoology

Title of the Course: Cytology, Genetics and Infectious Diseases

Semester I - Zoology Core Course

Semester I

Course Title: Cytology, Genetics and Infectious Diseases	Course Credits: 4
Course Code: S21ZO1.1	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of ESA: 3 Hours
Formative Assessment Marks: 30	Summative Assessment Marks: 70

Content of Theory Course 1	60Hours
Unit I	15
Chapter 1. Structure and Function of Plasmamembrane - Plasma membrane: chemical structure—lipids and proteins - Endomembrane system: Active and passive transport, endocytosis and exocytosis	5hrs
Chapter 2. Structure and Function of Cell Organelles - Cytoskeleton: microtubules, microfilaments, intermediate filaments - Mitochondria: Oxidative phosphorylation; electron transport system - Peroxisome, ER, Golgi complex, Ribosome	10hrs
Unit II	15
Chapter 3. Nucleus and Chromatin Structure - Structure and function of nucleus in eukaryotes - Chemical structure and base composition of DNA and RNA - DNA supercoiling, chromatin organization, Ultra structure of chromosomes	5 hrs
Chapter 4. Cell cycle, Cell Division and Cell Signaling - Introduction to Cell cycle and its regulation, apoptosis - Cell division: mitosis and meiosis - Cell-cell interaction: cell adhesion molecules, cellular junctions	10 hrs
Unit III	15hrs
Chapter 5. Mendelism and Sex Determination - Basic principles of heredity: Mendel's laws- monohybrid cross and dihybrid cross - Complete dominance and Deviation of Mendelism. - Mechanism of Sex- determination - Chromosomal and Environmental. - Sex-linked inheritance in humans	7 hrs
Chapter 6. Extensions of Mendelism, Genes and Environment - Extensions of Mendelism: Multiple Alleles, Gene Interaction. - The Interaction Between Sex and Heredity: Sex-Influenced and Sex-Limited Characteristics	8Hrs

- Maternal cytoplasmic inheritance - Kappa particles in <i>Paramecium</i> and shell coiling in snail. - Interaction between Genes and Environment: Environmental Effects on Gene Expression	
Unit IV	15hrs
Chapter 7. Human Chromosomes and Patterns of Inheritance - Patterns of inheritance: autosomal dominance, autosomal recessive, X-linked recessive, X-linked dominant. - Chromosomal anomalies: Structural and numerical aberrations with examples. - Human karyotyping and Pedigree analysis.	8 hrs
Chapter 8. Infectious Diseases Structure, life cycle and pathogenicity of human pathogens.	7 hrs

Suggested Readings :

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA(2004).
2. Alberts et al: Molecular Biology of the Cell: Garland(2002).
3. Cooper: Cell: A Molecular Approach: ASM Press(2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman(2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson(2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby- Kuby Immunology. W H Freeman(2007).
8. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell(2017).
9. Principles of Genetics by B. D. Singh
10. Cell-Biology by C. B. Pawar, Kalyani Publications
11. Economic Zoology by Shukla and Upadhyaya

Zoology Core Lab Course Content Semester I

Course Title: Cell Biology ,Cytogenetics and Infectious diseases Lab	Course Credits: 2
Course Code:: S21ZO1.2	L-T-P per week: 0-0-4
Total Contact Hours: 60	Duration of ESA: 3 Hours
Formative Assessment Marks: 15	Summative Assessment Marks: 35

Lab Course Content

S.No.	List of Labs to be conducted	60hrs
1	Understanding of simple and compound microscopes.	4hrs
2	To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue/any suitable stain (virtual/ slaughtered tissue).	8hrs
3	To study the different stages of Mitosis in root tip of <i>Allium cepa</i> .	8hrs
4	To study the different stages of Meiosis in grasshopper testis (virtual).	4hrs
5	To check the permeability of cells using salt solution of different concentrations.	4hrs
6	Study of parasites in humans (e.g. Protozoans, Helminthes in compliance with examples being studied in theory) permanent microslides.	4hrs
7	To learn the procedures of preparation of temporary and permanent stained slides, with available mounting material.	4hrs
8	Study of mutant phenotypes of <i>Drosophila</i> sp. (from Cultures or Photographs).	4hrs
9	Preparation of polytene chromosomes (<i>Chironomus</i> larva or <i>Drosophila</i> larva).	8hrs
10	Chromosomal aberration Syndromes from the pictures provided. (Virtual/optional).	4hrs
11	To prepare family pedigrees.	8hrs

Suggested Readings:

1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA(2004).
2. Alberts et al: Molecular Biology of the Cell: Garland(2002).
3. Cooper: Cell: A Molecular Approach: ASM Press(2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman(2004).
5. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby- Kuby Immunology. W H Freeman(2007).
6. Kesar, Saroj and Vasishta N.2007 Experimental Physiology: Comprehensive Manual. Heritage Publishers, NewDelhi.

II Semester BSc Zoology

Course Title: Biochemistry and Physiology

Core Course Content

Course Title: Biochemistry and Physiology	Course Credits: 4
Course Code: S21ZO2.1	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of ESA: 3 Hours
Formative Assessment Marks: 30	Summative Assessment Marks: 70

Core Course content

Content	60hrs
Unit I	15hrs
Chapter 1. Structure and Function of Biomolecules: - Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates). - Lipids (saturated and unsaturated Fatty acids, Tri-acylglycerols, Phospho lipids, Glycolipids and Steroids) - Structure, Classification and General Properties of α-amino acids; Essential and non-essential amino acids, Levels of organization in proteins; Simple and conjugate proteins.	8hrs
Chapter 2. Enzyme Action and Regulation - Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action. - Isozymes; Mechanism of enzyme action - Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions ; Equation of Michaelis-Menten, Concept of K_m and V_{max}, Enzyme inhibition - Allosteric enzymes and their kinetics	7hrs
Unit 2	15hrs
Chapter 3. Metabolism of Carbohydrates and Lipids - Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway Glycogenolysis and Glycogenesis Lipids- Biosynthesis of palmitic acid; Ketogenesis, β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms	10hrs

Chapter 4. Metabolism of Proteins and Nucleotides Catabolism of amino acids: Transamination, Deamination, Urea cycle, Uric acid cycle, vitamins	5hrs
Unit 3	15hrs
Chapter 5. Digestion and Respiration in humans - Structural organization and functions of gastrointestinal tract and associated glands. - Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins - Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood, Respiratory pigments, Dissociation curves and the factors influencing it;	8hrs
Chapter 6. Circulation and Excretion in humans - Components of blood and their functions; hemopoiesis - Structure of mammalian heart-Double circulation - Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation - Blood clotting: Blood clotting system - Structure of kidney and its functional unit; Mechanism of urine formation	7hrs
Unit IV	15hrs
Chapter 7. Nervous System and Endocrinology in humans - Structure of neuron, Types of synapse - Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers. - Endocrine glands - pituitary, thyroid, parathyroid, pancreas and adrenal - Classification of hormones;	8hrs
Chapter 8. Muscular System in humans Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus	7hrs

Suggested Readings:

1. Nelson & Cox: Leininger's Principles of Biochemistry: McMillan (2000)
2. Zubay et al: Principles of Biochemistry: WCB (1995)
3. Voet & Voet: Biochemistry Vols I & 2: Wiley (2004)
4. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press
5. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology, XI Edition, Hecourt Asia PTE Ltd. /W.B.Saunders Company. (2006).
6. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).

7. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
8. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
9. Chatterjee CC Human Physiology Volume I & 2, 11th edition, CBS Publishers (2016).

B.Sc Zoology Semester II Core Course Lab Content

Course Title/Code: Biochemistry and Physiology	Course Credits: 2
Course Code: S21ZO2.2	L-T-P per week: 0-0-4
Total Contact Hours: 60	Duration of ESA: 3 Hours
Formative Assessment Marks: 15	Summative Assessment Marks: 35
Model Syllabus Authors:	

Title of the Course: Physiology and Biochemistry

List of labs to be conducted	60Hours
1. Preparation of models of nitrogenous bases- nucleosides and nucleotides. 2. Preparation of models of amino acids and dipeptides. 3. Preparation of models of DNA and RNA. 4. Qualitative analysis of Carbohydrates, Proteins and Lipids. 5. Qualitative analysis of Nitrogenous wastes – Ammonia, Urea and Uric acid. 6. Separation of amino acids or proteins by paper chromatography.	20
7. Determination of the activity of enzyme (Urease)-Effect of [S] and determination of K_m and V_{max} . 8. Determination of the activity of enzyme (Urease) - Effect of temperature and time. 9. Action of salivary amylase under optimum conditions. 10. Quantitative estimation of Oxygen consumption by fresh water Crab. 11. Quantitative estimation of salt gain and salt loss by fresh water.	15
12. Estimation of Hemoglobin in human blood using Sahli's haemoglobinometer. 13. Counting of RBC in blood using Hemocytometer. 14. Counting of WBC in blood using Hemocytometer. 15. Differential staining of human blood corpuscles using Leishman stain. 16. Recording of blood glucose level by using glucometer.	15
Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	10

INDIAN ACADEMY

Degree College - Autonomous

Department of Zoology

III Semester B.Sc

Molecular Biology, Bioinstrumentation and Techniques in Biology

Course Code: S21ZO3.1

Total Hours: 60

MOLECULAR BIOLOGY

45hrs

Unit 1:

Molecular Basis of Life

Introduction. RNA and DNA as genetic material, experimental proof of DNA as genetic material – Griffith's experiment, Hershey and Chase Experiment, RNA- Fraenkel and Singer 3 Hours

Nucleic Acids

Nucleoside and Nucleotide structure of DNA, Watson and Crick model of DNA and tRNA structure- Clover leaf model and other forms of DNA (A and Z). 4 Hours

DNA Replication

Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication, Theta model and Rolling circle model. 5 Hours

DNA Repair

Causes and mechanism – Photoreactivation, excision repair, mismatch repair, SOS repair. 4 Hours

Unit 2:

Recombination in Prokaryotes

Transformation, Conjugation and Transduction in bacteria 5 Hours

Structure of Prokaryotic and Eukaryotic gene

Genetic-code, Properties and wobble hypothesis 3 Hours

Transcription in Prokaryotes and Eukaryotes

Mechanisms, Promoters and RNA polymerase, transcription factors, Post transcriptional modifications of eukaryotic mRNA. 6 Hours

Unit 3:

Translation

Mechanism of translation in prokaryotes, Post translational modification of proteins.

4 Hours

Regulation of Gene Expression

Regulation of Gene expression in Prokaryotes – Operon concept (Lac and Tryp) 5 Hours

Insertional elements and Transposons

Transposable elements in *Drosophila* and Maize 3 Hours

Mutations

Introduction, Types of Gene mutations – Transition, Transversion, Frameshift, Reverse, Missense, Silent and Nonsense mutations. 3 Hours

Unit 4: Bioinstrumentation and Techniques in Biology

15hrs

- Micro technique: Introduction and procedure – fixation, embedding, microtomy, staining – simple and differential and mounting.
- Separation techniques: Principle and applications of Centrifugation, Chromatography (Details of types and techniques to be avoided).
- Autoradiography: Principle and applications.
- Microscopy: Principle – magnification and resolution. Types: Light, Phase contrast, Fluorescent and Electron microscopy (TEM and SEM).
- Micrometry: Principle and applications.
- Endoscopy: Principle and applications.
- Kidney replacement therapy: Dialysis – Hemodialysis and Continuous ambulatory peritoneal dialysis.
- Statistical tools and their applications – Mean, Median and Mode, Standard Deviation (SD).

Course Code: S21ZO3.2

SEMESTER III (Lab Sessions)

Total Units:60 hrs

1. Extraction of DNA from cauliflower	4hrs
2. Extraction of DNA from Bacteria.	8hrs
3. Extraction of DNA from Liver tissue	4hrs
4. Paper Chromatography for separation of Leaf pigments	4hrs
5. Paper Chromatography for separation of Drosophila eye pigments	8hrs
6. Paper Chromatography for separation of Aminoacids	8hrs
7. Estimation of RNA by Orcinol method	8hrs
8. Estimation of DNA by DPA method	8hrs
9. Visit to Research Institutes / Centres / Industries and submission of report.	8hrs

References

1. Glick, B.R and Pasternak J.J (1998) Molecular biotechnology, Principles and Applications of recombinant DNA, Washington D.C. ASM press.
2. Old R.W., Primrose S.B., (1993). Principles of gene manipulation -An Introduction to Genetic Engineering, Blackwell Scientific Publications.
3. Lewin, B., Gene VI New York, Oxford University Press.
4. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
5. Sambrook et al., (2000) Molecular Cloning. Volumes I, II & III, Cold spring Harbor Laboratory Press New York, USA
6. Karp. G (2002) Cell and Molecular Biology, 3rd Edition, John Wiley & Sons.
7. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Matsudaira, P., Darnell, J. (2004). Molecular Cell Biology. Scientific American Books Inc. NY.
8. Sibi G. (2018). Industrial Microbiology and Biotechnology, Himalaya Publishing House.
9. Prescott and Dunn (2002). Industrial Microbiology, Agrobios (India) Publishers.
10. Patel A.H. (2011). Industrial Microbiology, 2nd Edition, Laxmi Publishers.
11. Sullia S. B and Shantharam S: (1998.) General Microbiology, Oxford and IBH Publishing Co. Pvt. Ltd.
12. Bisen P.S (1994). Frontiers in Microbial Technology, 1st Edition, CBS Publishers.
13. Glaser A.N and Nikaido.H (1995). Microbial Biotechnology, W.H Freeman & Co.
14. Prescott and Dunn (1987). Industrial Microbiology 4th Edition, CBS Publishers and Distributors.
15. Crueger W. and Crueger A. (2000). A textbook of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
16. Stanbury P.F, Whitaker H, Hall S.J (1997). Principles of Fermentation Technology. Aditya Books (P) Ltd.

IV Semester B.Sc

Gene Technology, Immunology and Computational Biology

Course Code: S21ZO4.1

PART-A: Gene Technology

Total hours: 25 hrs

Unit I: Recombinant DNA technology

12 hrs

- a. Introduction.
- b. Components of rDNA technology:
 - i. Molecular tools: Restriction enzymes, DNA ligases, Alkaline phosphatase
 - ii. Vectors: Plasmids, Bacteriophages, Cosmids, Artificial chromosome vectors
- c. Methods of gene transfer in animals: Transfection – microinjection, electroporation, lipofection and shot-gun method.
- d. Isolation of desired gene: cDNA library, Genomic library, Organo-chemical synthesis, Amplification through PCR

Unit II: Applications of Biotechnology

13hrs

- a. **Transgenesis:** 3 hrs
 - i. Introduction – Meaning and significance.
 - ii. Transgenesis in mice, knock out and knock in technology.
- b. **Animal improvement:** 3 hrs
 - i. Super ovulation and Embryo transfer: Steps, Difference between surgical and non- surgical transfers, Benefits and limitations of embryo transfer.
 - ii. Artificial insemination
 - iii. Sperm sexing.
- c. **Gene therapy:** 4hrs
 - i. Introduction.
 - ii. Approach for gene therapy: Somatic cell gene therapy, Embryo cell gene therapy and Germ cell gene therapy.
 - iii. In vivo and ex-vivo gene therapy.
 - iv. Gene therapy strategies for Cancer: Tumor necrosis factor gene therapy, Suicide gene therapy, Gene replacement therapy and Antigene and antisense gene therapy.
- d. **DNA fingerprinting or Profiling:** RFLP, VNTR, Microsatellites (Simple tandem repeats and Single nucleotide polymorphisms (SNPs) techniques. Application of DNA fingerprinting. 3hrs

PART- B: IMMUNOLOGY

Total hours: 25 hrs

Unit III:

Immunity- Innate and acquired immunity (active and passive), Humoral and cell mediated immunity. Cells and organs Primary- Bone marrow, spleen, thymus and secondary lymphoid organs of immune responses and their functions. 7 Hours

Antigens-Types, epitopes, haptens and factors influencing antigenicity. Antibodies- Structure, types, properties and functions of immunoglobulins. Production of antibodies (Hybridoma technology). Blood cell components, ABO blood grouping, Rh typing. Antigen Antibody reaction-In vitro tests – Precipitation, Immuno electrophoresis, Hemagglutination, Labeled antibody (RIA, ELISA and Immuno-fluorescent techniques). 8 Hours

Complement system-Alternate and Classical pathway. Hypersensitivity and Allergic reactions. 6 Hours

Vaccines and Immunization-Passive and Active immunization. Types of Vaccines – Inactivated, Attenuated and Recombinant Vaccines – Peptide and DNA Vaccines. 4 Hours

PART – C: Computational Biology

Total Hours: 10 hrs

Unit IV:

Introduction to Computer: Computer softwares-operating system-Windows, UNIX, Linux, Application software-word processor, spread sheet. Introduction to statistical software (SPSS). 2 Hours

Biological Databases: Data mining and applications, accessing bibliographic databases-PubMed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence data bank, SWISS-PROT. Structural databases -protein data Bank (PDB). Sequence alignment -Global and Local alignment, scoring matrices. Restriction mapping -NEB CUTTER, Similarity searching (FASTA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs. 8 Hours

SEMESTER IV (Lab Sessions)

GENETIC TECHNOLOGY, IMMUNOLOGY

Course Code: S21ZO4.2

	Total Units:60
1. Isolation of plasmid DNA (<i>E. coli</i>)	8 Unit
2. Restriction digestion of DNA	8 Units
3. Separation of DNA by Agarose Gel Electrophoresis	4 Units
4. Protein separation by PAGE (Demonstration)	6 Units
5. Amplification of gene by PCR	4 Units
6. Blood grouping	2 Units
7. WIDAL test and VDRL test	4 Units
8. ELISA – Demonstration	8 Units
9. Ouchterlony Double diffusion (ODD) & Single Radial Immunodiffusion	4 Units
10. Rocket Immunelectrophoresis	4 Units
11. Construction of phylogenetic tree using Bioinformatics tool.	8 Units

References

1. Glick, B.R & Pasternak J.J (1994) Molecular Biotechnology, Principles and Applications of Recombinant DNA, American Society for Microbiology, Washington D.C
2. Christopher H. (1995) Gene cloning and manipulating, Cambridge University Press
3. Nichol, D.S.T (1994). An Introduction of Genetic Engineering, Cambridge University Press.
4. Old. R.W. and Primrose, S.B. (1986) Principles of Gene manipulation, An introduction to genetic engineering (3rd Edition) Black well Scientific Publications.
5. Lewin B. (1994) Genes VI, New York, Oxford University Press.
6. Elgert Klaus- Immunology: Understanding Immune system. Wiley & Sons. 2009.
7. Ivan M and Roitt- Essential Immunology: 5th Edition, Blackwell Scientific Publications, London. 1994.
8. Kuby-Immunology, 7th edition, Freeman, New York. 2013
9. Campbell A.M., Heyer L.J. Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings. 2006.
10. Rastogi SC- Bioinformatics: concepts, skills & applications. Benjamin Cummings.2003.
11. Prakash S Lohar –Bioinformatics. MJP publishers. 2009.
12. Sundaralinga M B- Bioinformatics. Saras Publications. 2010.
13. Ignacimuthu - Basic Bioinformatics. Narosa Publishing House. 2009.
14. Lukar K Buehler-Bioinformatics basics. 2nd Edition. Taylor & Francis. 2008.
15. Janusz M Bujnicki- Practical Bioinformatics. Springer. 2006.



DEPARTMENT OF GENETICS

Syllabus of

M.Sc., APPLIED GENETICS

(Program Code: IAMOS01)

Academic Year: 2020-21 onwards

Batch: 2020 - 2022

DEPARTMENT OF GENETICS
M.Sc APPLIED GENETICS (Program Code: IAMOS01)

REGULATIONS PERTAINING TO M.Sc APPLIED GENETICS (CBCS)DEGREE

SEMESTER SCHEME 2020-21 Onwards

1. AIMS AND OBJECTIVES :

1. Understand the steps involved in Recombinant DNA technology and applications of Genetic engineering
2. To impart knowledge on Human Genetics as Genes are the common factor of the qualities of most human-inherited traits. Study of human genetics can answer questions about human nature, can help understand diseases and the development of effective treatment and help us to understand the genetics of human life.
3. To instill practical and theoretical skills in the branches of Applied Genetics
4. Demonstrate knowledge in the applications of biomedical genetics.

I a. Programme Educational Objectives (PEOs) and Programme Outcomes (POs)

PEOs	Programme Educational Objectives (PEOs):		Programme Outcomes(POs)
PEO1	To promote a profound and integrated comprehension of branches of Genetics and their implication towards the advancement of health and biological sciences.	PO1	Able to identify and solve problems associated with the different types of human, animal and plant diseases.
PEO2	To understand how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.	PO2	Develop an in-depth understanding of the principles of genetics, cytogenetics, developmental genetics, molecular mechanisms of cellular physiology, plant and microbial genetics, bioinformatics, human genetics etc., to obtain a sound knowledge of various fields of genetic study
PEO3	To develop insight into the mathematical, statistical, and computational basis of genetic analyses that use genome-scale data sets in systems biology settings	PO3	Enable to think analytically and creatively to solve problems, judge arguments and make decisions in scientific and other contexts.

PEO4	To enable comprehensive and detailed understanding of genetic methodology and how quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms.	PO4	Develop a commitment to life-long learning and career pursuits within the life sciences disciplines.
PEO5	To facilitate the students to acquire the skills required in starting their own ventures and generating self-employment making them successful entrepreneurs also to develop skills in diagnostic testing, haematology, Invitro fertilization techniques etc. used in clinical and research laboratories will provide them opportunity to work in diagnostic or research laboratory	PO5	Develop ability to integrate the basic knowledge in genetics with other related disciplines

I b. Mapping of PEOs with POs:

PEOs	Programme Outcomes(POs)
PEO1	PO1, PO3, PO5
PEO2	PO1, PO5
PEO3	PO1, PO2, PO3, PO5
PEO4	PO1, PO2, PO3, PO4
PEO5	PO4, PO5, PO3

2. DURATION OF THE COURSE: 2 YEARS (4 Semesters)

3. ELIGIBILITY FOR THE COURSE:

a) B.Sc. graduates with any Life Science subject securing at least 50% marks in aggregate of all optional subjects are eligible. B.Sc. graduates in Biotechnology and B.Sc. (Hons.) graduates in Genetics / Biotechnology / Biology / Botany / Microbiology / Zoology are also eligible provided they have secured 50% marks in the aggregate of all the optional subjects.

b) In the absence of candidates in (a), Graduates in Agricultural Science, Dairy Sciences, Horticulture, Forestry, Fisheries, Pharmacy, Engineering (Biotechnology), Medicine / Dental or Agricultural Engineering, with 50% marks in the aggregate are eligible.

4. MEDIUM OF INSTRUCTION: English

5. ATTENDANCE:

- a) Theory: 75%
- b) Practical: 75%

6. TEACHING METHODS (PEDAGOGY):

1. LECTURES –a) ICT based b) Chalk and board method, both helps the teacher to maintain eye contact with students and to engage in healthy interaction during lecture, important concept of papers.
2. SEMINARS - Students undertake meticulous search for data and citations and are encouraged to present in individual/group on any area from the pertaining curriculum.
3. PRACTICAL LEARNING - These sessions aim to give students an insight into the working environment, knowledge of experimental methods, instrumentation and techniques and an even understanding of the academic material taught on the practical course.
4. FIELD TRIPS - Fieldwork helps the students to put their theoretical knowledge into practice and allow to explore specific areas or learn particular techniques.
5. PROJECTS - It helps enhance student's critical thinking skills, their abilities to analyze, interpret, and evaluate information; derive a hypothesis to solve problems and apply course material to achieve a specific outcome and effectively communicate during viva.
6. E-LEARNING – Students indulge into e-resources like JGATE, INFLIBNET, NPTEL, COURSERA, Bioinformatics is part of their curriculum as a soft core paper.
7. CO-CURRICULAR ACTIVITIES – Student involvement in co- curricular activities is another way for students to build upon the knowledge and skills. Pictionary, Pick and speak, model making, collage, quiz are the most common co-curricular activities in which students are involved.
8. Rewarding excellence -Recognize and reward excellent student performance.

7. EVALUATION:

Post Graduate Program

1. CIA: Seminars, Assignments, Internal exams (Mid-term & End-Term) – 10 Marks each. Total of 30 marks / paper. Soft core Paper of 15 marks with similar criteria.
2. Theory Examination: Total marks -70 marks/ paper (Section – A: 15 marks, Section B: 25 marks, Section C: 30 marks), soft core – 35 marks / paper (Section – A: 10 marks, Section B: 10 marks, Section C: 15 marks).
3. Practical exam: Major experiments. Minor Experiments and Viva – voce – 35 Marks. CIA- 15 Marks.

INDIAN ACADEMY

Degree College - Autonomous

DEPARTMENT OF LIFE SCIENCES- GENETICS

M.Sc. APPLIED GENETICS – COURSE MATRIX

SEMESTER I

Paper code	Title of the Paper	Total hrs	Hrs/ week	Marks			Credits	Paper code	Total hrs	Hrs/ week	Marks			Credits	Total marks	Total Credits
				IA	Exam	Total					IA	Exam	Total			
MGE 101	Cell Biology	52	4	30	70	100	4	MGE 106	60	4	15	35	50	2	150	6
MGE 102	Basic Genetics	52	4	30	70	100	4	MGE 107	60	4	15	35	50	2	150	6
MGE 103	Essentials of cytogenetics	52	4	30	70	100	4	MGE 108	60	4	15	35	50	2	150	6
MGE 104	Biological chemistry	52	4	30	70	100	4	MGE 109	60	4	15	35	50	2	150	6
MGE 105	Cellular physiology	40	3	30	70	100	2	-	-	-	-	-	-	-	100	2
	Total	248	19	150	350	500	18		240	16	60	140	200		700	26

SEMESTER II

THEORY								PRACTICALS								Total marks	Total credits
Paper code	Title of the Paper	Total hrs	Hrs/ week	Marks			Credits	Paper code	Total hrs	Hrs/ week	Marks			Credits			
				IA	Exam	Total					IA	Exam	Total				
MGE 201	Molecular Biology	52	4	30	70	100	4	MGE 206	60	4	15	35	50	2	150	6	
MGE 202	Genetics of development	52	4	30	70	100	4	MGE 207	60	4	15	35	50	2	150	6	
MGE 203	Mutation & Cancer biology	52	4	30	70	100	4	MGE 208	60	4	15	35	50	2	150	6	
MGE 204	Evolutionary genetics	52	4	30	70	100	4	MGE 209	60	4	15	35	50	2	150	6	
MGE 205	Bioinformatics & Biostatistics	40	3	30	70	100	2	-	-	-	-	-	-	-	100	2	
	Total	248	19	150	350	500	18		240	16	60	140	200	8	700	26	

SEMESTER III

THEORY								PRACTICALS							Total marks	Total credits
Paper code	Title of the Paper	Total hrs	Hrs/ week	Marks			Credits	Paper code	Total hrs	Hrs/ week	Marks			Credits		
				IA	Exam	Total					IA	Exam	Total			
MGE 301	Genetic engineering	52	4	30	70	100	4	MGE 306	60	4	15	35	50	2	150	6
MGE 302	Microbial & plant genetics	52	4	30	70	100	4	MGE 307	60	4	15	35	50	2	150	6
MGE 303	Human genetics	52	4	30	70	100	4	MGE 308	60	4	15	35	50	2	150	6
MGE 304	Cell physiology practicals	-	-	-	-	-	-	MGE 304	60	4	15	35	50	2	50	2
OE 305	Open elective	52	4	30	70	100	4	-	-	-	-	-	-	-	100	4
	Total	208	16	120	280	400	16		240	16	60	140	200	8	600	24

SEMESTER IV

THEORY								PRACTICALS							Total marks	Total credits
Paper code	Title of the Paper	Total hrs	Hrs/ week	Marks			Credits	Paper code	Total hrs	Hrs/ week	Marks			Credits		
				IA	Exam	Total					IA	Exam	Total			
MGE 401	Genomics & Proteomics	52	4	30	70	100	4	MGE 406 & MGE 407	60	4	15	35	50	2	250	10
MGE 402	Immunology & Haematology	52	4	30	70	100	4									
MGE 403	Biomedical genetics	52	4	30	70	100	4	MGE 408 & MGE 409	60	4	15	35	50	2	250	10
MGE 404	Plant & Animal biotechnology	52	4	30	70	100	4									
PR 405	Project			30	70	100	4	-	-	-	-	-	-	-	100	4
	Total	208	16	150	350	500	20		120	8	30	70	100	4	600	24

RESULT:

- Minimum for pass – Theory - 25 marks, Practical paper –25 marks, Internal marks –Minimum 13 marks (Both theory and practical)
- Grading System SGPA

Final Result/Grade Description

Semester/Program% Of marks	Semester GPA/Program CGPA	Grade Alpha Sign	Result / Class Description
90.1 - 100	9.01 – 10.00	O	Outstanding
80.1 – 90.0	8.01 – 9.00	A+	First Class Exemplary
70.1 – 80.0	7.01 – 8.00	A	First Class Distinction
60.1 – 70.0	6.01 – 7.00	B+	First Class
55.1 – 60.0	5.51 – 6.00	B	High Second Class
50.1 – 55.0	5.01 – 5.50	C	Second Class
40.0 – 50.0	4.00 – 5.00	P	Pass Class
Below 40	Below 4.0	F	Re-Appear

c). CGPA

Table of Conversion of % Marks to Grade Point

% Marks	Grade Point
96 - 100	10
91 - 95	9.5
86 – 90	9.0
81 – 85	8.5
76 – 80	8.0
71 – 75	7.5
66 – 70	7.0
61 – 65	6.5
56 - 60	6.0
51 – 55	5.5
46 – 50	5.0
41 – 45	4.5
40	4

LEARNING OUTCOME:

1. Comprehend principles of genetics and relate it to human genome and genomes of other model organisms.
2. Identify and solve problems associated with the different types of human, animal and plant diseases.
3. Analyze and apply the broad areas of advanced field of study like biomedical genetics, Immunology, Bioinformatics and Nano biotechnology in modern day biotechnological research.
4. Provides an in-depth understanding of the principles of genetics, cytogenetics, developmental genetics, molecular mechanisms of cellular physiology, plant and microbial genetics, bioinformatics, human genetics etc., to obtain a sound knowledge of various fields of genetic study.
5. Apply and transfer an in-depth understanding of the principles of genetics to obtain a sound knowledge of various fields of Science, involve in Research activities and also pursue Ph.D

I SEMESTER THEORY SYLLABUS
MGE-101: CELL BIOLOGY

52Hrs

Course Objectives:

1. To enable students to comprehend the structure and functions of various organelles and that extracellular matrix.
2. To acquire knowledge on the cytoskeletal elements and the mechanism of various signaling pathways.
3. To acquaint with various techniques used in cell and molecular biology and their applications in resolving scientific biological problems.

Course Outcomes (COs):

1. Comprehend and relate the structure and functional aspects of various cell organelles.
2. Cognize and contrast the interaction of a cell with extracellular proteins and other cells.
3. Describe and demonstrate the familiarity with the components of cytoskeletal elements.
4. Understand the basic principles of signal transduction mechanisms and infer the role of different extracellular signals and receptors in cellular communication.
5. Elucidate the principles of various techniques in cell and molecular biology.

MGE-101: CELL BIOLOGY

52 Hrs

Unit I

Overview of cells:

03 hrs

Structure, types and kinds of cells, Differences between prokaryotic and eukaryotic cells.

Membrane systems:

15 hrs

a) **Plasma membrane:** Structure and chemical composition: Fluid-mosaic model, Membrane lipids, carbohydrates and proteins, Transport across membranes: Diffusion, active transport, co-transport and bulk transport, Membrane potentials – resting potential and types of propagation of action potentials, liposomes.

b) Organelle membrane:

Endoplasmic reticulum: The smooth and rough endoplasmic reticulum and their functions.

Golgi complex: Types and mechanisms of vesicular transport within the Golgi complex and their functions.

Lysosomes: Lysosomal membranes and their functions.

Mitochondria: Ultrastructure, oxidative metabolism, proton gradients, ATP synthesis, importing of mitochondrial proteins.

Chloroplasts: Ultrastructure, overview of photosynthesis, photophosphorylation, fixation of carbon dioxide and the synthesis of carbohydrates, importing of chloroplast proteins.

Nucleus: Structural organization and functions of nuclear membrane.

Unit II

Cellular interactions and their environment:

08 hrs

a) Interaction of cells with non cellular substrates The extra cellular space, the extracellular matrix, collagens, proteoglycans, fibronectin, laminin and other proteins, Integrins, focal adhesions and hemidesmosomes.

b) Interactions of cells with other cells Selectin, immunoglobulin super family and integrin super family, cadherins, Junctions: tight junctions, gap junctions and desmosomes, Plasmodesmata.

Unit II

Cytoskeleton and cell motility:

08 hrs

Microtubules-structure and function, dynamic property; Molecular motors, Cilia and flagella- structure and function, Intermediate filaments, microfilaments, muscle contractility, non-muscle motility.

Cell signaling:

08 hrs

Communication between cells and their environment, basic characteristics, second messengers and G protein-complex-coupled receptors, role of calcium as a second messenger, receptor tyrosine kinases, MAP kinase cascade, other signaling pathways- NO, IP3 pathways in plants.

Unit IV

Techniques in cell and molecular biology:

10 hrs

Microscopy: Bright-field, phase-contrast, polarization, fluorescence, confocal, microphotography, video processing and image processing, cell culturing, Ultracentrifugation, Isolation, purification and fractionation of proteins and nucleic acids, Autoradiography, Flow cytometry.

References:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. & Watson, J.D.
2. Molecular Biology of Cell, II Ed., Garland Pub. Inc. N.Y.
3. Lodish, H., Berk, A., Zipuosky, L.S., Matsudaira, P., Baltimore, D. & Darnell, J. Molecular Cell Biology – IV Ed., W.H. Freeman & Company.
4. Gilbert, S.F. Developmental Biology, Sinauer Associates Inc.
5. Wilson, E.B. Cell in Development and Inheritance, Mac Millan, N.Y.
6. Celis, J.E (Ed.),. Cell Biology: A Laboratory Hand Book – Vol. I & II,
7. Academic Press.
8. Darnell, J. H. Lodish & D. Baltimore. Molecular Cell Biology, Scientific
9. American Books, Inc., USA.
10. Cooper, G.M.. The Cell: A Molecular Approach, Sinauer Associates Inc.
11. Lewin B. Genes VIII, Oxford University Press, Oxford, N.Y. & Tokyo.
12. Garrett & Grisha.. Molecular Aspects of Cell Biology, Sounders, N.Y.
13. Karp G. Cell and Molecular Biology, II Ed., John Wiley & Sons, N.Y.

I SEMESTER THEORY SYLLABUS

MGE 102 Basic Genetics

52 hrs

Course Objectives:

1. To obtain an in-depth knowledge of various patterns of inheritance and the experimental and practical basis of those concepts
2. To understand cell-cell hybridization techniques, linkage, crossing over and principle of construction of linkage maps
3. To apply statistical and biometric methods of analysis in genetics research by using Chi-Square test, Students' t test, probability, Anova etc.,

Course Outcomes:

1. Students gained knowledge of various patterns of inheritance in unicellular and multicellular organisms.
2. Acquire knowledge on hybridization techniques, crossing over, linkage and linkage and chromosome mapping.
3. Analyse and apply various non-mendelian inheritance patterns in the form of gene interactions, extranuclear inheritance of traits of various organisms.
4. Apply statistical and biometric methods of analysis like Chi square test in genetics research
5. Derive an understanding of various mechanisms of sex determination

MGE-102: BASIC GENETICS

52Hrs

UNIT I

13 hrs

Introduction to Science of Inheritance: Model genetic organisms. Life history and Inheritance pattern in bacteriophage (T4), Fungi (Neurospora), Algae (Chlamydomonas), Bacteria (E. coli), Plant (Arabidopsis), Caenorhabditis, Drosophila and Mouse.

Mendelian principles: Mendel and his laws, Applications of laws and probability tests. Chi-square test and its application in the analysis of Genetic data. Pattern of inheritance in haploid (Neurospora) and diploid (Drosophila). Extension of Mendelism- alleles, allelic variation and genetic factor dominant relationship, basis of dominant and recessive inheritance. Multiple alleles and allelic series, lethal alleles, penetrance and expressivity, pleiotropy.

UNIT II

13 hrs

Chromosomal basis of inheritance: Concepts and evidences, sex chromosomes, Sex determination, molecular mechanism of sex determination in *Drosophila* and man. Sex linked inheritance in *Drosophila* and man. Multiple sex chromosomes, sex- limited and sex influenced traits.

Linkage and crossing over: Concept, Genetic recombination and constructions of genetic map. Genetic and linkage map in *Drosophila*, *Neurospora*, Algae and plants (Maize). Interference and coincidence. Mitotic recombination.

UNIT III

13hrs

Non-Mendelian inheritance/ Extranuclear genes: Maternal inheritance, Extra nuclear inheritance in *Neurospora*, *Chlamydomonas*, *Paramecium*, Yeast, *Drosophila* and Man, Mitochondrial and Chloroplast genes.

Somatic cell genetics: Cell-cell hybridization, cell hybrids, mapping of genes by cell hybridization methods and in-situ hybridization.

UNIT IV

13hrs

Transposable genetic elements :

Discovery and definition of transposons, simple transposons (IS elements), composite transposons (Tn3, Tn5), Ac/Ds elements in maize, P elements in *Drosophila*, Retrotransposons, mechanisms of transposition. Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation.

REFERENCES

1. Atherly A. G., Girton, J. R. & McDonald, J. F., 1999. The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers.
2. Brookers R. J., Benjamin/Cummings, 1999. Genetics: Analysis and Principles, Longman Inc.
3. Garner E. J., Simmons, M. J. & Snustad, D. P., 1991. Principles of Genetics, John Wiley & Sons Inc., N.Y.
4. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C. & Gelbart, 1996. An Introduction to Genetic Analysis, W H. Freeman and Company, N.Y.
5. Monroe W. Strickberger. 1996. Genetics, 3rd Ed., M. W. Mac Millan Publishing Co., N.Y.
6. Watson, J.D., Hopkins, N. H., Roberts, J. W. Steitz & Weiner, A. M., 1987. Molecular Biology of the Genes, The Benjamin/Cummings Publishing Company Inc., Tokyo.

7. William S. Klug & Michael R. Cummings, 1996. Essentials of Genetics, 2nd Ed., Prentice Hall Internationals.
8. Daniel L. Hartl & Elizabeth W. Jones, 1999. Essential Genetics, 2nd Ed., Jones & Bartlett Publishers
9. Tom Strachan & Andrew P. Read, 2004. Human Molecular Genetics 3, 3rd Ed., Garland Science, N.Y.
10. Robert H. Tamarin, 2002. Principles of Genetics, 7th Ed., TaTa McGraw-Hill Edition, New Delhi, India.
11. Griffiths, A.J.G., Willian M. Gelbart, Richard C. Lewontin & Jeffrey H. Miller, 2003. Modern Genetic Analysis: Integrating Genes and Genomes, 2nd Ed., W. H. Freeman and Company, N.Y.

I SEMESTER THEORY SYLLABUS

MGE-103: ESSENTIALS OF CYTOGENETICS

52hrs

Course Objectives:

1. To gain an in-depth knowledge of concepts and essentials of cytogenetics
2. To obtain an in-depth knowledge of polytene chromosomes, lampbrush chromosomes and B chromosomes and understand their evolutionary significance and their role in development
3. To carry out a detailed analysis of Evolution of sex chromosomes and evolution of new karyotypes

Course Outcomes:

1. Students are able to build an elaborate knowledge of various concepts in Cytogenetics.
2. Students gain an in-depth knowledge of various special types of chromosomes and understand their evolutionary significance and their role in development.
3. Students are able to perform a detailed analysis of Evolution of X and Y chromosomes and the chromosomal mechanics in the evolution of new karyotypes. Students are able to perform a detailed analysis of Evolution of X and Y chromosomes and the chromosomal mechanics in the evolution of new karyotypes.
4. Students obtain a sound knowledge of chromosome organization and structure, Explain and identify the differences between types of chromatin and the evolutionary significance of heterochromatin and the chromatin modification mechanisms in heterochromatin.
5. Students are able to provide experimental evidence for the chromosome theory of inheritance and Chromosomal mechanics in speciation processes.

PAPER – MGE-103: ESSENTIALS OF CYTOGENETICS

52hrs

UNIT I

13hrs

Nucleus and Chromosome structure: Chromosomal theory of inheritance, Interphase nucleus, nuclear membrane, nuclear matrix and other structures, Molecular organization of prokaryotic and eukaryotic chromosomes, Nucleosome structure, Chromosomal protein, Higher order of eukaryotic chromosomes, DNA scaffolds and loops, structure of eukaryotic chromosomes, Chromomere, Kinetochore, Centromeres and Telomeres, Heterochromatin and Euchromatin.

UNIT II

Cell division: Mitotic and meiotic transmission of chromosomes, Specialized Chromosomes; Lampbrush chromosomes: Types, occurrence, specialized organization and biological significance. Polytene chromosomes: Occurrence, structural organization and their functional role. Supernumerary chromosomes: Occurrence, role during meiosis and mitosis and their evolutionary significance. 13hrs

Chromosome aberrations: Changes in chromosome structure, Origins of changes in chromosome structure. Deletions, duplications, inversions and translocations. Genetic significance of Robertsonian and non-Robertsonian translocations.

UNIT III

Changes in chromosome number: Anueuploidy (monosomy, trisomy, double trisomy, tetrasomy, nullisomy): Causes and consequences. Polyploidy (haploids, triploids, tetraploids, allotetraploids): Occurrence, types and genetic significance 13hrs

Role of chromosomes during evolution: Chromosomal changes and species differentiation, Chromosomal mechanics in speciation processes (Rodents, Insects). Role of heterochromatin in species evolution and karyotypic differentiation(Drosophila and mammals).

UNIT IV

Evolution of sex chromosomes: Types of Sex chromosomes, simple and multiple sex chromosome. Evolution of X and Y chromosome. Chromosome imprinting phenomena. 13 hrs

Chromosomes in evolution: Evolution of new Karyotypes (Ex. Drosophila virilis group), Practical applications of rearrangements: Balancers, Ring chromosomes, Attached X- chromosome in Drosophila.

REFERENCES

1. Goodenough Ursula, 1984. Genetics. 3rd Ed., CBS College Publishing.
2. Hamerton, J. L., 1984. Human Cytogenetics. Vols. I &II. Academic Press, N.Y.
3. White, M.J.D., 1973. Animal Cytology and Evolution, Cambridge University Press.
4. White, M.J.D. Modes of Speciation, W.H. Freeman & Co.
5. Gardner, Simmons, & Snustad, 1997. Principles of Genetics 8th Ed., John Wiley and Sons.
6. Lewin, B., 1996. Genes VI, John Wiley and Sons.
7. Mark H. F. L., 2000. Medical Cytogenetics, Marcel Dekker Inc, N.Y.
8. Sambamurthy, A.V.S., 1999. Genetics, Narosa Publishing House, New Delhi.
9. Sumner, A.T. 2003. Chromosomes: Organization and Function, Blackwell Publishing, USA

I SEMESTER THEORY SYLLABUS

MGE-104: BIOLOGICAL CHEMISTRY

52hrs

Course Objectives:

1. To enable to understand and apply the biochemical aspects in biological systems like physiological and metabolic events.
2. To enhance knowledge in the quantitative and qualitative estimation of biomolecules.
3. To instill knowledge in various biochemical concepts and their applications in biological research perspective.

Course Outcomes:

1. Students developed ability to apply basic principles of chemistry to biological systems and molecular biology.
2. Able to relate and experiment various interrelated physiological and metabolic events.
3. Understand and experiment the fundamental concepts of biology, chemistry and biochemistry
4. Acquire knowledge in the quantitative and qualitative estimation of biomolecules and critically analyze the inheritance pattern in the offsprings.
5. Students obtained knowledge about the influence and role of structure in reactivity of biomolecules and research the application of the same.

MGE-104: BIOLOGICAL CHEMISTRY

52hrs

UNIT I

13hrs

Biomolecules:

Carbohydrates - Classification, structure and properties of different classes, chemical reactions, derived sugars.

Amino acids and Proteins – Structure, classification and properties of amino acids and proteins, non-protein amino acids, essential amino acids, amphoteric properties of amino acids, dissociation, chemical reactions. Classes and properties of proteins. Structural Organization of proteins (Primary, Secondary, Tertiary and quaternary structure).

Lipids – Classification, structure of lipids, fatty acids, phospholipids, sphingolipids, glycolipids and steroids, chemical reactions.

Nucleic acids – Structure and properties of different types of RNA, Structure of DNA. Watson – Crick model of DNA, Polymorphism in DNA Structure.

UNIT II

13hrs

Enzymes: History, classification and nomenclature, specificity of enzyme; Kinetics of enzyme catalyzed reaction - Chemical kinetics, Michaelis – Menten equation, Transformation of M-M equation, L-B Plot, quantitative assay of enzyme activity, factors affecting enzyme activity, Mechanism of enzyme action – hypothesis, catalytic mechanism, acid-base and covalent catalysis – activation and inhibition of enzymes,

allosteric modulation, coenzymes and isoenzymes.

UNIT III

13hrs

Bioenergetics: Laws of thermodynamics and their application to biological process, basic concepts of metabolic energy, capture and transfer, biochemical energetics – free energy concept, high energy phosphate compounds (ATP and others)

Biological Oxidation: Oxidation–reduction reactions, biological redox potential, mitochondrial electron transport chain, oxidative phosphorylation, chemical and chemiosmotic hypothesis.

UNIT IV

13hrs

Metabolism:

Carbohydrates: Glycogenolysis, glycogenesis, regulation of glycogen metabolism, glycolysis, gluconeogenesis, fermentation reactions, TCA cycle, glyoxylate cycle, pentose phosphate pathway.

Proteins and amino acid metabolism: Enzymatic and chemical hydrolysis of protein, general metabolism of amino acids – transamination, deamination, decarboxylation, urea cycle, uric acid biosynthesis.

Lipids: Biosynthesis of fatty acids – Regulation of fatty acid synthesis. Oxidation of fatty acids – scheme of β -oxidation, energetics of β -oxidation, other pathways.

Nucleic acids - Biosynthesis of purines and pyrimidines.

REFERENCES

1. Basic Concepts of Biochemistry, Gilbert, H.F., McGraw Hill professional, New York, 2002
2. Biochemistry. Down, M.B., Lipincott Willam & Wilkins, Landon, 1999
3. Biochemistry. Campbell, M., AND Farrell, D., 4th ed. Thomson Brooks/Cole, 2005
4. Biochemistry. Stryer, L., 4th ed, W.H. Freeman and Company, New York, 1999
5. An Introduction to Practical Biochemistry, 3rd ed., Tata McGraw Hill, New Delhi, 2001
6. Biochemistry. Power & Chatwal, Himalaya publishing House, New Delhi, 2000
7. Biochemistry. Mathew, Sand Van Holde., 2nd. Benjamin/Cumming publishing Comp. London, 1995
8. Biochemistry – Lehninger
9. Biochemistry – Voet & Voet

I SEMESTER THEORY SYLLABUS
MGE-105: CELLULAR PHYSIOLOGY

40 Hrs

Course Objectives:

1. To give a detailed description of the cell environment, buffering systems, water, gases and blood pressure regulation. A thorough knowledge of radiations in the cell environment and their effects on cells.
2. To obtain insight into ion channels and carriers and movement of solvent and solutes across cell membrane.
3. To obtain an in-depth knowledge of excitability and contractility of cells, synaptic transmission of action potentials, salutatory conduction and an analysis of effects of various factors on action potential of nerve cells.

Course Outcomes:

1. Students gain insight into the cell microenvironment, buffering systems, and the homeostasis of water, gases and blood pressure and knowledge of radiation effects on cells.
2. Students can illustrate the structure of Plasma membrane and permeability to water and solutes, partition coefficient and permeability.
3. Students perform a detailed study of Measuring membrane potential, resting membrane potential and action potential, voltage clamping use of Nernst equilibrium potential and Goldman Constant Field equations.
4. Students demonstrate an in-depth knowledge of ion channels and carriers and movement of solvent and solutes across cell membrane.
5. Students demonstrate an in-depth knowledge of ion channels and carriers and movement of solvent and solutes across cell membrane.

UNIT I

13hrs

THE CELL ENVIRONMENT

Components of the cellular environment, Water, gases and pressure for survival of cells. Buffers and buffering systems- resistance of cells to pH changes, halophilic organisms.

Radiations in the cell environment – natural radiations, different kinds of ionizing radiations and their effect on cells.

Temperature-Thermoregulation, and thermal resistance, Thermal resistance of dormant cells, temperature effects on rate of diffusion and conductivity. Vant Hoff equation for Q10

UNIT II
BIOMEMBRANES

14hrs

Cell Homeostasis and Transport: Membrane permeability to water and solutes, partition coefficient and permeability, volume and distribution of water and electrolytes, normal balance. Effect of narcotics and anesthetics upon permeability

Membrane potentials: Measuring membrane potential, separation of charge, generation of resting potential and propagation of action potential. Factors controlling ion movements, Nernst equilibrium potential, Goldman Constant Field equations for movement of solvent and solutes across cell membrane.

Channels: Voltage sensitive sodium channels and voltage clamping. Extracellular recordings- compound action potential and cardiac action potential. Patch clamp techniques for single channel and whole cell recording.

UNIT III

13 hrs

EXCITABILITY and CONTRACTILITY

Action potentials of cells- rate and conduction of nerve impulses, saltatory conduction, heat production and nerve activity, synaptic transmission of action potentials, effects of various factors on action potential of nerve cells. Action potentials in muscle fibers

Contractility- contraction of smooth muscle cells, cardiac cells and skeletal muscle fibers. Molecular orientation in muscle fibers, structural proteins, calcium conductance and source of energy for contraction, mechanisms of muscle contraction, work and heat generation in muscle contraction

REFERENCES

1. Arthur C. Giese. Cell Physiology (W B Saunders Co)
2. David J. Aidl. The Physiology of Excitable Cells (Cambridge University Press)
3. David Landowne. Cellular Physiology (Tata –McGrwa Hill CompaniesInc).
4. Gary G Mathews. Cellular Physiology of Nerve and Muscle(Wiley)
5. James Keener and James Sneyd. Mathematical Physiology: I. Cellular Physiology (Springer)
6. James Kew and Ceri Davies. Ion Channels: From Structure to Function (Oxford UniversityPress)
7. Mordecai P. Blaustein, Joseph P. Y. Kao and Donald R. Matteson.. Cellular Physiology and Neurophysiology (Mosby) Second edition
8. Mordecai P Blaustein , Joseph P.Y Kao, and Donald R Matteson. Cellular Physiology (Elsevier/Mosby)
9. Nicholas Sperelakis. Cell Physiology Source Book (Elsevier Inc) Third edition
10. Terence Allen and Graham J. Cowling The Cell: A very short introduction (Oxford UniversityPress)

I SEMESTER – PRACTICAL SYLLABUS

MGE-106 CELL BIOLOGY

Total : 60 hrs

Course Objectives:

1. To inspire interest in microscopic analysis of tissues and enable students to identify various stages in cell division.
2. To study vital staining and other staining techniques.
3. To perform the isolation of various organelles like chloroplast, mitochondria and nucleus.

Course Outcomes:

1. The students are able to perform vital staining to observe mitochondria in actively dividing yeast cells.
2. The course enables the students to identify the stages of mitotic cell division.
3. The students are able to distinguish between and identify the various stages and sub-stages of meiotic cell division in grasshopper testis tissue.
4. The students study the structure of X-chromatin in humans.
5. The students gain an insight into the various techniques used for organelle isolation.

MGE-106 CELL BIOLOGY

Total : 60 hrs

1. **Vital staining of Mitochondria**
2. **Study of Mitosis in Onion root tips**
3. **Identification of meiotic stages using permanent slides**
4. **Preparation of temporary/permanent slides of meiotic stages grasshopper testis (Poecilocera/Oxyasps).**
5. **Study of X-chromatin in human (Buccal smear)**
6. **Cell fractionation (demonstration)**
7. **Isolation of chloroplast (spinach leaves)**
8. **Isolation of mitochondria (spinach leaves)**
9. **Isolation of nucleus (sheep liver)**
10. **Culturing of microorganisms (Paramecium, Euglena) to observe cell motility**

I SEMESTER – PRACTICAL SYLLABUS

MGE -107- BASIC GENETICS

Total : 60 hrs

Course Objectives:

1. To make the students to understand the Life Cycle of *Drosophila melanogaster*
2. To apply the inheritance of traits from generation to generation
3. To acquaint in mounting the various parts of *Drosophila*

Course Outcomes:

1. Students are able to understand the Life cycle of *Drosophila*
2. Apply Mendel's Laws of inheritance
3. Able to prepare culture media of *Drosophila melanogaster*
4. Understand the basic concepts of mounting of Sex comb in *Drosophila*
5. Distinguish abnormalities in sperm shape of mouse

MGE -107- BASIC GENETICS

Total : 60 hrs

1. Study of *Drosophila* life cycle and its external morphology.
2. *Drosophila* culture: media preparation and handling of flies
3. Study of *Drosophila* mutants
4. Mounting of sex comb of *Drosophila melanogaster*.
5. Mounting of genital plate of *Drosophila melanogaster*.
6. Mounting and study of forewings of *Drosophila melanogaster*.
7. Study of venation patterns in different *Drosophila* species.
8. Study of Law of segregation and Law of independent assortment in fruit flies
9. Study of sperm shape abnormalities in mouse.

I SEMESTER – PRACTICAL SYLLABUS

MGE-108 ESSENTIALS OF CYTOGENETICS

Total : 60hrs

Course Objectives:

1. To study the process of meiotic cell division.
2. To provide an insight into chromosomal aberrations and study various modes of inducing them.
3. To deduce the structure of special types of chromosomes like polytene chromosomes.

Course Outcomes:

1. The students are able to dissect and prepare meiotic tissues in *Laccotrephis* and *Sphaerodema* and study various stages of meiosis.
2. Students are adept in the preparation of salivary gland tissue for the visualization of polytene chromosomes.
3. The Students gain exposure in the handling of model organisms like rats and in the preparation of metaphase plate from rat bone marrow.
4. By the end of the course the students are able to successfully culture and propagate paramecia and stain them for the observation of nucleic acid.
5. The students observe the induction of polyploidy in onion root tips

MGE-108 ESSENTIALS OF CYTOGENETICS

Total : 60 hrs

1. Study of meiosis in *Laccotrephis* and *Sphaerodema*.
2. Study of inversion polymorphism in *Chironomous*/mosquito polytene chromosomes.
3. Study of chromosomal aberrations induced by chemicals and X-rays (Rat). (Institutional visit)
4. Preparation of metaphase plate from rat bone marrow(Institutional visit)
5. Induction of Polyploidy in onion root tips
6. Feulgen staining of DNA in protozoa (*Paramecium*)

I SEMESTER – PRACTICAL SYLLABUS

MGE-109 BIOLOGICAL CHEMSITRY

Total : 60 hrs

Course Objectives:

1. To study the process of ATPase activity
2. To provide an insight into esterase activity
3. To deduce optimum blood glucose and serum cholesterol

Course Outcomes:

1. Understand the process of ATPase activity
2. Acquisition of knowledge about esterase activity

3. Able to estimate proteins and amino acids in Biological samples
4. Gain knowledge in the estimation of blood glucose and cholesterol
5. Able to prepare phosphate from egg yolk

MGE-109 BIOLOGICAL CHEMSITRY

Total : 60 hrs

1. Study of sodium-potassium ATPase activity in animal tissues (sheep).
2. Estimation of acetylcholine esterase activity by Hestrin's method (sheep).
3. Preparation of phosphatides from egg yolk.
4. Estimation of proteins in liver/mouse by Lowry's/Bradford's method.
5. Estimation of amino acids by Sorenson's method.
6. Determination of blood glucose and serum cholesterol in clinical samples.

II SEMESTER THEORY SYLLABUS

MGE-201: MOLECULAR BIOLOGY

52Hrs

Course Objectives:

1. To provide comprehensive understanding of salient features and structure of nucleic acids.
2. To impart elaborate understanding of the key events of prokaryotic and eukaryotic replication, transcription and translation.
3. To gain in-depth knowledge on the mechanism of gene regulation and expression.

Course Outcomes (COs):

1. Compare the genome structure and function of eukaryotic cells with that of simpler prokaryotic cells.
2. Illustrate the structural organization of genes and the control of gene expression.
3. Distinguish between positive and negative control of gene expression.
4. Apply the knowledge of various operons in formulating and executing experiments involving gene expression studies to address biological problems.
5. Apply the knowledge and link rapid advances in molecular biology to comprehend the mechanisms involved in various genetic diseases

UNIT I

13Hrs

Structure and Properties of DNA, RNA and Replication:

Information flow in biological systems: Central dogma. Biochemical evidences for DNA as genetic material. Watson and Crick model of DNA, Supercoiling- twist, writhe and linking number, different forms of DNA (A, B, Z). Structure and functions of different types of RNA. Characteristics and functions of bacterial DNA polymerases, Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Fidelity of replication, Nearest neighbor frequency analysis. Eukaryotic DNA polymerases and mechanism of replication. Telomere synthesis-telomerases. Replication of viral DNA, rolling circle model. Inhibitors of replicatio

UNIT II

13Hrs

Transcription

Characteristics and function of bacterial RNA polymerases, mechanism of transcription and regulation. Eukaryotic RNA polymerases- transcription factors, mechanism of transcription and regulation. Stringent response. Post transcriptional modifications of mRNA (5'cap formation, poly adenylation, spliciosome assembly, splicing editing), stability. Processing of tRNA and rRNA. Inhibitors of transcription. Ribozyme technology: mechanism of action and applications.

UNIT III

13Hrs

Translation and protein targeting:

Genetic code, Wobble hypothesis. Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in prokaryotes and eukaryotes. Differences between prokaryotic and eukaryotic protein synthesis, codon usage, Inhibitors of protein

synthesis. Co and post-translational modifications of proteins. Control of translation in eukaryotes.

Signal hypothesis, Export of secretory proteins- transport and localization of proteins.

UNIT IV

13 Hrs

Regulation of Gene expression:

Gene regulation, Operon model-Inducible and repressible systems, lac, gal, trp, his and arabinose operon; Attenuation, positive and negative regulation, role of cAMP and CRP in the expression of lac genes, catabolite repression, regulation of eukaryotic gene expression, transcriptional control, cis control elements, promoters, enhancers, transacting factors, homeobox in the control of developments in insects and vertebrates. DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (si RNA and mi RNA).

REFERENCES:

1. Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications,.
2. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry Pub WH Freeman Co.
3. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology , Pub. Oxford.
4. Mathews, Van Holde, Ahern, Biochemistry by, Pub Pearson education.
5. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. Molecular Biology of the Cell.
6. Cooper, G.M. The Cell: A molecular approach, ASM Press, USA.
7. Garrett, R.H. and Gresham, C.M.. Molecular aspects of Cell Biology, International edition, Saunders College Pub.
8. Karp, G. Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
9. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J. Molecular Cell Biology, Scientific American Books Inc. NY.

THEORY SYLLABUS- II SEMESTER

MGE-202: GENETICS OF DEVELOPMENT

52hrs

Course Objectives:

1. To perform a detailed analysis of molecular events of Oogenesis and spermatogenesis.
2. To analyze cell fate and pattern formation, molecular analysis of basic body plan and understand the genetics of axis specification in *Drosophila*.
3. To give an account on Stem cells, Embryonic stem cells and therapeutic cloning, transgenic stem cells and Regeneration Therapy and to describe Cellular aging and death.

Course Outcomes:

1. Students perform a detailed analysis of molecular events of Oogenesis and spermatogenesis and Hormonal regulations
2. Students are able to provide an in-depth account of Molecular events of fertilization and genetics of multicellularity cleavage in early development
3. Students can account of Early vertebrate development and Morphogenetic and cell movement.
4. Students give an account on Stem cells, Embryonic stem cells and therapeutic cloning, transgenic stem cells and Regeneration Therapy. A description of Cellular aging and death, Caspases, Cellular death receptors, Apoptosis and mechanism of Apoptosis.
5. Students perform a detailed analysis of Cell fate and pattern formation, molecular analysis of basic body plan, Genetics of axis specification in *Drosophila*, *C. elegans*, Amphibians and mammals

MGE-202: GENETICS OF DEVELOPMENT

52hrs

UNIT I

13hrs

Gametogenesis and differentiation: Oogenesis and spermatogenesis, Hormonal regulations.

Fertilization and development: Molecular events of fertilization, activation of sperm motility, gamete fusion, Role of calcium during egg activation; Genetics of multicellularity: cleavage and molecular events.

UNIT II

13 hrs

Early vertebrate development: An introduction to early developmental process-

Development of epidermis and neural tissue, formation of embryonic mesoderm and endoderm.

Morphogenetic and cell movement: Gastrulation in vertebrates, regulation of tissue separation in the amphibian embryo, role of basement membrane in cell migration,

epithelial morphogenesis, branching morphogenesis of mammalian epithelia.

UNIT III

13 hrs

Pattern formation: Cell fate and pattern formation, mutational and molecular analysis of basic body plan, Communication between and among cells, Genetics of axis specification in *Drosophila*, *C. elegans*, Amphibians and mammals.

Metamorphosis: Molecular mechanisms of: Ecdysone action, Signalling during larval organ differentiation, Hormone response during metamorphosis, Genetics of eversion and differentiation of imaginal disc cells; Regeneration: Cellular processes, Formation of blastomeres, Neuronal innervation, Transdifferentiation.

UNIT IV

13 hrs

Stem cells: Embryonic stem cells – therapeutic cloning, Multipotent adult stem cells, transgenic stem cells. Regeneration Therapy – neural diseases, cancer. Directed differentiation of stem cells.

Cellular aging: Concepts of aging, Cellular change during aging, theories.

Cell death: Apoptosis and mechanism of Apoptosis; Caspases, pro-apoptotic and anti-apoptotic proteins, Cellular death receptors, Signals for cell survival.

REFERENCES

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10. Davis. J.M., Basic Cell Culture.

THEORY SYLLABUS- II SEMESTER

MGE-203: MUTATION AND CANCER BIOLOGY 52Hrs

Course Objectives:

1. To give a description of basic concepts of mutation, mutagenesis and mutagenic agents and their effects.
2. To give a detailed analysis of DNA damage and repair mechanisms and DNA repair diseases.
3. To gain an in-depth view of cancer cytogenetics and cancer genetics.

Course Outcomes:

1. Students gain knowledge of Basic concepts of mutation, mutagenesis and mutagenic agents and their effects, effects of physical and chemical mutagens
2. Students perform a detailed analysis of DNA damage and repair mechanisms and an account of DNA repair defects in Human diseases
3. Students perform an in-depth analysis of Cancer cytogenetics and cancer genes- oncogenes, tumor suppressors, role of P53 in cancer induction
4. Students gain an understanding of tumor immunology, Mechanism of immune response to cancer, cancer diagnostics & therapy, Biochemical, histological and radiological methods for cancer diagnosis. An analysis of Chemotherapy and radiotherapy strategies for cancer treatment, Immunotherapy of cancer
5. Students are introduced to Cancer biology, mechanism of Carcinogenesis, types of cancers, characteristics of cancer cells

UNIT I

13 Hrs

Basic concepts of mutation and mutagenesis : Introduction, historical perspective; Types of mutations: microlesions - substitution, frameshift, non-frameshift, insertion, deletion; Macrolesions; spontaneous and induced mutations.

Mutagenic agents and their effects: Ionizing – alpha, beta, gamma and X radiations; Non-ionizing radiations - Ultraviolet and electromagnetic radiations; radiation dosimetry.

Mutagenic and clastogenic effects of radiations - Radiation effects on DNA; single strand breaks, double strand breaks, base damages, cross links, dimerisation. Chromosome and chromatid aberrations, breaks, exchanges, dicentrics, translocations, achromatic lesions, aneuploidy.

Chemical mutagens and their mechanisms – Agents which induce alkylation, deamination, base substitution, intercalation. Clastogenic effects of chemicals.

UNIT II

13 Hrs

DNA damage and repair mechanisms : Introduction, DNA damage, types of DNA repair and their mechanisms – Direct repair, Base excision repair, Nucleotide excision

repair, mismatch repair, recombinational repair, Photoreactivation, SOS repair; DNA repair genes, role of P53 gene in DNA repair and apoptosis. DNA repair defects in Human diseases – Ataxia Telangiectasia, Xeroderma Pigmentosum, Bloom's syndrome, Fanconi anemia, Cockayne syndrome, hereditary breast cancer

Cancer biology and carcinogenic agents: Introduction, neoplasia, anaplasia, metaplasia and hyperplasia, types of cancer- benign, malignant, metastatic cancers. Carcinomas, sarcomas, adenomas, haemopoietic cancers. Characteristics of cancer cells - changes in cell membrane structure and functions, tumor angiogenesis.

Carcinogenic agents – Physical, chemical and biological agents in carcinogenesis. Historical highlights, types of chemical carcinogens; direct acting, pro-carcinogens, co-carcinogens, mechanism of their action. Viral carcinogenesis – Role of viruses in causation of human cancer; Tobacco and diet related cancers

UNIT III

13 Hrs

Cancer cytogenetics and cancer genes: Somatic mutation theory of cancer, Cytogenetic and karyotype nomenclature, Various types of chromosomal aberrations in cancers, Philadelphia chromosome, Role of mismatch repair in cancer.

Oncogenes : Historical aspects, provirus, protovirus and oncogene hypothesis. Functional class of oncogenes (proto-oncogenes) Mechanism of carcinogenic transformation by oncogenes, viral oncogenes. Tumor suppressor genes- properties and mechanism of tumor suppression with special reference to p53 gene. Inherited cancers

UNIT IV

13 Hrs

Tumor immunology and cancer diagnostics & therapy: Tumor immunology – Introduction, Mechanism of immune response to cancer, natural killer cells and cell mediated cytotoxicity. Biochemical, histological and radiological methods for cancer diagnosis.

Chemotherapy and radiotherapy strategies for cancer treatment. Cancer chemotherapeutic drugs.

Types of radiation therapy.

Immunotherapy of cancer – Rationale of immunotherapy, Tumor necrosis factor, interleukins, cytokines, interferons, vaccines, monoclonal antibodies.

REFERENCES:

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2. Raymond W. R Cancer Biology, Oxford University Press, New York.
3. Becker F. F (Ed) Cancer, Vol.1-3, Plenum Press, New York.
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9. Umadevi P, Nagaratnam A and Satish Rao B.S Introduction to Radiation Biology,
B.I. Churchill Livinstone Pvt. Ltd. New Delhi

THEORY SYLLABUS- II SEMESTER

MGE- 204: EVOLUTIONARY GENETICS

52hrs

Course Objectives:

1. To make the Students to understand Biochemical and Genetic basis of formation of new species and inheritance of characteristics.
2. To enable the students to gain absolute knowledge on Darwinism, origin of species, modern synthetic theory and various theories of evolution.
3. To gain in depth knowledge on adaptive variation in the process of evolution.

Course Outcomes:

1. Describe the adaptive features of both primary and secondary aquatic vertebrates, desert reptile and mammals and also experiment the evolutionary aspects.
2. Elucidate the Chemical basis of origin of life and experiments for supporting that idea.
3. Describe and solve the mystery of the origin of new species by understanding the concepts of theory of Evolution considering Darwinism and Modern Synthetic theory.
4. Expound understanding of adaptive significance of coloration and mimicry with respect to environmental influence and the formation of variations in the expression of the characters in the process of evolution.
5. Describe the Isolating mechanisms, modes of speciation, Biological & Evolutionary Species

UNIT I

13 hrs

Evolutionary theories: Overview of history and evolutionary thought, Lamarckism and its limitations, Darwinism and its limitations, Mendelian and Biometrician controversy, Neo-Darwinism: [Mendelian population](#), [Gene pool](#), [Allele frequencies and genotype frequencies](#), [Hardy-Weinberg genetic equilibrium and its applications](#).

Evolutionary forces that affect the allelic frequencies, (i) Mutation (ii) Migration (iii) Selection- Stabilizing selection, Directional selection, Disruptive selection, Balancing selection, Frequency dependant selection, Density dependant selection, Group and kin selection, selection coefficient, selective value, Selection in natural populations, Genetic drift, Nonrandom mating.

UNIT II

13 hrs

Driving forces of Evolutionary: Fitness, Selection, Migration, random drift in small population, Non-darwinism, molecular polymorphism, nucleic acids and proteins, molecular clock, neutral theory of evolution, evolution random walk.

UNIT III

13 hrs

Isolating mechanisms: Classifications, Geographic isolation, Reproductive isolation, Premating isolation: Climatic, Seasonal, Habitat, Ethological, Post mating isolation: Gametic mortality, Hybrid inviability, Hybrid sterility, Hybrid breakdown, Origin of reproduction isolation, Muller's view. Dobzhansky view.

Speciation: Species types and Species categories, Concepts of species, Models of speciation: Based on distribution-sympatric, allopatric, stasipatric, Based on genetic drift: Genetic revolution, Genetic transience, Founder flush theory, Hybridization and speciation, Phyletic gradualism and punctuated equilibrium, Molecular aspect of speciation, speciation genes.

UNIT IV

13 hrs

Molecular phylogenetics: Construction of phylogenetic tree, Phylogenetic inferences: Distance method, Parsimony, maximum - likelihood method, Molecular phylogenetics of *Homo sapiens* and related issues, Hominid evolution.

Human population genetics and evolution: Basic attributes and polymorphic structures in human protein coding genes. Mitochondrial DNA polymorphism. Y-chromosome polymorphism and Single nucleotide polymorphism (SNP), Human society.

REFERENCES

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THEORY SYLLABUS- II SEMESTER

MGE-205: BIOINFORMATICS AND BIOSTATISTICS 40 hrs

Course Objectives:

1. To enable the students to the concepts and principles of biology, computer science, mathematics and Bioinformatics.
2. To facilitate the students to enumerate biological macromolecular structures
3. To make the students to understand different methods to characterize and manage the different types of Biological data.

Course Outcomes:

1. Able to understand and apply the concepts of Bioinformatics
2. Understand the basic principles of biology, computer science and mathematics to address complex biological problems
3. Students are able to enumerate biological macromolecular structures and structure prediction methods
4. Capable of analyzing and understanding different types of protein and other organism specific databases
5. Able to explain about the methods to characterise and manage the different types of Biological data.

MGE-205: BIOINFORMATICS AND BIOSTATISTICS 40 hrs

Part A: Bioinformatics

UNIT I

13hrs

Introduction to bioinformatics: Gene, Genome and Genomics, Proteomics and applications.

Sequence Analysis: Nucleotide and proteomic sequence analysis, Homology sequence analysis – BLAST, FASTA, Pairwise sequence analysis, Multiple sequences- CLUSTALW, Phylogenetic analysis.

UNIT II

13hrs

Biological Databases: Significance, Primary and Secondary databases, Nucleotide and proteome databases, Database querying software's.

Computer applications: Computer organization. Computer hardwares and computer software. Operating system: Basics of Windows, Unix and Linux .Spreadsheet and its applications. Databases, Computer networks: Internet, world wide web and applications. Information technology, Multimedia.Computer applications in genomics.

Part B: Biostatistics

UNIT III

14hrs

Introduction: Data collection, sampling (random and non random). Frequency distribution, histogram and frequency curve. Stem and leaf and box plot techniques. Time series graph. Measures of central tendency and dispersion. Skewness and kurtosis.

Probability: Conditional probability. Addition and multiplication rules of probability. Probability distributions. Binomial, Poisson and Normal distributions. Applications in genetics: simple, linear regression and correlation.

Tests of significance: Chi-square test, T-test, Z- test and F- test. Analysis of variance (one-way and two-way classified data).

REFERENCES

1. Attwood, T.K. & D.J. Parry-Smith (1999): Introduction to bioinformatics, Pearson Education Asia, New Delhi
2. Bergeron (2005): Bioinformatics computing. Pearson Education.
3. Campbell (2004): Discovering Genomics, Proteomics and Bioinformatics, Pearson Education.
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8. Nabendu Pal and Sahadeb Sarkar (2006): Statistics- Concepts and applications. PHI.
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12. Medhi, J. (1992) Basic Statistics, New Age Publications.

II SEMESTER – PRACTICAL SYLLABUS

MGE-206 MOLECULAR BIOLOGY

Total : 60 hrs

Course Objectives:

1. To gain expertise in the methods of nucleic acid isolation from various tissues.
2. To perform the estimation of cellular DNA and RNA using standard techniques.
3. To analyze genomic DNA using Agarose Gel Electrophoresis (PAGE) technique.

Course Outcomes:

1. The students gain experience in handling of various tools and equipment used in molecular biology and study the isolation of genomic DNA from plant and animal tissue.
2. The students are adept in the estimation of total RNA by Orcinol method.
3. The course provides valuable experience in the estimation of DNA by Burton's method.
4. The students are able to analyze genomic DNA by agarose gel electrophoresis.
5. The students are introduced to the study of isozymes and proteins by SDS-PAGE.

MGE-206 MOLECULAR BIOLOGY

Total : 60 hrs

1. Isolation of genomic DNA from plant tissue and animal tissue.
2. Estimation of cellular DNA by standard method (Burtons).
3. Estimation of RNA by orcinol method.
4. Analysis of genomic DNA by agarose gel electrophoresis.
5. Study of isozymes by (PAGE) electrophoresis.

II SEMESTER – PRACTICAL SYLLABUS

MGE-207 GENETICS OF DEVELOPMENT

Total : 60 hrs

Course Objectives:

1. To experiment the early development of frog/chick.
2. To expertise in mounting of chick embryos during development.
3. To experience morphogenetic movements in chick *in vivo*.

Course Outcomes:

1. Understand the early development of frog/chick.
2. Acquire knowledge in mounting of chick embryos during development.
3. Acquaint morphogenetic movements in chick *in vivo*.
4. Analyze early embryogenesis in Frog.
5. Experiment imaginal discs in *Drosophila*.

MGE-207 GENETICS OF DEVELOPMENT

Total : 60 hrs

1. Study of the early development of frog/chick.
2. Observation of permanent slides of developmental stages of frog/chick embryo
3. Mounting of chick embryos during development.
4. Morphogenetic movements in chick *in vivo* experiment.
5. Study of imaginal discs in *Drosophila*.
6. Fish: induction, spawning and early embryogenesis.

II SEMESTER – PRACTICAL SYLLABUS

MGE-208: MUTATION AND CANCER BIOLOGY

Total: 60 hrs

Course Objectives:

1. To study mutations in bacteria and the use of Ames test.
2. To study differential gene expression using polytene chromosomes in drosophila
3. To study the MTT assay and its uses.

Course Outcomes:

1. The students analyze differential gene expression in polytene chromosome of *Drosophila*
2. The students are able to analyze mutations using the Ames test.
3. The course enables students understand the genetic basis of insecticide resistance.
4. The students study insecticide susceptibility in Culicine mosquitoes.
5. The students understand the principle of viability assays and study the MTT assay.

MGE-208: MUTATION AND CANCER BIOLOGY

Total: 60 hrs

1. Differential gene expression: demonstration of ecdysone/heat-induced gene expression in polytene chromosome of *Drosophila*
2. Detection of mutation in E.coli by Ames test.
3. Genetic basis of insecticide resistance
4. Susceptibility studies by using different insecticides in Culicine mosquitoes.
5. Genetic basis of insecticide resistance by using adulticide.
6. MTT assay
7. Trypan blue dye exclusion test

II SEMESTER – PRACTICAL SYLLABUS

MGE-209: EVOLUTIONARY GENETICS

Total : 60

hrs

Course Objectives:

1. Enable the students to understand the Quantitative characters in *Drosophila*.
2. To experiment change in gene frequencies.
3. To analyze Hardy-Weinberg principles

Course Outcomes:

1. Students are able to understand the Quantitative characters in *Drosophila*
2. Expertise in analyzing change in gene frequencies.
3. Understand Hardy-Weinberg principles and applications
4. Distinguish homology and analogy of organs in organisms
5. Analyze Genetic drift

MGE-209: EVOLUTIONARY GENETICS

Total : 60 hrs

1. Quantitative characters in *Drosophila*: Sternoplurals and Acrostichals, Mean and standard error.
2. Calculation of change in gene frequencies.
3. Applications of Hardy-Weinberg principles and genetic problems.
4. Experiments on Genetic Drift: a) Population size b) Sampling Error
5. Studies on Homology Analogy

THEORY SYLLABUS- III SEMESTER

MGE-301 GENETIC ENGINEERING

52 Hrs

Course Objectives:

1. To provide adequate knowledge on salient features and applications of tools used in RDT.
2. To enable students to understand the methodology used in construction of recombinant DNA.
3. To facilitate students to obtain deeper insight into the various techniques used in genetic engineering.

Course Outcomes (COs):

1. Elucidate the features of various enzymes used in genetic engineering.
2. Contrast the cloning and expression vectors with respect to their characteristic features.
3. Explain the construction of genomic and c- DNA library and their applications.
4. Comprehend and illustrate the steps and strategies involved in genetic manipulation.
5. Analyze and implement the hybridization techniques in construction of recombinant DNA.

MGE-301 GENETIC ENGINEERING

52 Hrs

UNIT I

13Hrs

Genetic Engineering and Tools of Genetic Engineering:

Genetic Engineering – Introduction, scope and importance

Restriction endonucleases –types, nomenclature, recognition sequences, cleavage pattern, T4 DNA ligase and NAD dependent DNA ligase of *E. Coli* ligation techniques, Vectors –general characteristics of vectors, desirable characters such as size orisite, selection / marker gene, restriction sites and unique multiple cloning sites for cDNA cloning, cloning and expression vectors –Plasmids –PBR 322 pUC vectors, Ti Plasmids – M13 derived pUC vectors, Phage vectors – lambda based vectors, M13, Cosmids, Phagemids, ARS, Mini Chromosome, yeast artificial chromosomal vectors (YAC), Shuttle vectors specific promoters for expression in yeast cells, transcriptional terminators, selection of marker genes for bacteria and yeast cells: Vectors for plants; expression vectors. Vectors for animals – SV40, Bovine papilloma virus (BPV), Retrovirus.

UNIT II

13Hrs

Gene Cloning, gene libraries and transformation techniques:

Cloning and selection of individual gene, gene libraries, preparation of cDNA libraries; isolation and purification of mRNA ; importance of poly-A tailing in the preparation of cDNA library; Genomic library isolation and purification of total genomic DNA, partial digestion with suitable enzyme size fractionation and end modification.

Transformation Techniques : Preparation of competent cells of bacteria, yeast insect, Methods of DNA transfer, exogenously supplied chemical methods, calcium phosphate precipitation method, liposome mediated method and electroporation, Agrobacterium T-DNA mediated method, gene gun method ; Determination of transformation / transfection efficiency. Lambda DNA based DNA recombinants : In vitro packaging of DNA using packaging extracts infection of bacteria using packaged lambda viruses containing recombinant DNA.

UNIT III**13Hrs****Plating, screening and selection:**

Preparation of nutrient media with selection, marker antibiotics and additives for visual screening of recombinant clones, selection of clones, amplification and preservation.

Labeling of DNA, RNA and proteins : Use of radioactive isotopes, Non –radioactive labeling relative advantages and disadvantages, in-vivo labeling, Nick translation, random primer labeling, auto-radiography, auto-fluorography.

UNIT IV**13Hrs*****In vitro* translation and Hybridization techniques :**

Purification of mRNAs and translation using cell free systems from wheat germ extract or rabbit reticulocytes and characterization of protein products on gel electrophoresis. Blotting experiments – southern , Northern western and western / southern blotting methods, agarose gel, polyacrylamide gel and 2D gel electrophoresis ; DNA microarrays (DNA chips) to study gene expression.

REFERENCES:

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2. Davies J.A. and Reznikoff, Butterworth-Heinemann Milestones in Biotechnology , classic papers on genetic engineering.
3. D.V. Goeddel, Methods in enzymology –Gene Expression Technology, Vol. 185, Academic press Inc. San Diego.
4. Glick and Pasternak – Molecular biotechnology, Principles and application of recombinant DNA.
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6. Old R.W. and S.B. Primrose Principles of gene manipulation, Boston Blackwell Scientific Publications.

THEORY SYLLABUS- III SEMESTER

MGE- 302: MICROBIAL AND PLANT GENETICS

52 Hrs

Course Objectives:

1. To gain insight into Microbial Genetics, the generalized life cycles of microbes, Bioremediation and phytoremediation, Biosensors.
2. To study the significance of plants as genetic model systems and gene regulation in plants.
3. To perform an in-depth analysis of Molecular and genetic basis of Crown Gall disease development and the Genetic basis of disease resistance and susceptibility in plants.

Course Outcomes:

1. Students take an in-depth look into Microbial Genetics, an Over view of generalized life cycles of microbes, Non- sexual variation, Tetrad analysis and linkage detection, Bioremediation and phytoremediation, Biosensors.
2. Students perform an Over view of plants as genetic model systems, gene regulation in plants, ABC model of regulation of flower development, Development of dorsal and ventral asymmetry in leaves. Role of KNOX genes in evolution of compound leaf, Mechanism of self-incompatibility in plants
3. Students analyze the Molecular and genetic basis of Crown Gall disease development, Genetic basis of disease resistance and susceptibility in plants. Molecular basis of host pathogen interaction, Mechanism of T-DNA transfer and their utility in production of transgenic plants.
4. Students are able to provide a description of Protoplast technology- Isolation, maintenance and viability tests for protoplast, methods of protoplast fusion and its application
5. Students give an account on Biofertilizers, Production and beneficial roles of Rhizobium, Azotobacter blue green algae, mycorizal fungi and Azolla.

MGE- 302: MICROBIAL AND PLANT GENETICS

52 Hrs

UNIT I

13 Hrs

Microbial Genetics: Overview of Microbes as genetic tools for basic and applied studies. Over view of generalized life cycles of microbes. Non- sexual variation. Significance of haploidy. Heterokaryosis and parasexuality. Tetrad analysis and linkage detection in *Neurospora*. Mitotic recombination in *Neurospora crassa* and *Aspergillus nidulans*, gene conversion in fungi, Bioremediation and phytoremediation, Biosensors.

Fermentation technology: Fermentors, bioreactors, Selection of microbes, Fermentation media, Fermentation enzymes, Production of alcoholic beverages, Vitamins and antibiotics

UNIT II

13 Hrs

Gene regulation in plants: Over view of plants as genetic model systems, gene regulation in plants. Genes involved in regulation of flower development. Homeotic genes, Development of dorsal and ventral asymmetry in leaves. Role of KNOX genes in evolution of compound leaf. Types of abiotic stresses and gene regulation during water deficit and heat stress. Plant nodule genes. Mechanism of self-incompatibility in plants.

UNIT III

13 Hrs

Applied genetics of plants: Genetic basis of disease resistance and susceptibility in plants. Molecular basis of host pathogen interaction. Molecular and genetic basis of Crown Gall disease development. Agrobacterium- Genetics of Ti plasmid. Plant wound genes and control of 'vir' gene expression. Mechanism of T-DNA transfer and their utility in production of transgenic plants.

UNIT IV

13Hrs

Protoplast technology: Isolation, maintenance and viability tests for protoplast, regeneration of plants from protoplast, methods of protoplast fusion and its application.

Biofertilizer: Production and beneficial roles of *Rhizobium*, Inoculants and *Azotobacter* inoculants, field application of *Rhizobium*, *Azotobacter* blue green algae, mycorizal fungi and *Azolla*

REFERENCES

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2. Brahma Mishra, (2009). *Fertilizer Technology and Management*, I.K. International Publishing House Ltd., New Delhi.
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15. Srivastava, P.S., Alka Narula, Sheela Srivastava, (2004). *Plant Biotechnology and Molecular Markers*, Anamaya Publishers, New Delhi

THEORY SYLLABUS- III SEMESTER

MGE- 303: HUMAN GENETICS

52 Hrs

Course Objective:

1. To enable the students to grasp the fundamentals of gene therapy, problem solving in the fields of Science, Medicine and Society.
2. To gain knowledge and apply the techniques of principles of inheritance of human traits, diseases related to genes and chromosomes.
3. To familiarize with immune system and the importance of antibody and cell mediated immune responses in defense mechanism to defend human from various pathogenic infections and diseases.

Course Outcomes:

1. Students can synthesize and incorporate the fundamentals of gene technology in order to understand how such technology impacts human.
2. Employ the scientific method for the acquisition of new knowledge to solve problems regarding human genome, diseases and inheritance pattern.
3. Apply to real life situations and one's life the principles of human heredity.
4. Students can access and apply historical and current knowledge regarding human heredity, and understand how such knowledge has influenced law, medicine and society.
5. Understand the pattern of immune response against various pathogenic agents and research and apply the concepts in the field of Clinical genetics.

MGE- 303: HUMAN GENETICS

52 Hrs

UNIT I

13 Hrs

Basics of human genetics:

History of human genetics, karyotype and idiogram. Nomenclature of human chromosomes, Denver, London and Paris and ISH nomenclature. Pedigree, Pattern of inheritance. Identifying recombinants and non-recombinants in pedigrees. Somatic cell fusion, cell hybrids and Radiation hybrids, Genetic and physical map distances, Two-point mapping - LOD score analysis.

UNIT II

13 Hrs

Genetic mapping of complex traits: Difficulties in mapping complex traits. Allele sharing methods- Affected sib pair analysis. Allelic association mapping. Linkage disequilibrium mapping. Transmission disequilibrium test. Whole genome scan and mapping. Integration of Cytogenetic, genetic and physical maps.

Genetic basis of chromosomal syndromes

Chromosomal syndromes: Down's, Turner's, Klinefelter's, Edward's syndrome, Cri-du-chat's, Patau's. Genetic diseases (Cystic fibrosis and Marfan syndrome). Inborn errors of metabolism (Phenylketonuria and Mucopolysaccharidosis),

UNIT III

13 Hrs

Genetic disorders

Neurogenetic disorders (Charcot-Marie-Tooth syndrome and Parkinson disease), Genetic disorders of Haemopoietic systems (Sickle cell anemia and Thalassemia), Genetic disorders of eye (Retinitis pigmentosa, Glaucoma and Cataracts), Muscle genetic disorders (Duchenne and Becker Muscular Dystrophy), Genome imprinting syndromes (Prader-Willi & Angelman syndromes, Beckwith-Wiedeman syndrome, Genetic disorders in skeleton and skin, Congenital heart diseases, Learning disorders, Genetics of Infertility, Cognitive disabilities, Schizophrenia and Anxiety disorders, Complex syndromes (Atherosclerosis, Diabetes mellitus, Rheumatoid Arthritis), Mitochondrial syndromes.

UNIT IV

13 Hrs

Diagnosis: Prenatal diagnosis: (i) Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography (ii) Invasive methods- Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy. Technology in reproductive assistance

Counseling, Therapy and Ethics:

Genetic counseling: Definition, Components, Psychotherapeutic counseling, Decision making, risk assessment and counseling in Mendelian and multifactorial syndromes, Gene therapy, Management of genetic disorders, Models of eugenics, human right, human genetics and legal, social and ethical considerations.

REFERENCES

1. H. Harris & K. Hirschhorn, 1983. Advances in Human Genetics. (Vol. 10-13), Plenum Press, N.Y. & London.
2. Muin J. Khoury, Julian Little & Wylie Burke, 2004. Human Genome Epidemiology, Oxford University Press.
3. Lai Poh San & Eric P H Yap, 2001. Frontiers in Human Genetics – Diseases & Technologies, World Scientific.
4. Frank A. Barile, 2004. Clinical Toxicology- Principles & Mechanisms, CRC Press.
5. Jeffrey C. Hall & Jay C. Dunlap, 1995. Advances in Genetics – Incorporating Molecular Genetic Medicine (Vol. 32), Academic Press.
6. J. Fernandes, J.M. Saudubray & G. Van den Berghe, 1996. Inborn Metabolic Diseases – Diagnosis and Treatment (Second Edition), Springer.
7. Sally A. Moody, 1999. Cell Lineage and Fate determination, Academic Press.
8. James C. Thomas & David J. Weber (Ed.), 2001. Epidemiological Methods for the Study of Infectious Diseases, Oxford University Press.

III SEMESTER – PRACTICAL SYLLABUS

MGE-305: GENETIC ENGINEERING

Total : 60 hrs

Course Objectives:

1. To study various techniques of plasmid DNA isolation.
2. To provide hands on training in molecular biology techniques like Restriction digestion and Ligation.
3. To introduce various methods of genetic transformation.

Course Outcomes:

1. The students perform Restriction enzyme digestion of DNA and understand the principles and underlying mechanisms involved in Restriction digestion and ligation.
2. The students are able to amplify DNA using PCR method and characterize it using PAGE.
3. The course provides hands on training in basic methods in genetic transformation including the preparation of competent cells and fusion using various methods.
4. The students are introduced to key concepts in Western and Southern Blotting.
5. The students gain experience in various methods of plasmid DNA isolation.

MGE-305: GENETIC ENGINEERING

Total : 60 hrs

1. Isolation of Plasmid DNA
2. Restriction enzyme digestion/Ligation of DNA and calculation of molecular weight of the digested DNA
3. DNA amplification by PCR method.
4. Preparation of competent cells in *E. coli*.
5. Transformation through CaCl₂, PEG methods.
6. Western and Southern Blotting.

III SEMESTER – PRACTICAL SYLLABUS

MGE 306: MICROBIAL AND PLANT GENETICS

Total : 60 hrs

Course Objectives:

1. To gain experience in bacterial culture techniques and media preparation.
2. To study gram staining and its significance.
3. To extract DNA from bacterial cells.
4. To perform nucleic acid staining in paramecium.

Course outcomes:

1. The students gain valuable insight and experience in bacterial media preparation, aseptic techniques and bacterial culture.
2. The students perform the extraction of total DNA from bacterial cells.
3. The students are able to culture and maintain paramecium cultures and perform nucleic acid staining using Methyl green-pyronin.
4. The students study the experimental basis of protoplast extraction.
5. The course enables the students to perform replica plating in bacteria.

MGE 306: MICROBIAL AND PLANT GENETICS

Total : 60 hrs

1. Bacterial culture and Gram staining.
2. Extraction of DNA from bacterial cells.
3. Replica plating technique.
4. Isolation of bacteriophage from sewage water.
5. Methyl green-pyronin staining to localize nucleic acids in appropriate tissue.
6. Plant tissue culture- protoplast extraction.
7. Toluidine blue staining for RNA and DNA.

III SEMESTER – PRACTICAL SYLLABUS

MGE 307: CELLULAR PHYSIOLOGY

Total : 60 hrs

Course Objectives:

1. To understand and appreciate the principles of Chromatography techniques
2. To acquire knowledge in the estimate of RNA and DNA
3. To appreciate the principals involved in the estimation of ascorbic acid contents in the different tissues

Course Outcomes:

1. Students analyze the principle involved in chromatography techniques
2. Able to estimate RNA and DNA
3. Acquaintance of an estimation of ascorbic acid contents in the different tissues
4. Analyze ascorbic acid contents in the different tissues.
5. Determination of rate of active transport of glucose across the intestine

MGE 307: CELLULAR PHYSIOLOGY

Total : 60 hrs

1. Paper chromatography of amino acids.
2. Thin layer chromatography of eye pigments.
3. Estimation of RNA by orcinol method.
4. Determination of myosin ATPase activity.
5. Effect of ATPase in central nervous system in the rats.
6. Estimation of ascorbic acid contents in the different tissues.
7. Determination of rate of active transport of glucose across the intestine.

III SEMESTER – PRACTICAL SYLLABUS

MGE-308: HUMAN GENETICS (Practical)

Total: 60 hrs

Course Objectives:

1. To gain knowledge and able to identify and distinguish normal human karyotype and abnormal human karyotype
2. Acquire knowledge about Lymphocyte culture, harvesting, conventional staining and preparation of human normal karyotype.
3. To impart in-depth knowledge of Chromosome staining and banding techniques.

Course Outcomes:

1. Illustrate the structure and number of normal and abnormal human karyotypes
2. Gain knowledge and hands on experience in Lymphocyte culture, harvesting, conventional staining and preparation of human normal karyotype.
3. Understand and analyze Chromosome staining and banding techniques.
4. Acquire knowledge in differential staining of human blood
5. Acquaintance of blood smear preparation and Blood cell counting.

MGE-308: HUMAN GENETICS (Practical)

Total: 60 hrs

1. Study of normal human karyotype.
2. Study of abnormal human karyotype.
3. Lymphocyte culture, harvesting, conventional staining and preparation of human normal karyotype.
4. Chromosome staining and banding techniques.
5. Chromosomal preparations using solid tumor/leukemia samples.
6. Differential staining of human blood.
7. Blood smear study of drum sticks in Neutrophils.
8. Blood cell counting: using Haemocytometer. (RBC and WBC)

IV SEMESTER THEORY SYLLABUS

MGE- 401: GENOMICS AND PROTEOMICS

52 Hrs

Course Objectives:

1. To introduce the terms-genomics, proteomics and other omics and their significance
2. To perform an analysis of Gene prediction- experimental methods and computer based methods.
3. To describe mapping techniques, sequencing methods and functional analysis techniques.

Course Outcomes:

1. Students analyze the various subfields of genomics, proteomics and other omics including transcriptomics, metabolomics and their significance
2. Students perform an Analysis of Gene prediction- experimental methods and computer based methods, gene prediction rules and various softwares used for prediction.
3. Students are able to provide a description of the experimental methods used in various fields of genomics including mapping techniques, sequencing methods and functional analysis techniques.
4. Students take an indepth look into the various genome databases, the annotation of genomes and taxonomy and significance of genomes of various model organisms.
5. Students can account on the Concepts of evolution of genomes and the hypotheses available to explain the evolution of genomes in lifeforms.

UNIT I

13 Hrs

Organization of genomes:

Introduction: Genome, Genomics, Omics and importance, General features, C-value paradox. Gene identification; gene prediction rules and software's; Genome databases; Annotation of genome. Genome diversity: taxonomy and significance of genomes – bacteria, yeast, *Caenorhabditis*, *Homo sapiens*, *Arabidopsis*, etc.

UNIT II

13 Hrs

Mapping genomes:

Genetic mapping – i) Cross breeding and pedigree analysis, ii) DNA markers - RFLPs, SSLPs, SNPs

Physical mapping - Restriction mapping, Fluorescent *in situ* hybridization, Radiation hybrid mapping and Sequence tagged site mapping.

UNIT III

13 Hrs

Genomics:

Genome projects: The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project.

Structural genomics: Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole –genome shotgun sequencing

Understanding a genome sequence: locating the genes in a genome sequence, determining the functions of individual genes and by studying the activity of a protein coded of an unknown gene

UNIT IV

13 Hrs

Pattern of genome evolution:

The origin of genomes- Origin of macromolecules, RNA world and DNA world

Acquisition of new genes (By gene duplication) and Gene families – (Types, Pseudogenes, Origin of gene families (lateral gene transfer, allopolyploidy). Synthetic genomes and their applications

REFERENCES

1. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
2. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific
3. Graur, D and W H Li, 2000. Fundamentals of molecular evolution. Sinauer Associates.
4. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. 2004. Genetics from Genes to Genomes. McGraw Hill.
5. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
6. The Human Genome 2001, Nature Vol. 409.
7. The *Drosophila* Genome. 2000, Science Vol. 267.
8. The *Caenorhabditis elegans* genome 1998. Science Vol. 282.
9. The Arabidopsis Genome 2000 Nature vol. 408.
10. Primrose, S. B., and R. M. Twyman . 2006. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA

IV SEMESTER THEORY SYLLABUS
MGE -402 IMMUNOGLOGY AND HEMATOLOGY

52 hrs

Course Objectives:

1. To empower the students to understand the different cells and tissues involved in defence mechanism of defending human beings from diseases caused by various microorganisms.
2. To enable the students to understand the normal and inappropriate immune responses and their consequences and also the importance of vaccination in the process of protecting human from infectious diseases
3. To facilitate the students to understand the apply the knowledge on hemolytic disorders and also to enable them to acquire knowledge in setting up of blood bank and blood safety.

Course Outcomes:

1. Acquire a broad and coherent theoretical and technical knowledge of cells and tissues of immune system.
2. Elucidate pathologies associated with an inappropriate immune response which leads to autoimmune disorders. Also to understand and analyse the importance of vaccination in defending human beings from various infectious diseases.
3. Comprehend a broad and coherent theoretical and technical knowledge of haematology and hemolytic disorders. Also to critically analyse functions of blood cells and platelets in defence mechanism.
4. Acquisition of indepth knowledge on different types of blood groups and able to apply compatibility testing and antihuman globulin test.
5. Understand and apply the acquired knowledge on blood transfusion, administration of blood bank and blood safety.

MGE -402 IMMUNOGLOGY AND HEMATOLOGY

52 hrs

UNIT I

13 Hrs

Overview and Cells of the Immune system: Historical account, innate immunity: Anatomic barriers, Physiologic barriers, Phagocytic barriers, Microbial antagonism, Inflammation, PRRs, TLRs and PAMPs. Acquired immunity: Naturally acquired, artificially acquired and adaptive, Humoral and cell mediated immunity, Complement system: components, activation and biological consequences.

Tissues and cells of immune system: Structure of lymph node, spleen, mucosal associated lymphoid tissue and gut associated lymphoid tissue. Biology of cells of the immune system: Hematopoiesis, Microphages (Neutrophils), Macrophages, T-Lymphocytes, B-Lymphocytes, Dendritic cells and NK cells.

UNIT II

13 Hrs

Antigens, Immunoglobulins and T cell receptors: Factors influencing immunogenicity, Haptens, Classes of immunoglobulins, Structure of IgG, Kinetics of immunoglobulin synthesis, Genetic basis of immunoglobulin diversity, Genetic basis of T cell receptor diversity, MHC molecules – Types and structure (i) Clonal selection and immunological memory, Antigen recognition – exogenous pathway, endogenous pathway, cross presentation.

Vaccines: Principles of vaccination, primary and secondary responses, antibody engineering, Monoclonal antibodies and their applications, antigen-antibody interactions, congenital and acquired immunodeficiency. Autoimmunity and autoimmune diseases, Hypersensitivity.

UNIT III

13 Hrs

Blood composition and its disorders:

Blood: Composition, RBC'S- structure and function. Structure, function and synthesis of hemoglobin, Blood indices, peripheral blood smear, parasite in blood. Sick cell anaemia, thalassemias.

Screening tests for hemolytic disorders: Disorders of WBC, TC of RBC and WBC, DC of WBC.

Platelet structure and function: Bleeding disorders and investigations, coagulation process and theory, disorders. Coagulation of blood.

UNIT IV

13 hrs

Transfusion medicine:

Blood group and antigens: ABO and sub groups, antigen and antibodies, Rh blood grouping, other blood group systems, compatibility testing, antihuman globulin test.

Blood transfusion: Selection of blood donors, blood transfusion procedures, Complication of blood transfusion, Blood component therapy, organization and administration of blood bank, blood safety.

REFERENCES

- 1 H.Harris & K.Hirschhorn, 1983. Advances in Human Genetics. (Vol. 10-13), Plenum Press, N.Y. & London.
- 2 Muin J. Khoury, Julian Little & Wyile Burke, 2004. Human Genome Epidemiology, Oxford University Press.
- 3 Lai poh San & Eric P H Yap, 2001. Frontiers in Human Genetics – Diseases & Technologies, World Scientific.
- 4 Frank A. Barile, 2004. Clinical Toxicology- Principles & Mechanisms, CRC Press.
- 5 Jeffrey C. Hall & Jay C. Dunlap, 1995. Advances in Genetics – Incorporating Molecular Genetic Medicine (Vol. 32), Academic Press.
- 6 J. Fernandes, J.M.Saudubray & G.Van den Berghe, 1996. Inborn Metabolic Diseases – Diagnosis and Treatment (Second Edition), Springer.
- 7 Sally A. Moody, 1999. Cell Lineage and Fate determination, Academic Press.
- 8 James C. Thomas & David J. Weber (Ed.), 2001. Epidemiological Methods for the Study of Infectious Diseases, Oxford University Press.

THEORY SYLLABUS- IV SEMESTER
MGE- 403: BIOMEDICAL GENETICS

52 Hrs

Course Objectives:

1. To acquaint students with various genetically inherited diseases, diseases caused by viruses, bacteria, fungi and protozoa.
2. To enable students to comprehend how basic pharmacokinetic processes are defined, expressed and affected; how pharmacokinetics together with pharmacodynamics determine the effect intensity and effect duration of a drug.
3. To enable students to demonstrate mastery of cutting edge research approaches in developing various molecular therapeutics and understand the process of drug development.

Course Outcomes (COs):

1. Comprehend and illustrate the role of genetic and genomic assessment in clinical practice, including applications in disease screening, diagnosis, and treatment.
2. Understand and correlate the relationship between pharmacokinetics and pharmacodynamics to prevent adverse medication implications in patients and to relate the concepts with the best and advanced clinical practice to augment drug delivery care.
3. Outline the process of drug development and account for critical factors and decision points in drug development process.
4. Acquaint with how nanotechnology is implemented in treatment of various diseases.
5. Integrate novel biomedical knowledge and emerging technologies in professional practice for enhanced health care.

PAPER-MGE- 403: BIOMEDICAL GENETICS

52 Hrs

UNIT I

13 Hrs

Human Diseases

Etiology, pathology, symptoms and treatment of the genetically inherited diseases – PKU, Alkaptonuria, Galactosemia, Von’Gierke disease, Lesch Nyhan syndrome, Gout, Sickle Cell Anemia, Beta Thalassemia and Diabetes; Evaluation of organ functions – liver, kidney, cardiac and gastric function tests.

Mode of infection, symptoms, epidemiology and control measures of disease caused by – Viruses (HIV, Hepatitis- B, Rabies, HSV-1); Bacteria (Typhoid, Syphilis, TB); Fungi (Aspergillosis, Histoplasmosis, Cryptococcosis); Protozoa (Malaria, Amoebiasis)

UNIT II

13 Hrs

Pharmacodynamics and Pharmacokinetics

Pharmacodynamics – Drug receptors and administration, relationship between drug concentration and response; Pharmacokinetics – ADME, Concepts in toxicology, acute, subacute and chronic toxicity studies, Calculation of LD50 and ED50, biological half-life, physicochemical principles, drug accumulation; Molecular mechanisms of drug action.

Drug discovery

Introduction, conventional drug design approaches, irrational vs rational, Lipinski's rule of five, Drug development process (Preclinical, clinical and toxicological evaluation); Novel Drug Development approaches – QSAR (quantitative structure activity relationship), High throughput screening.

UNIT III

13 Hrs

Molecular therapeutics

Gene therapy, barriers to gene delivery, overview of inherited and acquired diseases as candidates for gene therapy, Liposome-mediated gene delivery, cellular therapy, use of stem cells, recombinant therapy; Erythropoietin in the treatment of Leukemia, Insulin analogues and its role in diabetes, Streptokinase and urokinase in thrombosis, role of recombinant interferons, immunostimulants and immunosuppressors in organ transplants.

UNIT IV

13 Hrs

Nanobiotechnology

Introduction, types and synthesis of nanomaterial, protein-based nano structures, DNA-based nano structures; Applications of nanomaterial – nanobiosensors, drug and gene delivery, disease diagnostics, cancer therapy.

Genetics and Society

Population screening for genetic diseases, Ethical issues involved in medical genetics, Human genome project and its practical implications, Eugenic and dysgenic effects.

REFERENCES:

1. Bartram G. Katzung, . Basic and Clinical Pharmacology, Mc Graw Hill publications, USA.
2. Burtis and Ashwood, . Tietz Fundamentals of Clinical Chemistry , WB Saunders Company, Oxford Science Publication, USA.
3. Devlin, Text book of biochemistry with clinical correlations , John Wiley and Sons, New York.
4. Jawetz, Melnick and Adelgerg, . Medical Microbiology, Lange Medical Publications, California.
5. Judit Pongracz and Mary Keen, . Medical Biotechnology, Elsevier publications, Churchill, Livingstone.
6. Lachman, L., Lieberman A.H., Joseph and Kanig,.The Theory & Practice of Industrial Pharmacy, Vergese Publishing House, Bombay.

7. Lalit M Srivatsava, Nibhriti Das and Subrata Sinha,.Essentials of practical Biochemistry, CBS publishers, India.
8. Sawhney and Randhir Singh,. Introduction to practical Biochemistry, Narosa publishing house, London.
9. Wilson, K. and Walker, J., Practical Biochemistry, Cambridge University Press, UK.

IV SEMESTER – THEORY SYLLABUS

MGE-404: PLANT AND ANIMAL BIOTECHNOLOGY

52hrs

Course Objectives:

1. To provide students new knowledge and widening of the knowledge of handling of classical and modern plant biotechnology processes, including breeding of healthy plants, plants with improved characteristics and plants for biomolecule production.
2. To facilitate the students to obtain skills on biotechnological processes such as cell and tissue culture, gene transfer in plants and also applicative value in pharmaceutical and food industry, in agriculture and in ecology.
3. To illustrate the techniques, procedure and growth patterns of animal tissue and organ culture, cell lines and commercial applications of animal tissue culture.

Course Outcomes:

1. Apply knowledge acquired in plant breeding which is of disease resistant, healthy and improved characteristics.
2. Construct the techniques involved in cell and tissue culture and gene transfer in plants and also its applications in pharmaceutical, agriculture and food industries.
3. Illustrate and experiment the techniques, procedure and growth patterns of animal cell culture.
4. Outline the history and structure of animal cell and describe the in vitro applications of animal cell culture.
5. Construct the techniques in production of cloned animal and its applications. Also to make the students to understand the uses of animal cells in vaccine production.

UNIT I:

Introduction to Cell and Tissue Culture

13 hrs

Plant tissue culture media (composition, types and preparation); Plant growth regulators in tissue culture, Selection and preparation of explant; Micropropagation – Direct regeneration, Indirect regeneration – callus culture and organogenesis, Somatic embryogenesis; Protoplast isolation and culture, somatic hybridization; Haploid production – Androgenic haploids (anther, pollen culture) and Gynogenic haploids (ovary, ovule culture); Somaclonal variation and its significance; Cell suspension culture; Cell culture methods for secondary metabolite production; Cryopreservation, Gene banks for germplasm conservation.

UNIT II:

13 hrs

Gene Transfer in Plants

Promoters – 35S, Ubiquitin; Marker genes – Reporter genes (OS, CAT, GUS, Lux, Luc, GFP), Selectable markers (antibiotic resistance marker, antimetabolite resistance marker, herbicide resistant marker); Gene transfer methods – Vector or Agrobacterium mediated gene transfer – Ti and Ri plasmids, virulence genes, Agrobacterium vectors – cointegrate vectors and binary vectors; Plasmid vectors – pBLUESCRIPT IIKs, pBin 19, pGreen vectors; Virus mediated gene transfer – Caulimo viruses, Gemini viruses, RNA viruses; Vectorless or Direct gene transfer – Physical methods - particle bombardment, electroporation, microinjection; Chemical methods – PEG mediated, Calcium phosphate coprecipitation, polycation DMSO.

ANIMAL BIOTECHNOLOGY

UNIT III:

13 hrs

Animal tissue culture requirements and methods:

Introduction, Types of culture- Organ culture, cell culture, organotypic culture, histotypic culture.

Design and layout of animal tissue culture laboratory, maintenance of sterile condition

Equipments – Essential, beneficial and useful equipments, consumable items.

Culture medium- Physico-chemical properties, complete media, serum, serum free media, balanced salt solutions, selection of medium and serum.

Preparation and sterilization – Apparatus, Reagents and media, storage Contamination- Source and types of contamination

Primary culture- Types (Primary explant and primary cell cultures). Primary explant culture method (mouse/chick embryo tissues). Primary cell culture method- disaggregation (enzymatic, mechanical) and culturing. Lymphocyte culture method (Suspension culture)

UNIT IV

13Hrs

Cell-lines, Organ culture, large scale cultures and applications of animal tissue culture: Cell lines: Definition, Evolution of cell lines, continuous cell lines, cell line designation, maintenance, subculture, maintenance records. Cell line banking, cryopreservation, cell viability assays

Organ culture - Methods, Raft and grid methods, Watch glass technique, Maximow single slide technique, agar gel technique, histotypic culture ; Gel and sponge technique, hollow fibres, spheroids

Large scale cultures – Fermentor design, scaleup in suspension and monolayer. Downstream processing.

Use of animal cells as replacement for whole animal in toxicity testing.

Commercial application of animal tissue culture – Uses of animal cells in vaccine production, Cell cultures in the production of medicinally important compounds – pharmaceuticals, enzymes, hormones, interleukins, interferon's.

REFERENCES:

1. Ballinic C.A., Philips J.P and Moo Young M, (1989). Animal Biotechnology, Pergamon
2. Butler, M., (2006). Animal Cell Culture and Technology, Bios, Oxford, UK
3. Cartwright T(1994) Animal cells as bioreactors, Vol.VI, CU Publishers, Cambridge
4. Cheryl, D.H. and Cyndi, L.M. (2005). Basic cell culture protocols, Humana press, New Jersey.
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8. Glick B.R and Pasternak J.J., (1998). Molecular Biotechnology, ASM Press, Washington DC.

IV SEMESTER – PRACTICAL SYLLABUS

MGE-406 & 407: GENOMICS AND PROTEOMICS AND IMMUNOLOGY AND HAEMATOLOGY (Practical)

Total : 60

hrs

Course Objectives:

1. To facilitate the students to understand the apply the knowledge on hemolytic disorders and also to enable them to acquire knowledge in setting up of blood bank and blood safety.
2. Elucidate pathologies associated with an inappropriate immune response which leads to autoimmune disorders.
3. To describe mapping techniques, sequencing methods and functional analysis techniques.

Course Outcomes:

1. Acquisition of in-depth knowledge on different types of blood groups and able to apply compatibility testing and antihuman globulin test.
2. Acquire a broad and coherent theoretical and technical knowledge of cells and tissues of immune system.
3. Comprehend a broad and coherent theoretical and technical knowledge of hematology and hemolytic disorders.
4. Students take an in-depth look into the various genome databases, the annotation of genomes and taxonomy and significance of genomes of various model organisms.
5. Students perform an Analysis of Gene prediction- experimental methods and computer based methods, gene prediction rules and various softwares used for prediction.

MGE-406 & 407: GENOMICS AND PROTEOMICS AND IMMUNOLOGY AND HAEMATOLOGY (Practical)

Total: 60

hrs

1. Estimation of cellular DNA by spectrophotometric method or EtBr method.
2. Studies on Serum proteins by electrophoresis.
3. Single radial immunodiffusion and determination of immunoglobulin concentration.
4. Double radial immunodiffusion by Ouchterlony method.
5. Enzyme-linked immunosorbent assay.
6. TC, DC blood counts.
7. PAGE of haemoglobin.

IV SEMESTER – PRACTICAL SYLLABUS

MGE-408&409: BIOMEDICAL GENETICS AND PLANT AND ANIMAL BIOTECHNOLOGY

Total: 60

hrs

Course Objectives:

1. To provide students new knowledge and widening of the knowledge of handling of classical and modern plant biotechnology processes.
2. To facilitate the students to obtain skills on biotechnological processes such as cell and tissue culture, gene transfer in plants.
3. To understand various approaches related to disease diagnostic assays and many other assays involved in human health management.

Course Outcomes:

1. To familiarize with the techniques of plant tissue culture, mechanisms of gene transfer and various molecular markers.
2. To have the basic understanding of plant tissue culture and its maintenance, callus culture and suspension culture
3. Able to perform tissue culture with various explants and also to isolate protoplast used in transformation studies.
4. Demonstrate the knowledge about importance of different important parameters in Cell culture technique.
5. Demonstrate various disease diagnostic assays involved in animal health management.

MGE-408&409: BIOMEDICAL GENETICS AND PLANT AND ANIMAL BIOTECHNOLOGY

Total: 60

hrs

1. Introduction to general requirements of animal tissue culture laboratory.
2. Cleaning, washing, Preparation and sterilization methods for tissue culture work.
3. Preparation of media, serum, BSS, PBS, Trypsin etc.,
4. Plant tissue culture techniques.
5. Lymphocyte culture technique, Preparation of human metaphase Chromosomes.
6. Separation of peripheral blood mononuclear cells (PBMCs) - Histopaque method.
7. Primary explant culture of mouse pup/adult/ chick embryo organs.
8. Mouse bone marrow/hemopoietic cell cultures.
9. Contamination of cultures.
10. Pedigree analysis.
11. Molecular diagnosis of biochemical disorders. (Phenylketonuria, Alkaptonuria and Survey of mucopolysaccharide disorders)

DEPARTMENT OF CHEMISTRY

M.Sc CHEMISTRY REVISED SYLLABUS (WEF 2019-22)

&

**REVISED PAPERS OF MCH-305 (GREEN CHEMISTRY
to BIOLOGICAL CHEMISTRY) FROM 2024 TO 25
BATCH STUDENTS)**

Programme Educational Objectives

PEO_ID	Programme Educational Objectives
PEO_1	Students will be well prepared for successful careers in the profession at an industry and/or in government in one or more of discipline of chemistry.
PEO_2	Students will be academically prepared to become licensed professional chemists in due course and will contribute effectively in serving the society.
PEO_3	Students will be engaged in professional activities to enhance their own achievement and simultaneously contribute in service of humankind.
PEO_4	Students will be successful in higher education in Chemistry
PEO_5	Students will provide leadership quality to work in all kind of circumstances, diverse environment such as interdisciplinary and multidisciplinary learning systems.

Programme Specific Outcomes

PSO_ID	Programme Specific Outcomes
PSO_1	Academic competence: (i) Understand fundamental principles and advanced concepts of organic, inorganic and physical chemistry. (ii) Demonstrate understanding of various types of reactions, reaction mechanisms, stereochemistry, photochemistry, rearrangements, heterocyclic and medicinal chemistry, and reactions involving use of metals. (iii) Interpret analytical data for structure elucidation obtained using NMR, IR, UV and Mass spectroscopy.
PSO_2	Personal and Professional Competence: (i) Carry out experiments which include various chemical techniques and also setting of dry reactions, handling of hazardous reagents, assembling of apparatus, isolation of natural products, purification by column chromatography. (ii) Evaluate results obtained, observations and conclusion of experiments. Documentation of results. (iii) Formulate ideas, scientific writing and authentic reporting, effective presentation and communication skills.
PSO_3	Research Competence: (i) Outline research problem related to research area of interest and planning of methodology for execution. (ii) Review scientific literature and findings in systematic manner and processing of information obtained to understand scope for novelty. (iii) Design novel synthetic routes using a retrosynthetic approach for development of elegant, economic and eco-friendly schemes.
PSO_4	Entrepreneurial and Social competence: (i) Demonstrate importance of industrial applications of organic chemistry in various fields. (ii) Devise chemical processes with Green approach having advantage in safe operations.
PSO_5	To propose/develop: Cost effective and novel methods of synthesis of bioactive compounds/nanomaterials and in turn to design target oriented drugs to treat different diseases.

PROGRAMME OUTCOMES

PO_ID	PROGRAMME OUTCOMES
PO_1	Master of Science in Chemistry basically aims at the training of students with a detailed knowledge base in Chemistry of potential utility in academia as well as Industry through advanced course work and laboratory work in the department and a project work in industries or premier institutions
PO_2	To qualify NET/GATE/SET/Civil Services and other competitive examinations.
PO_3	For exploring global level research opportunities for doctoral and post-doctoral studies
PO_4	For professional employment in different domains such as academics, industries, analytical laboratories, scientific organizations, entrepreneurship, administrative positions etc.
PO_5	For enhancing the connectivity between academic and industrial institutions.

Continuous Internal Assessment – Scheme of Evaluation For PG Theory Courses

Activities (CIA: 30 Marks)	Proposed and Approved Scheme		Total Marks (30)
	IA-1	IA-2	
Session Test Maximum Marks	35	70	
1. Weightage (Marks)	05	10	15
2. Assignment -I	05		05
3. Assignment-II	05		05
4. Classroom participation	05		05
Total			30

PG CIA Components Practical paper (30 MARKS & 15 MARKS)

Activities (CIA: 30 Marks)	Total Marks (30)	Total Marks (15)
Session Test Maximum Marks		
1.Lab Performance	15	05
2.Obervation	05	05
3. Mock Test	10	05
Total	30	15

CIA Components Project Work (30 MARKS)

Activities(CIA: 30Marks)	Total Marks (30)
Session Test Maximum Marks	
1.Project Performance/Participation	15
2.Thesis Preparation	10
3. Class participation/Attendance	05
Total	30

M.Sc I SEMESTER-CHEMISTRY MCH-101: INORGANIC CHEMISTRY-I

COURSE	DETAILS
CODE	MCH-101
TITLE	INORGANIC CHEMISTRY-I
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Advanced principles of bonding in inorganic compounds. The structure and applications of isopoly and heteropoly anions of vanadium, molybdenum and tungsten and metal carbonyl clusters.
CObj_2	The structure of important silicon containing compounds and the correlation between their structure and application. The various principles and applications of solvent system, hard-soft acid base (HSAB), theories of acids and bases and concept of super acids.
CObj_3	The chemistry of non-metal containing compounds such as boranes, borazines, sulphurnitrogen compounds and phosphorus-nitrogen compounds.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Appreciate the different theories of chemical bonding and be able to apply these theories to solve structures
CO_2	Correctly write the structures of heteropoly, isopoly anions and metal carbonyl clusters and relate the structure to chemical reactivity.
CO_3	Understand the three dimensional structure of silicates and catalytically important molecules such as aluminosilicates (zeolites) and apply their knowledge towards selectivity based on structure.
CO_4	Write the structure of nonmetallic compounds and classify boranes based on STYX.
CO_5	Outline concepts of VSEPR models, Structural elucidations.

MCH-101: INORGANIC CHEMISTRY-I

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X							X		
CO_2			X			X				
CO_3		X							X	
CO_4	X						X			
CO_5			X			X				

M.Sc I SEMESTER-CHEMISTRY
MCH-101: INORGANIC CHEMISTRY- I

52hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	UNIT-I	Chemical Bonding- VSEPR model, shapes of molecules-ClF_3, ICl_4^-, TeF_5^-, I_3, TeCl_6^{2-}, XeF_6, SbCl_6^{3-}, IF_7, ReF_7, XeF_8^{2-}, TaF_8^{3-}; Bent rules and energetics of hybridization; electronegativity and partial ionic character; Bonds-Multicenter, Synergic and Agostic bonding. Lattice energy: Born-Lande equation, Kapustinskii equation; polarizability and partial covalent character, radius-ratio rules, structures of simple solids, Zintl-isoelectronic relationship in solids. Molecular orbital theory: LCAO and MO diagrams of heteronuclear diatomic (CO, NO, HF, ICl) and triatomic molecules (CO_2 and NO_2).	13hrs	Employable Skills 1. EMP 2. SKD 3. EDP
2	UNIT-II	Chemistry of main group elements- Structure and bonding in boranes, carboranes, metallocarboranes, Wade's rules, borazines, phosphazenes, S, N-compounds. Silicates - Classification, structures, isomorphous replacement, pyroxenes, layered and vitreous silicates, zeolites and molecular sieves.	13hrs	Employable Skills and analytical Skills 1. EMP 2. SKD 3. EDP
3	UNIT-III	HSAB concept: Basis of HSAB concept, acid-base strength, hardness and softness, symbiosis, applications of HSAB concept; Acid- base concept in non-aqueous media, reactions in BrF_3, N_2O_4, anhydrous H_2SO_4, CH_3COOH. Isopoly and heteropoly acids of W, Mo and V, preparations, properties, structure	13hrs	1. EMP 2. SKD 3. EDP

		and applications. Stereoisomerism- Chirality, optical activity- CD, ORD, Cotton effect, absolute configuration of metal complexes, magnetic circular dichroism.		
4	UNIT-IV	A. M-M bond and metal atom clusters, halide clusters, bonding in $[\text{ReCl}_8]^{2-}$. Metal carbonyl clusters- LNCC's and HNCC's. Electron counting in carbonyl clusters, Wades-Mingos and Lauher rules. B. Nuclear Chemistry-The atomic nucleus-elementary particles, quarks, classification of nuclides based on Z and N values, nuclear stability, nuclear potential, binding energy. Nuclear Models: Shell model-salient features, forms of the nuclear potential, filling of orbitals, nuclear configuration, Liquid drop model, Fermi gas model, Collective model and Optical model. Radioactivity, radioactive decay kinetics, Parent-daughter decay-growth relationship-secular and transient equilibria, theories of α, β^-, β^+ and γ-decay, internal conversion, Auger effect.	13hrs	1. EMP 2. SKD 3. EDP

REFERENCE BOOKS:

1. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 6th edition (1999).
2. Advanced Inorganic Chemistry, 6th edition; F. A. Cotton and G. Wilkinson.
3. Inorganic Chemistry IV edition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
4. Inorganic Chemistry, II edition, D. F. Shriver, P. W. Atkins and C. H. Langford ELBS; Oxford University Press, 1994.
5. Chemistry of elements; N. N. Greenwood and A. E. Earnshaw, Butterworth Heinemann (1997).

M.Sc I SEMESTER-CHEMISTRY
MCH-102: ORGANIC CHEMISTRY-I

52hrs

COURSE	DETAILS
CODE	MCH-102
TITLE	ORGANIC CHEMISTRY-I
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Basic concepts of bonding, structures, resonance, aromaticity, hyperconjugation and tautomerism in organic molecules.
CObj_2	Generation, structure, stability and reactivity of reactive intermediates. Conformation and stability of substituted cyclic systems, nomenclature and conformations of fused rings and bridged ring systems.
CObj_3	Stereochemistry of organic compounds, isomerism, different projection formulae with nomenclature and prochirality. Use of various oxidizing and reducing agents and their applications in the synthesis of industrially and pharmaceutically important compounds. Synthetic molecular receptors, their significance and functions.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Predict the products, identify reaction intermediates and propose suitable mechanism for organic reactions. Identify stereogenic centres, recognize enantiomers, diastereomers, meso compounds, draw stereochemical structures, and provide R/S designations of stereocenters.
CO_2	Apply the concepts of bonding, resonance, aromaticity, hyperconjugation and tautomerism to higher organic compounds.
CO_3	Draw stable conformations for substituted cyclic compounds, fused and bridged rings.
CO_4	Use of various oxidizing and reducing reagents for application in organic transformations of industrially and pharmaceutically important organic compounds.
CO_5	Understand the host-guest interactions in molecular receptors.

MCH-102: ORGANIC CHEMISTRY-I

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X						X			
CO_2		X							X	
CO_3			X			X				
CO_4		X								X
CO_5	X					X				

M.Sc I SEMESTER-CHEMISTRY

MCH-102: ORGANIC CHEMISTRY- I

52hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Nature of Bonding in Organic Molecules Delocalized chemical bonding: Conjugation, cross conjugation, resonance. Aromaticity. Huckel's rule of aromaticity. Aromatic systems with electron numbers other than six (including azulene, tropone, tropolone and annulenes). Antiaromaticity. Aromaticity in benzenoids, meso-ionic compounds. Homo-aromaticity. Alternant and nonalternant hydrocarbons, Energy levels in odd and even-alternant hydrocarbons. Hyperconjugation. Tautomerism. Reaction Mechanisms-I Generation, structure, stability and reactivity of carbocations, carbanions, carbon free radicals, carbenes and nitrenes. Classification of reactions and mechanisms. Kinetic and thermodynamic control, Hammond postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates. <u>Methods of determining mechanisms:</u> Based on the structure of products, determination of the presence of intermediates, isotopic labeling, and isotope effects. <u>Acids and bases.</u> Effect of structure on the strengths of acids and bases.	13hrs	Employable Skills 4. EMP 5. SKD 6. EDP
2	Unit -2	Reaction Mechanisms-II <u>Effect of structure on reactivity:</u> - Resonance and field effects; steric effects. The Hammett equation and linear free energy relationship,	13hrs	Employable Skills and analytical Skills

		substituent and reaction constants. Taft equation. <u>Nucleophilic substitution reaction at a saturated carbon</u>: SN1, SN2, and SET mechanisms. Effect of substrate structure, attacking nucleophile, leaving group. Ambident nucleophiles and substrates. Stereochemistry-I Fischer, Newman, Sawhorse and flying wedge projections and their interconversions. <u>Optical isomerism</u>: Elements of symmetry and chirality. D-L conventions. CIP rules, R-S and M-P conventions. Chirality in compounds with a stereogenic centre, and in allenes, alkylidene cycloalkanes and spiranes (with a stereogenic axis). Cram's and Prelog's rules. <u>Conformational analysis</u>: Conformational analysis of cycloalkanes: cyclobutane, cyclopentane, cyclohexanes (monosubstituted e.g., methyl, <i>iso</i>-propyl, <i>tert</i>-butyl and disubstituted cyclohexanes e.g., dialkyl, dihalo, diols), and cycloheptane.		1. EMP 2. SKD 3. EDP
3	Unit-3	Nomenclature and conformations of fused rings and bridged ring systems. <u>Prochirality</u>: Enantiotopic and diastereotopic atoms, groups and faces. Carbohydrates Introduction. Kiliani-Fischer synthesis, Determination of configuration of the monosaccharides, conformational analysis of monosaccharides. Synthesis of amino sugars-(N-acetylmuramic acid (NAMA), N-acetyl neuraminic acid NANA). Synthesis of aldonic, uronic, aldaric acids and alditols. Structure elucidation of sucrose and maltose. Structures of lactose, gentiobiose, and meliobiose.	13hrs	Employable Skills 1. EMP 2. SKD 3. EDP

4	Unit-4	Heterocyclic compounds Nomenclature of heterocyclic compounds. Structure, reactivity, synthesis and reactions of pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole, pyrimidine, purine and indole. Preparation and reactions of coumarins, acridines, cinnolenes and quinoxalines. <u>Synthetic Molecular Receptors:</u> Definition and Significance. Structure and function of receptors with molecular clefts, molecular tweezers, Receptors with multiple hydrogen bonding sites, Crown ether, Cryptates; Cyclodextrins, Cyclophanes, Calixarenes, ionophores, and micelles.	13hrs	Employable Skills 1. EMP 2. SKD 3. EDP

REFERENCE BOOKS:

1. Advanced Organic Chemistry – Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F A Carey and R J Sundberg Plenum, (1990).
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, (2000).
4. Structure and mechanism of Organic Chemistry, C K Ingold, Cornell University Press (1999).
5. Organic Chemistry, R T Morrison and R N Boyd, Prentice-Hall, (1998).
6. Stereochemistry of Organic Compounds, D Nasipuri, New-Age International, (1999).
7. Organic Synthesis, Jagadamba Singh and L. D. S. Yadav, Seventh Edition, 2011.
8. Organic Reaction Mechanisms, V. K. Alhuwalia and Rakesh Kumar Parashar, 4th Edition, 2012.
9. Understanding organic reaction mechanisms, A. Jacob, Cambridge, University Press, 1997.

M.Sc I SEMESTER-CHEMISTRY
MCH-103: PHYSICAL CHEMISTRY-I

52hrs

COURSE	DETAILS
CODE	MCH-103
TITLE	PHYSICAL CHEMISTRY-I
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Time dependent and time independent Schrödinger equations with solutions in simple systems. Apply variational method, time independent perturbation theory and time dependent perturbation theory to solve simple problems.
CObj_2	Matrix representation of quantum mechanics is discussed together with approximate methods.
CObj_3	The collision model of chemical reactions and how various factors such as temperature and catalyst can affect reaction rate and mechanism of thermal and photochemical hydrogen halogen reactions. The kinetics and thermodynamics of electrochemical reactions

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Show an understanding of wave mechanics in three dimensions.
CO_2	Describe the structure of the hydrogen atom and show an understanding of quantization of angular momentum.
CO_3	Recall and explain why certain factors such as concentration, temperature, medium and the presence of a catalyst will affect the speed of a chemical reaction.
CO_4	Understand the concept of activation energy and its calculation from kinetic data
CO_5	Define and explain surface and interfacial phenomenon.

MCH-103: PHYSICAL CHEMISTRY-I

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2				X					X	
CO_3	X								X	
CO_4	X					X				
CO_5			X					X		

M.Sc I SEMESTER-CHEMISTRY
MCH-103: PHYSICAL CHEMISTRY- I

52 hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Quantum Mechanics-I</u> Introduction to quantum mechanics. Schrödinger wave equation. Time-independent and time-dependent Schrödinger wave equations and the relation between their solutions. Eigen functions and Eigenvalues. Physical Interpretation of wave function. Concepts of Operators: Laplacian, Hamiltonian, Linear and Hermitian operators. Angular Momentum operators and their properties. Commutation of operators. Normalization, orthogonality and orthonormality of wave functions. Average (expectation) values. Postulates of quantum mechanics. Solutions of Schrödinger wave equation for a free particle, particle in a ring, particle in a three dimensional box. Quantum mechanical degeneracy, tunneling (no derivation). Application of Schrödinger equation to harmonic oscillator, rigid rotator. Eigen functions and eigenvalues of angular momentum. Ladder operator method for angular momentum.	13hrs	Employable Skills EMP SKD EDP
2	Unit -2	<u>Quantum Mechanics-II</u> Schrödinger equation to hydrogen atom in spherical polar co-ordinates. Solution of Φ, Θ, equation and statements of solution of R equation. Total wave functions of hydrogen atom. Quantum numbers and their characteristics. List of wave functions for few initial states of hydrogen like atoms. Diagrams of radial and angular wave functions. Radial and angular distribution function and their significance. Electron spin (Stern-Gerlach experiment), spin-orbital, anti-symmetry and Pauli-exclusion principle, Slater determinants. Coupling of Angular momenta. Russell-Saunders and JJ-coupling, Term symbols. Spin-orbital interaction	13hrs	Employable Skills and analytical Skills 1. EMP 2. SKD 3. EDP

		and explanation of term multiplicities (Na-D doublet). Zeeman effect. Approximate methods: Need for approximate methods. Perturbation method. Rayleigh Schrödinger perturbation theory for time-independent non-degenerate system. Application to electron in a box under the influence of an electric field. Application to He atom. Variation theory-statement and proof. Application of variation method to particle in a one-dimensional box and He atom.		
3	Unit-3	Chemical Dynamics-I A. Macroscopic and microscopic kinetics, Review of theories of reaction rate-Collision theory and Transition state theory, Comparison of collision theory with transition state theory, Arrhenius equation- characteristics, Significance of energy of activation, Temperature coefficient and its evaluation. Thermodynamical formulation of reaction rates (Wyne-jones and Eyring treatment), Reaction between ions in solutions – Influence of ionic strength on reaction rates (primary and secondary salt effects). B. Concept of Steady state kinetics, Chain reactions – chain length and chain inhibition, comparison of photochemical and thermal reactions, Mechanisms of thermal and photochemical reactions between hydrogen-bromine and hydrogen-chlorine. Comparative study of thermal and photochemical hydrogen-halogen reactions. Pyrolysis of acetaldehyde, Decomposition of ethane. C. Kinetics of fast reactions- Introduction, Study of reactions by relaxation method (Temperature and pressure jump), flow method (Plug flow method and Stopped flow method), Flash photolysis and Shock tube method.	13hrs	Employable Skills EMP SKD EDP
4	Unit-4	Chemical Dynamics-II D. Kinetics of homogeneous catalysis-kinetics of auto catalytic reactions, kinetics of acid-base catalysed reactions. Comparison of enzyme catalysed and chemical catalysed reactions,	13hrs	Employable Skills EMP SKD EDP

		Mechanism (Lock and Key theory), Kinetics of enzyme catalyzed reactions – Henri-Michaelis-Menten mechanism, Significance of Michaelis-Menten constant, Lineweaver-Burk plot. Effects of enzyme concentration, pH, Temperature, Activators and Inhibitors on enzyme activity. E. Theories of unimolecular reactions: Perrin theory, Lindemann theory, and Hinshelwood theory. F. Surface chemistry- Types of adsorption isotherms, Effect of temperature on adsorption, Mechanical adsorption, Estimation of surface area using BET equation, Gibbs adsorption isotherm and its significance, Surface tension and surface energy, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Surface film on liquids (electro-kinetic phenomena), Catalytic activity of surfaces.		

REFERENCE BOOKS:

1. Glasstone S., Thermodynamics for Chemists, Affiliated East-West Press Pvt. Ltd., (1960)
2. Mc. Quarrie D.A., Simon J.D., Molecular Thermodynamics, University Science Books, (1999).
3. Gupta M.C. Statistical Thermodynamics, Wiley Eastern Ltd., (1993).
4. Laidler K.J., Chemical Kinetics 3rd Edition, Pearson Publ., (2013).
5. House J.E., Principles of Chemical Kinetics, Wm C Brown Publisher, Boston (1997).
6. Glasstone S., Text Book of Physical Chemistry, 2nd Edition, Macmillan India Ltd., (1991).
7. Atkins P.W., de Paula J., Physical Chemistry, 7th Edition, Oxford Publ., (2002).
8. Puri B.R, Sharma L.R, Pathannia M.S., Principles of Physical Chemistry, 47th Edition. Shoban Lal Nagin Chand Co., (2017).

M.Sc I SEMESTER-CHEMISTRY
MCH-104: ANALYTICAL CHEMISTRY-I

52hrs

COURSE	DETAILS
CODE	MCH-104
TITLE	ANALYTICAL CHEMISTRY-I
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVE

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Different analytical techniques.
CObj_2	Precision and accuracy can be calculated.
CObj_3	Calibration methods are used to calibrate the equipments.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Outline and recall basic knowledge of fundamentals and application of organic and physical chemistry through chemical and scientific theories. Students learn the basic principles and applications of the theory of indicators.
CO_2	Students can be familiarizing with Separation techniques. Use of safety responsibilities residing in working with chemicals.
CO_3	The students also trained in the field of Ion exchange Chromatography, Thin-layer Chromatography.
CO_4	Students also expertise in handling of various electro analytical techniques. Standardize/calibrate the apparatus and instrument. Carry out purification techniques.
CO_5	Write the experimental results and interpret it. Overall students can solve the problems related to spectroscopy.

MCH-104: ANALYTICAL CHEMISTRY-I

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1			X				X			
CO_2		X							X	
CO_3	X							X		
CO_4				X		X				
CO_5		X				X				

M.Sc I SEMESTER-CHEMISTRY
MCH - 104 ANALYTICAL CHEMISTRY

52hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Acid – Base Titrations: Basic principles, Titration curves for mono functional acids and bases, pH calculations, theory of indicators, fractions of phosphoric acid species as a function of pH. Titration curves for polyfunctional acids [H₃PO₄]. Redox Titrations: Nernst equation, Standard & formal potentials. Titration curves, end point signals, Indicators, criteria for the selection of indicators. Feasibility of redox titration. Titration of multicomponent system. Adjustment of analyte's oxidation state. Applications: Ce (IV), bromate, Iodates. Kinetic methods of analysis: Rate laws, psuedo first order kinetics, types of kinetic methods, fixed time methods. Applications of catalytic and non-catalytic kinetic methods.	13hrs	Employable Skills EMP SKD EDP
2	Unit -2	Precipitation titrations: Solubility product. Theoretical principles: Titration curves, end point signals, Mohr, Volhard and adsorption indicators. Applications: Estimation of F⁻, K⁺, CO₃²⁻, C₂O₄²⁻, acetylenes and mixture of halides Complexometric titrations:	13hrs	Employable Skills and analytical Skills EMP SKD

		Complexometric titrations with particular reference to EDTA titrations, suitability of polydentate ligands as titrants, expressions for the different forms of EDTA in solution as a function of pH, conditional stability constants, derivation of titration curve, effect of pH and second complexing agent on the conditional stability constant and titration curve. Selectivity by pH control, masking and demasking, metal ion indicators, types of EDTA titrations, titrations involving monodentat.		EDP
3	Unit-3	Karl-Fischer titrations: Stoichiometry of the reaction, preparation of the reagent, titration method, standardization of the reagent using water-in-methanol, determination of water in samples, interference and their elimination, application to quantitative analysis of some organic compounds- alcohols, carboxylic acids, acid anhydrides and carbonyl compounds. Non-Aqueous titration :Acid –base titrations in non-aqueous solvents-classification of solvents, leveling and differentiating solvents, acidic and basic titrants, methods of titration. Titrations in glacial acetic acid and ethylene diamine, applications of non-aqueous titrations. Gravimetric analysis: Formation and treatment of precipitates, co-precipitation, homogeneous precipitation, important precipitating agents and their significance in inorganic analysis.	13hrs	Employable Skills EMP SKD EDP

4	Unit-4	Separation Techniques: Solvent Extraction- Types – batch, Continuous, efficiency, selectivity, Distribution coefficient, Nernst distribution law, derivation, applications and numerical problems. Chromatography- Types, Terminology, Principles of paper, thin layer, column chromatography. Electro analytical techniques Membrane indicator electrodes- Classification of membranes, properties of ion-selective membranes, the glass electrode for P^H measurements, glass electrodes for other cations, crystalline membrane electrodes, liquid membrane electrodes. Ion-selective field-defect transistors (ISFETs): Mechanism of ISFET ion-selective behavior, application of ISFETs. Molecular selective electrode systems: Gas-sensing probes, biocatalytic membrane electrodes, disposable multiplayer p-ion systems.	13hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Fundamentals of Analytical Chemistry-Skoog, West and Holler 9th Edition; Mary Finch. (2014)
2. Modern Analytical Chemistry David Harvey; McGraw Hill Higher Education Publishers, (2010)
3. Vogel's Textbook of Quantitative Chemical Analysis, 6th edition; Pearson Education limited, (2007)
4. Analytical Chemistry-Gary .D. Christian (6th edition) John Wiley & sons (2010).
5. Analytical Chemistry Principles- John H Kennedy, 2nd edition, published by Cengage Delmar Learning India Pvt (2011).

M.Sc I SEMESTER-CHEMISTRY
MCH-105: MATHEMATICS FOR CHEMISTS

COURSE	DETAILS
CODE	MCH-105
TITLE	MATHEMATICS FOR CHEMISTS
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	SOFT-CORE
TOTAL CREDITS	3
TOTAL CONTACT HOURS	36
COTACT HOURS PER WEEK	3
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	3
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	To enable the students to acquire the basic knowledge on mathematics.
CObj_2	Mathematical concepts like vectors, matrices, calculus (differentiation, integration and differential equations), Fourier transform and probability.
CObj_3	Use of these concepts in physical chemistry, spectroscopy, crystallography, analytical chemistry, nature of bonding etc.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Students learn the basic principles and applications of Vectors and matrix algebra. Apply the concepts of calculus in understanding the derivations of thermodynamics and quantum mechanics.
CO_2	Discuss the applications of matrices in HMO concept and group theory.
CO_3	Understand the advantages in image resolution of infrared spectra using Fourier transform.
CO_4	Understand the complex motion of electrons and electronic wave functions which are based on probability.
CO_5	Apply matrix and vector methods in understanding diffraction patterns from crystal structures

MCH-105: MATHEMATICS FOR CHEMISTS

CO-PO MAPPING:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X						X			
CO_2			X			X				
CO_3		X						X		
CO_4				X					X	
CO_5		X				X				

MCH-105: SOFT CORE: MATHEMATICS FOR CHEMISTS

36 hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Vectors: vectors, dot and cross products; scalar and vector triple products and their applications. Tensors and their applications Matrix Algebra: Review of different types of matrices (including Hermetian and skew Hermetian); matrix addition and multiplication; determinant of a square matrix, transpose, adjoint and inverse of a square matrix. Solution to system of linear equation (a) by matrix method and (b) by Cramer's Rule. Characteristic equation of a square matrix, eigenvalues and eigenvectors	12hrs	Employable Skills EMP SKD EDP
2	Unit -2	Calculus: Rule for differentiation; Chain rule (for $f(x)=U^n$, $\sin u$, $\log u$ etc). Implicit differentiation and parametric differentiation and successive differentiation of order 2 (for explicit functions only). Applications of differentiation: Derivative as a slope of the tangent, derivative as a rate measure-velocity and acceleration. Increasing and decreasing functions-Maxima and minima-second derivative test-point of inflections-problems restricted to polynomial.	12hrs	Employable Skills and analytical Skills EMP SKD EDP

3	Unit-3	Integrations: Basic rules-simple substitution-Method of partial fractions-Integration by parts. Define integral and application to areas of plane curves. Functions of several variables: partial derivatives; co-ordinate transformation from cartesian co-ordinates to spherical and cylindrical coordinates and vice-versa. Elementary differential equation: Variable separable, exact first order equations, linear and homogeneous equation. Second order homogeneous differential equation with constant coefficients $f(D)$, $y=0$. Solution of differential equation by power series method. Fourier series: Simple problems. Probability: Review of permutations and combinations. Probability and addition theorem for mutually exclusive events and multiplication theorem for independent events. Curve fitting-Method of least squares.	12 hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Mathematical Preparation for physical chemistry, F. Daniells, M.Graw Hill Inc., US, 1959.
2. Mathematics for chemists, D. M. Hirst, Chemical Publishing Company Incorporated, New York, 1979.
3. Mathematics for chemists, P. G. Francis, Springer, 2011.
4. Basic Mathematics for chemists, P. Tebutt, Wiley-Blackwell, 1994.
5. Calculus and analytic geometry, 9th edition, G. B. Thomas, R.L. Finney, Addison-Wesley Publishing Company, Inc. 1996.
6. Short Course in differential equations, Rainvilles and Bedient, IBH publishers, 1968.
7. Mathematics for chemistry, G. Doggett and B. T. Sutcliffe Longmann Publishers, 1995.

M.Sc I SEMESTER-CHEMISTRY
MCH-106: INORGANIC CHEMISTRY PRACTICALS –I

COURSE	DETAILS
CODE	MCH-106
TITLE	INORGANIC CHEMISTRY PRACTICALS -I
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10 Experiments
PEDAGOGY	Lecture with practical training will be given to students.
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Reagents required for qualitative analysis inorganic salts and how to prepare them.
CObj_2	The principles of qualitative analysis of a mixture of inorganic salts containing rare elements and the skills required for the analysis.
CObj_3	The principles of spot analysis also explained.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Prepare reagents required for analysis.
CO_2	Carry out qualitative tests and identify inorganic radicals in a salt mixture.
CO_3	Identify the separation of rare elements present in the given mixture.
CO_4	Communicate the results of the experiment in a written and oral form.
CO_5	Understand the separation techniques used in the laboratory.

MCH-106: INORGANIC CHEMISTRY PRACTICALS –I

CO-PO MAPPING:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X					X				
CO_2			X					X		
CO_3		X				X				
CO_4				X					X	
CO_5		X					X			

MCH-106 Inorganic Chemistry Practical-I

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Semi micro qualitative analysis of mixtures containing two anions, two common cations and one less familiar elements: W, Mo, Ce, Th, Zr, V, U and Li	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	Semi micro qualitative analysis of mixtures containing rare elements: W, Mo, Ce, Th, Zr, V, U and Li.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
2. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).

M.Sc I SEMESTER-CHEMISTRY
MCH-107: INORGANIC CHEMISTRY PRACTICALS –II

COURSE	DETAILS
CODE	MCH-107
TITLE	INORGANIC CHEMISTRY PRACTICALS –II
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10 Experiments
PEDAGOGY	Lecture with practical training will be given to students.
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Preparation of solutions required for an experiment.
CObj_2	The principles of preparation of coordination compounds explained.
CObj_3	The various techniques involved in the preparation of coordination compounds.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Prepare reagents required for the synthesis of coordination compounds.
CO_2	Design a scheme for synthesis of coordination compound and execute it based on the principles learned.
CO_3	Solve problems encountered during a synthesis.
CO_4	Communicate the results of the experiment in a written and oral form.
CO_5	Understand the different techniques used for the synthesis in the laboratory.

MCH-107: INORGANIC CHEMISTRY PRACTICALS –II

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1	X							X		
CO_2		X				X				
CO_3		X				X				
CO_4	X						X			
CO_5				X			X			

MCH-107: INORGANIC CHEMISTRY PRACTICALS –II

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Preparation of inorganic complexes: 1. Cis- and trans- potassium dioxalatodiaquachromium(III) complex [analysis of oxalate and chromium] 2. Hexamminecobalt(III)chloride [analysis of cobalt] 3. Mercurytrithiocyanatocobaltate. 4. Preparation of pentamminechloro cobalt(III)chloride	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	Quantitative analysis of inorganic complexes: 1. Cis- and trans- potassium dioxalatodiaquachromium(III) complex [analysis of oxalate and chromium] 2. Hexamminecobalt(III)chloride [analysis of cobalt] 3. Mercurytrithiocyanatocobaltate. 4. Preparation of pentammine chloro cobalt(III)chloride.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
2. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).

M.Sc I SEMESTER-CHEMISTRY
MCH-108: PHYSICAL CHEMISTRY PRACTICALS –III

COURSE	DETAILS
CODE	MCH-108
TITLE	PHYSICAL CHEMISTRY PRACTICALS –III
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
CONTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10 Experiments
PEDAGOGY	Lecture with practical training will be given to students.
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Preparation and standardization of solutions. Preparation and standardization of solutions required for an experiment.
CObj_2	Use of a colorimeter for titrations. Use of a colorimeter in the estimation of mixtures. Determination of partial molal volume of solutions
CObj_3	Use of a colorimeter in the study of the kinetics of a reaction. Verify Beer's law of different ions.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Devise and carry out an experiment to study the kinetics of a reaction.
CO_2	Interpret the experimental data in terms of a rate equation.
CO_3	Identify wavelength of maximum absorbance
CO_4	To plot phase diagram of two/three component systems and interpret them.
CO_5	Use colorimeter/spectrophotometer for colorimetric estimations, titrations and kinetic studies.

MCH-108: PHYSICAL CHEMISTRY PRACTICALS –III

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-108 Physical Chemistry Practical –I

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Acid hydrolysis of methyl acetate at lab temperature. 1. Velocity constant for the saponification of ethyl acetate. 2. Verification of Beer's Law for Cu^{2+} ions 3. Verification of Beer's Law for Fe^{2+} ions.	26hs	Employable Skills EMP SKD EDP
2	Unit -2	4. Estimation of Fe^{2+} ions concentration in the given solution by titration of FAS versus KMnO_4 through colorimetric method. 5. Estimation of Fe^{2+} ions concentration using EDTA through colorimetric method 6. Phase diagram of two component systems and determination of E_C, E_T and the determination of the composition of given unknown. 7. Determination of partial molar volume of solute – H_2O system by apparent molar volume method. 8. Determination of the viscosity of a mixture by apparent molar volume method.	34hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Findlays practical physical chemisty revised by P. B. Levitt, Longman's London (1966).
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill International Edn. (1966)
3. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988)
4. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987)

M.Sc I SEMESTER-CHEMISTRY
MCH-109: PHYSICAL CHEMISTRY PRACTICALS –IV

COURSE	DETAILS
CODE	MCH-109
TITLE	PHYSICAL CHEMISTRY PRACTICALS –IV
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/FIRST
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10 Experiments
PEDAGOGY	Lecture with practical training will be given to students.
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	The use of a conductivity meter for determination of specific conductance and solubility of electrolytes.
CObj_2	The use of Potentiometer meter for titrations (acid base, redox, precipitation)
CObj_3	Plotting of data in two dimensions and identifying the end point of the titration.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Use the conductivity meter as a tool for quantitative analysis. Report the results of the experiment in written and verbal form.
CO_2	Use conductivity measurements to distinguish between electrolytes (strong and weak).
CO_3	Use colorimeter/spectrophotometer for colorimetric estimations, titrations and kinetic studies.
CO_4	Carry out an electrochemistry experiments to determine the single electrode potentials of different systems.
CO_5	Report the results of the experiment in written and verbal form.

MCH-109: PHYSICAL CHEMISTRY PRACTICALS –IV

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-109 Physical Chemistry Practical –II

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Conductometric Experiments</u> 1. Precipitation titration: conductometric titration of lithium sulphate versus BaCl ₂ 2. Conductometric titration of weak acid versus weak base. 3. Dissociation constant of weak acid (CH ₃ COOH) by conductometric method. 4. Determination of Equivalent conductance of a given strong electrolyte. Conductometric titration of strong acid versus strong base.	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	<u>Potentiometric Experiments</u> 6. Determination of single electrode potential of Cu ²⁺ /Cu and estimate the given unknown concentration. 7. Determination of single electrode potential of Zn ²⁺ /Zn and estimate the given unknown concentration. 8. Titration of weak acid against a strong base using quinhydrone electrode and calculation of pK _a and K _a values of the weak acid. 9. Determination of pH of a buffer by using quinhydrone electrode and comparison of the pH values obtained with glass electrode.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
2. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)
3. Experimental Physical Chemistry by Wilson, Newcombe & others, Pergamon Press, New York (1962)
4. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983)
5. Experimental Physical Chemistry by V. D. Atavale and Parul Mathur, New Age International, New York (2001)
6. Physical Chemistry Laboratory Principles and Experiments by H. W. Salberg J. I. Morrow, S. R. Cohen and M. E. Green Macmillan publishing Co .new York.
7. Practical's in physical chemistry A. Modern Approach by P.S Sindhu, Mac. Millan Publishers Delhi (2006).

M.Sc II SEMESTER-CHEMISTRY

MCH-201: INORGANIC CHEMISTRY-II

COURSE	DETAILS
CODE	MCH-201
TITLE	INORGANIC CHEMISTRY-II
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Kinetic and thermodynamic parameters as a measure of stability of coordination compounds. . Electronic spectroscopy and magnetic properties of coordination compounds.
CObj_2	Advanced theories of bonding in complexes along with their stereochemistry.
CObj_3	Mechanisms of inorganic redox reactions involving coordination compounds.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Understand and apply the principles of stability of complexes in synthesis of new molecules.
CO_2	Relate the structure of complexes to their properties.
CO_3	Use electronic spectroscopy as an analytical tool in the structural elucidation of complexes.
CO_4	Interpret the magnetic properties of transition metal complexes based on magnetic measurements
CO_5	Study the mechanisms of inorganic oxidation and reduction reactions involving coordination compounds.

CO-PO MAPPING:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

SECOND SEMESTER

MCH-201: INORGANIC CHEMISTRY- II

52 Hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Metal-Ligand equilibria in solution- Step-wise and overall formation constant and their relationship, trends in step-wise constant, kinetic and thermodynamic stability of metal complexes, factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, chelate effect, macrocyclic effect and their thermodynamic origin. Determination of binary formation constant by pH metry, spectrophotometry, polarography and ion exchange methods. Structure and bonding- Structure and bonding in hydride, dihydrogen, dioxygen, isocyanide, CO, NO, N₂ and tertiary phosphine complexes of transition metals.	13hrs	Employable Skills EMP SKD EDP
2	Unit -2	Metal- ligand bonding- Stereoisomerism- coordination numbers 3 to 8. Crystal field theory, salient features, spectrochemical series, splitting of d-orbitals in tetragonal, square planar, trigonal bipyramidal and square-pyramidal geometry, applications of CFT- colours of transition metal complexes, magnetic properties of octahedral complex, distortion of octahedral complex, CFSE and their uses, factors affecting CFSE, limitations of CFT, experimental evidence for metal-ligand covalent bonding in complexes, nephelauxetic effect, Ligand Field Theory, MO theory: tetrahedral and octahedral Stereochemical non-rigidity, self assembly in supramolecular chemistry. Chemistry.complexes (including π-bonding), angular overlap model.	13hrs	Employable Skills and analytical Skills EMP SKD EDP
3	Unit-3	Electronic spectra of coordination compounds- Spectroscopic ground states, selection rules, term	13hrs	Employable Skills

		symbols for d^n ions, Racah parameters, Orgel, Correlation and Tanabe-Sugano diagrams, spectra of 3d metal-aqua complexes of trivalent V, Cr, divalent Mn, Co and Ni, $CoCl_4^{2-}$, calculation of Dq, B and β parameters, CT spectra. Spectral properties of Lanthanide and Actinide metal complexes.		EMP SKD EDP
4	Unit-4	Magnetic properties of coordination compounds- Types of magnetic behavior, magnetic susceptibility and its determination- Gouy, Faraday, VSM method. Diamagnetic correction, orbital contribution, spin-orbital coupling, ferro- and antiferromagnetic coupling, spin-crossover. Magnetic properties of Lanthanide and Actinide metal complexes. Photochemical reactions of transition metals complexes: Basic photochemical processes, Kasha's rule, quantum yield, Jablonskii diagrams, photo substitution reactions, photo-redox reactions, ligand photoreactions, photoreactions and solar energy conversion.	13hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 6th edition (1999).
2. Chemistry of elements- N. N. Greenwood and A. E. Earnshaw, Butterworth Heinemann (1997).
3. Inorganic Chemistry IV edition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
4. Inorganic Chemistry, II edition, D. F. Shriver, P. W. Atkins and C. H. Langford, ELBS; Oxford University Press, 1994.
5. Inorganic Electronic spectroscopy, A. B. P. Lever, Elsevier. (1968).
6. Magnetochemistry, R.L. Carlin, Springer Verlag.

M.Sc II SEMESTER-CHEMISTRY

MCH-202: ORGANIC CHEMISTRY-II

COURSE	DETAILS
CODE	MCH-202
TITLE	ORGANIC CHEMISTRY-II
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	<i>HARD-CORE</i>
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Mechanisms and evidences for aromatic electrophilic and nucleophilic substitutions, addition reactions, elimination reactions and rearrangements.
CObj_2	Effect of substrate structure, leaving group and attacking species in the above reactions.
CObj_3	The orientation and stereochemistry of the product formed.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Explain the mechanistic pathway for aromatic substitutions, addition reactions, elimination reactions and rearrangements.
CO_2	Predict the stereochemistry of the products formed.
CO_3	Design reactions with the help of name reactions and rearrangements and use of suitable reagents.
CO_4	Know the uses of name reactions and rearrangements for the synthesis of industrially and pharmaceutically important compounds.
CO_5	Know the Synthesis and applications of selected reagents used for various organic transformations.

CO-PO MAPPING

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-202: ORGANIC CHEMISTRY- II

52 Hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Aromatic Substitution Reactions <u>Electrophilic Substitution Reactions:</u> The arenium ion mechanism. Orientation and reactivity. Energy profile diagrams. The <i>ortho/para</i> ratio, <i>ipso</i> attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Effect of leaving group. Amination, sulfonylation reactions; Diazonium coupling, Vilsmeier-Haack reaction, Gatterman reaction, Gatterman-Koch reaction and Hoesch reaction. <u>Nucleophilic substitution reactions:</u> The S_NAr, S_N1, benzyne and S_{RN}1 mechanisms. Reactivity: effect of substrate structure, leaving group and attacking nucleophile. Goldberg reaction, Bucherer reaction, Schiemann reaction, von Richter reaction, Sommelet-Hauser and Smiles rearrangements.	13hrs	Employable Skills EMP SKD EDP
2	Unit -2	Addition Reactions <u>Addition to carbon-carbon multiple bonds:</u> mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals. Regio, stereo- and chemoselectivities. Orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Addition of alkenes and/or alkynes to alkenes and/or alkynes. Ene synthesis. Michael reaction. <u>Addition to carbon-heteroatom multiple bonds:</u> Mechanism of metal hydride reduction (LiAlH₄, NaBH₄) of saturated and unsaturated	13hrs	Employable Skills and analytical Skills EMP SKD EDP

		carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents and organolithium reagents to carbonyl compounds and unsaturated carbonyl compounds. Conversion of aldehydes to nitriles. Hydrolysis of nitriles and addition of amines to isocyanates. Formation of xanthates. Wittig, Mannich and Stobbe reactions		
3	Unit-3	Elimination Reactions The E2, E1 and E1cB mechanisms. Orientation of the double bond. Reactivity-effects of substrate structure, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination reactions (including Chugaev reaction). Rearrangements Wagner-Meerwein, Pinacol-Pinacolone, Fries, Beckmann, Hofmann, Curtius, Lossen and Schmidt rearrangements. Benzil-benzilic acid rearrangement, Arndt-Eistert reaction, Tiffeneau-Demjanov reaction, Fritsch-Buttenberg-Wiechell rearrangement. Stevens, and Favorskii rearrangements, Dienone-phenol, Baeyer-Villiger oxidation. Neber rearrangement. Benzidine rearrangement,	13hrs	Employable Skills EMP SKD EDP
4	Unit-4	Amino acids and Peptides Synthesis of amino acids Classification and nomenclature of peptides. Sanger and Edman methods of sequencing. Cleavage of peptide bond by chemical methods. Peptide synthesis- Protection of amino group (Boc-, Z- and Fmoc-) and carboxyl group as alkyl and aryl esters. Use of DCC, EEDQ, HOBT in peptide bond formation reactions. Deprotection and racemization in peptide synthesis. solid phase techniques. Synthesis of oxytocin, gramicidin. Vitamins Biological importance and synthesis of Vitamins A, Vitamin B ₁ (thiamine), Vitamin B ₆ (pyridoxine), folic acid, pantothenic acid, riboflavin, Vitamin C, Vitamin E (α -tocopherol), Vitamin H (biotin), Vitamins K ₁ and K ₂ .	13hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Advanced Organic Chemistry – Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum (1990).
3. A Guide Book to Mechanism of Organic Chemistry, Peter Sykes, Longman (2000).
4. Structure and Mechanism of Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall (1998).
6. Modern Organic Reactions, H. O. House, Benjamin (1972).
7. Principles of Organic Synthesis, ROC Norman and J. M. Coxon, Blackie Academic and Professional (1996).
8. Stereochemistry of Organic Compounds, D. Nasipuri, New-Age International (1999).
9. Stereochemistry of Carbon Compounds, E. L. Eliel, S. H. Wilen and L. N. Mander, John Wiley (1994).
10. Organic Chemistry, Volumes I and II, I L Finar, Longman. (1999).
11. Medicinal Chemistry, A Kar, Wiley (2000).
12. Peptides Chemistry: A practical text book, M. Bodansky, Springer-Verlag NY, 1988.
13. Solid-phase peptide synthesis: A practical approach-E. Artherton & R.C. Sheppard, I R L, Oxford Univ. Press, 1989.
14. Peptides: Chemistry and Biology, N Selwad and H.-D. Jakubke, Wiley-VCH, 2002.

M.Sc II SEMESTER-CHEMISTRY

MCH-203: PHYSICAL CHEMISTRY-II

COURSE	DETAILS
CODE	MCH-203
TITLE	PHYSICAL CHEMISTRY-II
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	The advanced theories explaining the behavior of electrolytes such as Debye-Huckel theory and Bjerrum theory of ion association.
CObj_2	Structural models of electrified interface.
CObj_3	The kinetics and thermodynamics of electrochemical reactions.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Explain fundamental aspects of electrochemical reaction in terms of thermodynamics, kinetics and mass transport.
CO_2	Explain the structure of electric double layer at the interface and its role on electrode reactions.
CO_3	Account for the physical interpretation of distribution functions and discuss and show how these can be used in calculations of basic thermodynamic properties.
CO_4	Know the Concepts in classical laws of thermodynamics and their application, postulates of statistical mechanics, statistical interpretation of thermodynamics, ensembles.
CO_5	Understand the Mathematical framework for thermodynamics of system.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-203: PHYSICAL CHEMISTRY- II

52 Hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Thermodynamics-I</u> Thermodynamics: Concepts of partial molar properties – partial molar free energy, chemical potential, partial molar volume and its significance. Gibbs-Duhem equation, Gibbs-Duhem-Margulus equation. Determination of partial molar volume: Graphical method, intercept method and Apparent molar volume method. Concept of fugacity; Determination of fugacity by graphical method and compressibility factor method. Activity and activity coefficient: Determination of activity coefficient by EMF and solubility method. Thermodynamics of non-ideal system-Excess thermodynamic function, G^E, S^E, H^E etc. Phase Rule: Derivation of phase rule from the concept of chemical potential. Application of Phase Rule to three components system: Principle of triangular diagram: Plots for a mixture of three liquids consisting of one, two and three pairs of partially miscible liquids. Statistical Thermodynamics: Objectives of statistical thermodynamics, Concept of distributions, Types of ensembles. Thermodynamic probability, most probable distribution Law Partition Function, (Definition and significance): Molar and molecular partitions-translational, rotational, vibrational and electronic partition functions- Relation between thermodynamic functions (E, H, S, G and C_V) and the partition functions.	13hrs	Employable Skills EMP SKD EDP
2	Unit -2	<u>Thermodynamics-II</u> Sackur-Tetrode equation for entropy of translation function. Relation between equilibrium constant and partition function.	13hrs	Employable Skills and analytical

		Different Distribution Laws: Types of Statistics Maxwell – Boltzmann , Bose-Einstein and Fermi-Dirac statistics. Derivation of ations for above three distribution Laws. Comparison of Bose-Einstein and Fermi-Dirac statistics with Maxwell – Boltzmann statistics. Problems and their Solutions. Non-equilibrium Thermodynamics : Thermodynamic criteria for non-equilibrium states-Phenomenological Laws and Onsager's reciprocity relations, Coupled and Non-coupled reactions, Entropy production and entropy flow. Electro kinetic Phenomenon. Postulates and methodologies: Uncompensated heat and thermodynamics function production. de-Donder's inequality. Rate of entropy production. Transformations of the generalized fluxes and forces : eg., Chemical reaction, heat flow, Diffusion or material flow, flow of electric current		Skills EMP SKD EDP
3	Unit-3	<u>Electrochemistry-I</u> Electrochemistry of solutions: Ionic atmosphere, Debye-Huckel theory for the problem of activity coefficient, Debye-Huckel limiting Law, Debye-Huckel equation for appreciable concentration, Debye-Huckel Onsagar interactions Conductance equation and its extension to ion solvent. Thermodynamics of electrifield interface, derivation of electro capillary Lipmann's equation, surface excess, thermodynamic aspects of surface excess. The method of determination and measurement of interfacial tension as a function of applied potential difference across the interface.	13hrs	Employable Skills EMP SKD EDP

4	Unit-4	<u>Electrochemistry-II</u> Structure of electrified interface: Helmholtz theory Guoy- Chapman theory, Stern model. Overpotential: Concentration overpotential and Volmer equation. Electrocatalysis: Definition and Influence of various parameters. Quantum aspects of charge transfer at electrode solution interface, quantization of charge transfer, tunneling of electrons for hydrogen evolution with reference to electrocatalysis. Polarography: Ilkovic equation, half wave potential and its significance, qualitative and quantitative estimation of metal ions. Semiconductor- solution interface: Theory of double layers at semiconductor- electrolyte interface.	13hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Molecular thermodynamics, Donald A. Mc Quarrie, John D. Simon University Science Books California, (1999).
2. Thermodynamics for Chemists, by S. Glasstone, East-West Press, New Delhi, (1960).
3. Thermodynamics, by Rajaraman and Kuriacose, East-West Press, (1986).
4. Statistical Thermodynamics, M. C. Gupta (Wiley Eastern Ltd.) 1993.
5. Elementary Statistical Thermodynamics, N. D. Smith, Plenum Press, NY, (1982).
6. Elements of Classical and Statistical Thermodynamics, L. K. Nash, Addison-Wiley (1979).
7. Thermodynamics, Statistical Thermodynamics and Kinetics by Thomas Engel & Philip Reid, Pearson Education inc. (2007)
8. Modern Electrochemistry Vol-1 and 2 J. O. M Bockris and A. K. N. Raddy, Plenum New York (1978)
9. An introduction to electrochemistry- Samuel Glasstone East-West edition New Delhi (1942)
10. Text book of physical chemistry Samuel Glasstone , 2nd edition, Mac Millan India Ltd (1991)
11. Electrochemistry, Principles and applications, Edmund, C. Potter, Cleaver-Hume press London (1961).
12. Principles and applications of Electrochemistry- D. R. Crow 3rd edition Chapmanhall London (1988)

M.Sc II SEMESTER-CHEMISTRY

MCH-204: SPECTROSCOPY-I

COURSE	DETAILS
CODE	MCH-204
TITLE	SPECTROSCOPY-I
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Qualitatively predict which signals are to be observed in the rotational, vibrational or electronic spectrum of various materials ranging from single atoms (atomic spectroscopy) to molecules (IR, Raman, and UV-Vis Spectroscopy).
CObj_2	Basic concepts of group theory and its applications, fundamental aspects of classifying molecules based on various symmetry elements, point groups and constructing character table.
CObj_3	Principles and instrumentation of different molecular spectroscopic methods

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Recognize symmetry elements, identify point groups of molecules, construct and explain character table for simple molecules.
CO_2	Categorize molecules based on their symmetry properties and predict their molecular properties.
CO_3	Combine, evaluate and interpret information from the various spectroscopic techniques in determination of molecular structures.
CO_4	Understand the significance of Character table.
CO_5	Know the conceptual features of symmetry of an object.

CO-PO MAPPING:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-204: SPECTROSCOPY-I

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Symmetry and Group Theory in Chemistry Definition of groups, subgroups, cyclic groups, conjugate relationships, classes, simple theorems in group theory. Symmetry elements and symmetry operations, point groups, Schönflies notations, representations of groups by matrices, reducible and irreducible representations, characters of representations, Great Orthogonality Theorem (without proof) and its applications, character tables and their uses (representations for the C_n, C_{nv}, C_{nh}, D_{nh} etc groups to be worked out explicitly) Mulliken symbols for irreducible representations Direct products, Applications of group theory to quantum mechanics- identifying non-zero matrix elements, derivation of the orthonormalization conditions Unifying principles Interaction of electromagnetic radiation with matter- time-dependent perturbation theory, transition moment integral, selection rules- symmetry and spin forbidden transitions	13hrs	Employable Skills EMP SKD EDP
2	Unit -2	Microwave Spectroscopy Rotations of molecules, rigid diatomic molecule-rotational energy expression, energy level diagram, rotational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computation of intensities, effect of isotopic substitution, centrifugal distortion and the spectrum of a non-rigid rotor. Rotational spectra of polyatomic molecules- linear, symmetric top and asymmetric top molecules Stark effect, techniques and instrumentation	13hrs	Employable Skills and analytical Skills EMP SKD EDP

		Infrared Spectroscopy-I Vibrations of molecules, harmonic and anharmonic oscillators- vibrational energy expression, energy level diagram, vibrational wave functions and their symmetry, selection rules, expression for the energies of spectral lines, computation of intensities, hot bands, effect of isotopic substitution Diatomic vibrating rotor, Born-Oppenheimer approximation, vibrational-rotational spectra of diatomic molecules, P, Q and R branches, breakdown of the Born-Oppenheimer approximation.		
3	Unit-3	Infrared Spectroscopy-II Vibrations of polyatomic molecules: Normal coordinates, translations, vibrations and rotations, vibrational energy levels and wave functions, fundamentals, overtones and combinations Vibration-rotation spectra of polyatomic molecules- parallel and perpendicular vibrations of linear and symmetric top molecules, Techniques and instrumentation FTIR. Raman Spectroscopy Classical theory of the Raman effect, polarizability as a tensor, polarizability ellipsoids, quantum theory of the Raman effect, Pure rotational Raman spectra of linear and asymmetric top molecules, vibrational Raman spectra, Raman activity of vibrations, rule of mutual exclusion, rotational fine structure- O and S branches, Polarization of Raman scattered photons Structure determination from Raman and IR spectroscopy-AB ₂ and AB ₃ molecules Techniques and instrument	13hrs	Employable Skills EMP SKD EDP
4	Unit-4	Electronic Spectroscopy Born-Oppenheimer approximation, vibrational coarse structure, intensities by Franck-Condon principle, Dissociation energy, rotational fine structure, Fortrat diagram, pre-dissociation. Electronic structure of diatomic molecules- basic results of MO theory, classification of states by	13hrs	Employable Skills EMP SKD EDP

		electronic angular momentum-σ, π, δ, and ϕ molecular orbitals, selection rules, spectrum of singlet and triplet molecular hydrogen Electronic spectra of polyatomic molecules-localized MOs, spectrum of HCHO, change of shape on excitation Decay of excited states- radiative (fluorescence and phosphorescence) and non-radiative decay, internal conversion		

REFERENCE BOOKS:

1. Chemical Applications of Group Theory, F. A. Cotton, Wiley Eastern (1976).
2. Molecular Symmetry, D. S. Schonland, Van Nostrand (1965).
3. Introduction to Molecular Spectroscopy, C. N. Banwell, TMH Edition (1994).
4. Introduction to Molecular Spectroscopy, G. M. Barrow, McGraw Hill (Int. Students Edition) (1988).
5. Molecular Spectroscopy, J. D. Graybeal, McGraw Hill (Int. Students Edition) (1990).
6. Spectroscopy, Vols. 1-3, B. P. Straughan and W. Walker, Chapman Hall (1976).

M.Sc II SEMESTER-CHEMISTRY
MCH-205: GREEN SYNTHESIS (SOFT-CORE)
(UPTO 2019 to 2024)

COURSE	DETAILS
CODE	MCH-205
TITLE	GREEN SYNTHESIS (SOFT-CORE)
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	SOFT-CORE
TOTAL CREDITS	3
TOTAL CONTACT HOURS	36
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Understand Ultrasound, microwave, ionic liquids, phase transfer catalysts, polymer supports in organic synthesis.
CObj_2	Multi-component reactions as a tool for efficient atom economical reactions.
CObj_3	Sonochemical reactions

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Use ultrasound, microwave, ionic liquids, phase transfer catalysts, polymer supports and multi-component reactions for various organic transformations.
CO_2	Understand the uses of Ionic liquids in Organic synthesis.
CO_3	Design the mechanism for phase transfer catalysis.
CO_4	Know the synthetic applications of superoxide ions.
CO_5	Understand the use of polymer supported reagents in Organic synthesis.

CO-PO MAPPING:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

M.SC II SEMESTER- CHEMISTRY

MCH-205: GREEN SYNTHESIS (SOFT-CORE) (UPTO 2019-24)

36hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Use of ultrasound and Microwaves in Organic Synthesis <u>Use of ultrasound</u>: Introduction, Sonochemical esterification, substitution, addition, alkylation, oxidation, reduction and coupling reactions. <u>Use of Microwaves</u>: Introduction, concept, reaction vessel/medium, atom efficiency (% atom utilization), advantages and limitations. N-alkylation and alkylation of active methylene compounds, condensation of active methylene compounds with aldehydes and amines. Diels-Alder reaction. Deprotection of esters and silyl ethers.	7hrs	Employable Skills EMP SKD EDP
2	Unit -2	Ionic-liquids: Introduction, structure, synthesis and applications of some important ionic liquids in organic synthesis. . Polymer supported reagents in organic synthesis Introduction- properties of polymer support, advantages of polymer supported reagents and choice of polymers. <u>Applications: Substrate covalently bound to the support</u>: Synthesis of oligosachcharides, Dieckmann cyclisation. Preparation of polymer bound aldehyde and application in aldol and Wittig reactions. Synthesis of polystyryl boronic acid and use in diol protection reaction. <u>Reagent linked to a polymeric material</u>: Preparation of sulfonazide polymer and application in diazotransfer reaction. Synthesis of polymer bound per acid and its applications. <u>Polymer supported catalytic reactions</u>: Preparation of polymer supported $AlCl_3$ and application in etherification and acetal formation reactions.	12hrs	Employable Skills and analytical Skills EMP SKD EDP

3	Unit-3	Phase transfer catalysis and Crown ethers <u>Phase transfer catalysis</u>: Introduction, definition, mechanism of phase transfer catalysis. Types of phase transfer catalysts and reactions and their Advantages. Preparation of catalysts and their application in substitution, elimination, addition, alkylation, oxidation and reduction reactions. <u>Crown ethers</u>: Introduction, nomenclature, nature of donor site. General synthesis of Crown ethers. <u>Synthetic applications</u>: Alkylation, generation of carbenes, aromatic substitution and displacement reactions. Generation and application of superoxide anions. Cation deactivation reaction.	8hrs	Employable Skills EMP SKD EDP
4	Unit-4	Multi-component Reactions Use of the following reactions in organic synthesis: Passerini-Ugi; Hantsch; Biginelli; Doebner-Miller; Ritter; Jacobson; Betti; Robinson-Schopf; Barbier; Baylis-Hillmann; Ivanov and Suzuki coupling reaction.	9hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Stereochemistry of carbon compounds, E. L. Eliel, S. H. Wilen and L. N. Mander, John Wiley & Sons, 1994.
2. Stereochemistry, Potapov, MIR, Moscow, 1984.
3. Stereochemistry, Nasipuri, D, New Age, 1999.
4. Advanced organic chemistry, J. March, 4th Edn. John Wiley, 2008.
5. Organic Chemistry, R. E. Ireland Prentice-Hall India, New Delhi, 1975.
6. Some modern methods of Organic Synthesis, W. Caruthers, Cambridge Uni. Press London, 2nd Edn. 1998.
7. Green Chemistry, environment friendly alternatives, R. Sanghi and M M Srivastava, Narosa, New Delhi, 2003
8. Green Chemistry-an introduction text, Royal Society of Chemistry, UK, 2002.
9. Organic chemistry Vol. 2, 6th Edn., I. L. Finar, Longman, 1992
10. Crownethers & cryptands, G. W. Gokel, Monograph, The Royal Society of Chemistry, 1991.

M.Sc II SEMESTER-CHEMISTRY
MCH-205: BIOLOGICAL CHEMISTRY (SOFT-CORE)
(FROM 2024-25 ONWARDS)

COURSE	DETAILS
CODE	MCH-205
TITLE	BIOLOGICAL CHEMISTRY (SOFT-CORE)
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	SOFT-CORE
TOTAL CREDITS	3
TOTAL CONTACT HOURS	36
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Understanding the importance of metabolism of substrates.
CObj_2	Qualitative and quantitative estimation of the biological macromolecules.
CObj_3	Interpreting of data emanating from a Clinical Test Lab.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Acquire chemistry and biological importance of biological macromolecules.
CO_2	To know how physiological conditions influence the structures and re-activities of biomolecules.
CO_3	To understand the basic principles of protein and polysaccharide structure
CO_4	Design the structures of proteins.
CO_5	Understand the use of polymer supported reagents in Organic synthesis.

CO-PO MAPPING:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-205 BIOLOGICAL CHEMISTRY (SOFT CORE)

(FROM 2024-25 ONWARDS)

36hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Biochemical Thermodynamics : Introduction-stages of energy transformation. Energy reactions, exergonic and endergonic reactions. Thermodynamic interpretation of energy reactions. Relationship between free energy and equilibrium constant. Concept of entropy and free energy. Energy phosphates: Definition, examples, structural features of ATP. Energy coupling in biological reactions (explain the concept with suitable examples). Biological oxidation: comparison of oxidation with combustion using glucose as an example. Redox potentials of some biologically important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH). Mitochondrial electron transport chain, oxidative phosphorylation. Substrate level phosphorylation.	3hrs 9hrs	Employable Skills EMP SKD EDP
2	Unit -2	Enzymes & Mechanism of Enzyme action : Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed, mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. Transition state theory, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease,	9hrs	Employable Skills and analytical Skills EMP SKD EDP

		lysozyme and carboxypeptidase A. Co-Enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD⁺, NADP⁺, FMN, FAD, lipoic acid, vitamin B12. Mechanisms of reactions catalysed by the above cofactors.	3hrs	
3	Unit-3	Essential and trace elements in biological systems: with reference to Na⁺, K⁺, Ca²⁺, Fe²⁺, P, Cu, V and Ni. Metallo-porphyrins with special reference to haemoglobin, myoglobin and chlorophyll. Role of cobalamin (vitamin-B₁₂coenzyme) in living systems. NUCLEIC ACIDS Types–Components of nucleic acids, bases, nucleosides and nucleotides with structures. Partial structure of polynucleotide. Chargoffs rule of base equivalence, Semi conservative model, DNA replication, Structure of DNA (Watson-Crick model) and RNA. Biological roles of DNA and RNAs. Gentic code, characteristics of genetic codes, Central dogma in molecular biology.	3hrs 9hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Biochemistry, G. Zubey, Macmillan, NY, 1998.
2. Biochemistry, D. Voet and J. G. Voet, John Wiley & Sons, 1998.
3. Principles of Biochemistry, A. L. Lehninger, D. L. Nelson & M. M. Cox, 2nd Edn. Worth Publishers, NY, 2005.

M.Sc I SEMESTER-CHEMISTRY
MCH-206: INORGANIC CHEMISTRY PRACTICALS –III

60hrs

COURSE	DETAILS
CODE	MCH-206
TITLE	INORGANIC CHEMISTRY PRACTICALS –III
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10
PEDAGOGY	Lecture with practical training will be given to students.
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Basic and advanced techniques required for the separation of metal ions of a binary mixture.
CObj_2	Techniques of gravimetric estimation of ions.
CObj_3	Handling sintered glass crucibles.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Outline a protocol and carry out separation of metal ions in a mixture.
CO_2	Carry out the gravimetric estimation of a metal ion.
CO_3	Solve problems encountered during an analysis.
CO_4	Report the results of the experiment.
CO_5	To understand the techniques of gravimetric methods.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-206 Inorganic Chemistry Practical-III

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Preparations of solutions from their Ore: 1. Preparation of Fe in iron ore as Fe_2O_3 . 2. Preparation of Ni in Cu and Ni solution. 3. Preparation of Fe in Fe and Cr solution. 4. Preparation of Fe and Al solution from Ore. 5. Preparation of Cu in Cu and Fe solution. 6. Preparation of Cu in Cu and Zn solution.	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	Gravimetric analysis: 1. Gravimetric determination of Fe in iron ore as Fe_2O_3 . 2. Gravimetric determination of Ni in Cu and Ni solution. 3. Gravimetric determination of Fe in Fe and Cr solution 4. Total gravimetric estimation of Fe and Al. 5. Gravimetric estimation of Cu in Cu and Fe solution. 6. Gravimetric estimation of Cu in Cu and Zn solution.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
2. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and

Technical (1999).

3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; the National Pub. Co. (1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co., London (1972).

M.Sc I SEMESTER-CHEMISTRY
MCH-207: INORGANIC CHEMISTRY PRACTICALS –IV

60hrs

COURSE	DETAILS
CODE	MCH-207
TITLE	INORGANIC CHEMISTRY PRACTICALS –IV
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10
PEDAGOGY	Lecture with practical training will be given to students.
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of

CObj_ID	Course Objectives
CObj_1	Basic and advanced techniques required for the separation of metal ions of a binary mixture.
CObj_2	Volumetric techniques of quantitative analysis of metal ions.
CObj_3	Preparing ore solution by digestion methods.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Outline a protocol and carry out separation of metal ions in a mixture.
CO_2	Carry out the volumetric estimation of a metal ion.
CO_3	Solve problems encountered during an analysis.
CO_4	Design different volumetric methods to analyse.
CO_5	Report the results of the experiment in written and verbal form.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-207 Inorganic Chemistry Practical-IV

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Volumetric analysis I 1. Preparation and Standardization of Ca and Mg in Dolomite solution. 2. Preparation and Standardization. of Cu in Cu and Ni (German Silver). 3. Preparation and Standardization of Fe in Cu and Fe solution. 4. Preparation and Standardization of Zn in Cu and Zn solution. 5. Preparation and Standardization of Ni in Ni and Zn solution.	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	Volumetric analysis II 1. Volumetric estimation of Ca and Mg in Dolomite solution. 2. Volumetric estimation of Cu in Cu and Ni (German Silver). 3. Volumetric estimation of Fe in Cu and Fe solution. 4. Volumetric estimation of Zn in Cu and Zn solution. 5. Volumetric estimation of Ni in Ni and Zn solution.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Vogel's Text book of Qualitative Chemical Analysis, J. Bassett, G. H. Jeffery and J. Mendham, ELBS (1986).
2. Vogel's text book of Quantitative Chemical Analysis, 5th Edition, J. Bassett, G. H. Jeffery and J. Mendham, and R. C. Denny, Longman Scientific and Technical (1999).
3. Inorganic Semimicro Qualitative Analysis, V. V. Ramanujam; The National Pub. Co. (1974).
4. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Von Nostrand Reinhold Co London (1972)

M.Sc I SEMESTER-CHEMISTRY

MCH-208: PHYSICAL CHEMISTRY PRACTICALS –III

60hrs

COURSE	DETAILS
CODE	MCH-208
TITLE	PHYSICAL CHEMISTRY PRACTICALS –III
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
CONTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10
PEDAGOGY	Lecture with practical training will be given to students.
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Preparation and standardization of solutions.
CObj_2	Kinetic studies of a reaction.
CObj_3	Use of a colorimeter in the study of the kinetics of a reaction and in the estimation of mixtures.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Identify wavelength of maximum absorbance and Collect data using a colorimeter/spectrophotometer.
CO_2	Devise and carry out an experiment to study the kinetics of a reaction and Interpret the experimental data in terms of a rate equation.
CO_3	Use colorimeter/spectrophotometer for colorimetric estimations, titrations and kinetic studies.
CO_4	To plot phase diagram of two/three component systems and interpret them.
CO_5	Communicate the results of the experiment in a written and oral form.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-208 Physical Chemistry Practical –III

60hrs

S. No	Module title	Module Content	Number of Hours	40hrs Skills Developed
1	Unit -1	1. Study the hydrolysis of methyl acetate in presence of two different concentrations of HCl and report the relative strength. 2. Study the hydrolysis of methyl acetate in the presence of HCl at different temperatures and report the energy of activation. 3. Determination of dissociation constant of a given indicator by colorimetric method. 4. Study of kinetics of autocatalytic reaction between KMnO_4 versus oxalic acid. 5. Determination of degree of hydrolysis of aniline hydrochloride at room temperature and calculation of dissociation constant of the base by pH metry	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	5. Determination of degree of hydrolysis of aniline hydrochloride at room temperature and calculation of dissociation constant of the base by pH metry 6. Analysis of a binary mixture of two miscible liquids and to determine the composition of the given unknown mixture 7. Determination of pH of acetic acid with sodium acetate buffer by pH metry method. 8. Determination of pH of formic acid with sodium formate buffer by pH metry method. 9. Evaluation of Arrhenius parameter for the reaction between $\text{K}_2\text{S}_2\text{O}_8$ versus KI (first order)	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Findlays practical physical chemisty revised by P. B. Levitt, Longman's London (1966)
2. Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill International Edn. (1966)
3. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988)
4. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987)
5. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
6. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)
7. Experimental Physical Chemistry by Wilson, Newcombe & others, Pergamon Press, New York (1962)
8. Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983)
9. Experimental Physical Chemistry by V. D. Atavale and Parul Mathur, New Age International, New York (2001)
10. Physical Chemistry Laboratory Principles and Experiments by H. W. Salberg J. I. Morrow.

M.Sc I SEMESTER-CHEMISTRY

MCH-209: PHYSICAL CHEMISTRY PRACTICALS –IV

60hrs

COURSE	DETAILS
CODE	MCH-209
TITLE	PHYSICAL CHEMISTRY PRACTICALS –IV
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	FIRST/SECOND
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10
PEDAGOGY	Lecture with practical training will be given to students.
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	The use of a conductivity meter for determination of specific conductance and solubility of electrolytes. Plotting of data in two dimensions and identifying the end point of the titration
CObj_2	The use of conductivity meter for titrations (acid base, redox, precipitation).
CObj_3	The working, calibration and use of a potentiometer. The use of different reference and working electrodes.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Use the conductivity meter as a tool for quantitative analysis.
CO_2	Use conductivity measurements to distinguish between electrolytes (strong and weak).
CO_3	Identify problems where conductivity measurements can be used and devise protocols for the experiment. Carry out an experiment based on the protocol and find solutions to problems encountered during the experiment.
CO_4	Use the potentiometer as a tool for quantitative analysis.
CO_5	Identify problems where potentiometric measurements can be used and devise protocols for the experiment.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-209 Physical Chemistry Practical –IV

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Conductometry</u> 1. Acid mixture versus NaOH 2. Weak acid with salt versus NaOH 3. Strong acid with salt versus NaOH 4. Determination of strength of HCl, CH ₃ COOH and CuSO ₄ versus NaOH 5. To determine the acidic and basic dissociation constant of an amino acid and determination of isoelectric point by pH metry.	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	<u>Potentiometry</u> 1. K ₂ Cr ₂ O ₇ versus FAS 2. Acid mixture versus NaOH 3. KMnO ₄ versus FAS 4. Determination of pK _a value of phosphoric acid by pH meter.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

- Findlays practical physical chemistry revised by P. B. Levitt, Longman's London (1966).
- Experiments in Physical Chemistry by Shoemaker and Garland, McGraw Hill
a. International Edn. (1966)
- Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publications Meerut (1988)
- Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987)
- Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
- Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)
- Experimental Physical Chemistry by Wilson, Newcombe & others, Pergamon Press,
a. New York (1962)
- Experimental Physical Chemistry by R. C. Behra and B Behra, Tata McGraw, New Delhi (1983)
- Experimental Physical Chemistry by V. D. Atavale and Parul Mathur, New Age International, New York (2001)
- Physical Chemistry Laboratory Principles and Experiments by H. W. Salberg J. I. Morrow.

M.Sc III SEMESTER-CHEMISTRY
MCH-301: ORGANIC REACTION MECHANISM

COURSE	DETAILS
CODE	MCH-301
TITLE	ORGANIC REACTION MECHANISM
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Evidences for the mechanisms of substitution reactions. Factors affecting rate of substitution reaction. Molecular orbital diagram and conservation of orbital symmetry.
CObj_2	Formation, structure, stability, reactivity and reactions of free radicals. Principles and terminologies in photochemistry and photochemical reactions.
CObj_3	Pericyclic reactions, rules governing them and their applications. Molecular orbital diagram and conservation of orbital symmetry.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Explain the mechanistic pathway for aliphatic substitutions and free radical reactions with stereochemistry.
CO_2	Describe and explain photochemical and photo physical processes with mechanisms, and apply established experimental methods for the investigation of these processes
CO_3	Predict and rationalize the outcomes of pericyclic reactions with stereochemistry.
CO_4	Understand Pericyclic reactions, rules governing them and their applications.
CO_5	Design the structure, stability, reactivity and reactions of free radicals.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

ORGANIC CHEMISTRY SPECIALISATION
MCH-301: ORGANIC REACTION MECHANISMS

52hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Aliphatic nucleophilic and electrophilic substitution reactions <i>Nucleophilic substitution reactions:</i> Substitution at allylic carbon (allylic rearrangement), at a trigonal carbon (hydrolysis of esters and amides, use of DCC in the formation of anhydrides), substitution at a vinylic carbon. Neighboring group participation and S_Ni reactions. <i>Electrophilic substitution reactions:</i> SE_2, SE_1 and SE_i mechanisms. Hydrogen exchange, migration of double bonds, α-halogenation of aldehydes, ketones and acids. Aliphatic diazonium coupling, nitrosation at carbon bearing active hydrogens, diazo transfer reaction, carbene and nitrene insertion, decarboxylation of aliphatic acids, haloform reaction, Haller-Bauer reaction.	10hrs	Employable Skills EMP SKD EDP
2	Unit -2	Free-radical chemistry Generation of free-radicals: Thermal homolysis of peroxides, peresters and azo compounds, photochemical methods. Free radical reactions: Free-radical mechanisms in general. Free-radical substitution mechanisms. Mechanisms at an aromatic substrate. Neighboring group assistance in free-radical reactions. Reactivity for aliphatic substrates, reactivity at a bridgehead, reactivity in aromatic substrates, reactivity in the attacking radical. Halogenation at an alkyl	10hrs	Employable Skills and analytical Skills EMP SKD EDP

[illegible]

[illegible]

REFERENCE BOOKS:

1. Advanced Organic Chemistry – Reactions, Mechanism and Structure, Jerry March, JohnWiley (2008).
2. Understanding organic reaction mechanisms, A. Jacob, Cambridge Univ. Press, 1997.
3. Introduction to organic chemistry A. Streitweiser, Jr and C. H. Heathcock, Macmillan1985.
4. Physical and mechanistic organic chemistry, R.A.Y. Jones, 1st Edn. Cambridge Univ. Press, 1979.
5. Mechanisms of molecular migrations, Vols I and II, B. S. Thiagarajan, 1st Edn. Pergamon Press, Oxford, 1979.
6. P. J. Garratt in Comprehensive organic chemistry, D. Barton and W. D. Ollis, 1st Edn.Pergamon Press, Oxford, 1979.
7. Radicals in organic synthesis, B. Giese, Pergamon Press, 1986.
8. Stereo electronic effects in organic chemistry, P. Deslongchamps, 1st Edn. Pergamon Press, 1983.
9. Frontier orbitals and organic chemical reactions, Ian Fleming, John Wiley, 1980.
10. Molecular orbital theory for organic chemistry, A. Streitweiser, 1st Ed. Wiley & Sons NY, 1969.
11. Organic photochemistry, J. M. Coxon and B. Halton, 1st Edn, Cambridge Univ. Press,London, 1974.
12. Orbital symmetry, R. E. Lehr and A. P. Marchand, Academic Press, 1972.
13. Molecular reactions and photochemistry, C. H. Deputy and D. S. Chapman, 1st Edn. Prentice-hall India, New Delhi, 1972.
14. Stereochemistry of Organic Compounds: Principles and Applications, D Nasipuri, New-Age International, (1999).
15. Biochemistry, G. Zubey, Macmillan, NY, 1998.
16. Biochemistry, D. Voet and J. G. Voet, John Wiley & Sons, 1998.
17. Principles of Biochemistry, A. L. Lehninger, D. L. Nelson & M. M. Cox, 2nd Edn. Worth Publishers, NY, 2005.

M.Sc III SEMESTER-CHEMISTRY
MCH-302: CHEMISTRY OF NATURAL PRODUCTS

COURSE	DETAILS
CODE	MCH-302
TITLE	CHEMISTRY OF NATURAL PRODUCTS
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	<i>HARD-CORE</i>
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 10
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Classification, nomenclature, structure, biosynthesis, occurrence, analysis and pharmaceutical perspectives of natural products. Structural elucidation of these natural products by elemental analysis and characterization by different spectroscopic techniques.
CObj_2	Industrial synthesis of these natural products with stereochemistry and separation techniques.
CObj_3	Classification, synthesis and use of insect pheromones used in pest control.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Understand extraction and purification methods of natural compounds from available sources.
CO_2	Design efficient total synthesis of complex molecules by recognizing substructures amenable to known transformations.
CO_3	Familiarize with various types of natural products from different sources and their applications.
CO_4	Synthesize natural products industrially.
CO_5	Design various techniques for the isolation of natural products.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-302: CHEMISTRY OF NATURAL PRODUCTS

52 Hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Terpenoids and Carotenoids Classification, nomenclature, occurrence and isolation. Isoprene rules. Stereochemistry of citral, farnesol, limonene, 1,8-cineole, menthols and borneols. Correlation of configurations of terpenoids. Structure elucidation of camphene, α -pinene, β -caryophyllene, and α -santonin. Synthesis and biosynthesis of the following: Linalool, α -terpineol, fenchone, eudesmol, abietic acid. Commercial synthesis of camphor. Carotenoids: Structural relationship of α -, β - and γ -carotenes. Structure elucidation and synthesis of β -carotene	12hrs	Employable Skills EMP SKD EDP
2	Unit -2	Alkaloids Definition, nomenclature, occurrence, isolation, classification, General methods of structure Elucidation. Synthesis and biosynthesis of the following alkaloids: Ephedrine, hygrine, coniine and cocaine. Cinchona alkaloids: Cinchonine and quinine. Opioid alkaloids: Morphine, codeine, thebiene and heroin. Structure elucidation and synthesis of papaverine, reserpine and ergotamine. Photochemical synthesis of Nuciferine, coradyline and tylophorine.	12hrs	Employable Skills and analytical Skills EMP SKD EDP
3	Unit-3	Porphyrins and vitamin B₁₂ Structure elucidation and synthesis of haemin, chlorophyll-a and vitamin-B ₁₂ (synthesis of Vitamin-B ₁₂ from cobyrinic acid). Nucleic acids Introduction, components of nucleic acids, nucleosides, nucleotides and oligonucleotides. Structure elucidation and synthesis of nucleosides and nucleotides. Chemical synthesis of oligonucleotides: Protecting groups for hydroxy group in sugar, aminogroup in the base and phosphate functions. Methods of formation of internucleotide bonds: DCC,	7hrs 8hrs	Employable Skills EMP SKD EDP

		phosphodiester approach, phosphotriester approach, phosphite triester and phosphoramidite methods. Solid phase synthesis of oligonucleotides.		
4	Unit-4	Prostaglandins : Introduction, nomenclature, classification and biological role of prostaglandins. Structure elucidation and stereochemistry of PGE₁, PGE₂ and PGE₃. Synthesis of PGE₁ and PGE₂ by Corey's and Stork's approaches. Synthesis of PGE₃ by Upjohn's approach. Synthesis of prostacyclin I₂ and thromboxane B₂. Biosynthesis of prostaglandins. Insect pheromones : Introduction, classification. Pheromones in pest control. Syntheses of (one synthesis should be stereoselective synthesis) i) Grandisol (component of boll weevil pheromone) ii) Farnal (trail pheromone of pharaoh's ants) iii) Brevicomin (pheromone from <i>Dendroitis brevicomis</i>) iv) (+)- Disparlure (gypsy moth sex pheromone). v) 3,11-Dimethyl-2-nonacosanone (pheromone of German cockroaches). vi) Bombykol (sex pheromone of silkworm moth). vii) Multistriatin (Elm bark beetle sex pheromone)	7hrs 6hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Natural products: Their chemistry and biological significance-J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthorpe & J. B. Harborne, Longman, UK, 1994.
2. Terpenes, J. Verghese, Tata McGraw-Hill, New Delhi, 1982.
3. Chemistry of terpenes and terpenoids, A. Newman, Academic Press, London, 1975.

M.Sc III SEMESTER-CHEMISTRY

MCH-303: ORGANIC SPECTROSCOPY

COURSE	DETAILS
CODE	MCH-303
TITLE	ORGANIC SPECTROSCOPY
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Spectroscopic techniques including the basic principles for recording of NMR, IR, UV, and MS spectra.
CObj_2	Applications of UV-Vis spectroscopy. Identification and characteristics of functional groups using IR spectroscopy
CObj_3	Principles of nuclear magnetic resonance spectroscopy of ^1H , ^{13}C (1D and 2D) and other nuclei (^{15}N , ^{19}F , ^{29}Si and ^{31}P).

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Combine information from experimental NMR, IR, UV, and MS spectra and elucidate the structure of unknown organic compounds.
CO_2	Argue for a suggested molecular structure from analysis of the spectral data.
CO_3	Predict the NMR, IR, UV-Vis and MS spectra from a given molecular structure.
CO_4	Understand Fragmentation pattern, effect of isotopes in Mass spectroscopy.
CO_5	Write schematic approach of spectral details.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-303: ORGANIC SPECTROSCOPY

52hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Ultraviolet and visible spectroscopy Classification of electronic transitions, Terminology, Substituent and solvent effects, UV spectral study of alkenes, polyenes, enones and aromatic compounds. Empirical rules for calculating λ_{max}. Vibrational Spectroscopy: spectroscopy Sampling techniques, Group frequencies, factors affecting group frequencies, Bond order, Mass effect, Conjugation, Inductive, resonance, steric effects. Intramolecular interactions. Application of IR in the study of H-bonding, stereoisomerism and tautomerism. Complementarity of IR and Raman. Identification of the following organic compounds by IR: Alkanes, Alkenes, Alkynes, Aromatic compounds, Aldehydes, Ketones, Alcohols, Acids, Acid chlorides, Amides, Amines, Esters, Halides, Nitro compounds, etc., problems using UV and IR.	6hrs 9hrs	Employable Skills EMP SKD EDP
2	Unit -2	Nuclear magnetic resonance spectroscopy-I Introduction, Magnetic properties of nuclei-Resonance condition. Nuclear spin, population of nuclear spin levels and NMR isotopes, Relaxation methods. Instrumentation and sample handling, FT-NMR. Chemical shift. Mechanism of shielding and deshielding in Alkanes, Alkyl halides, Alkenes, Aromatic compounds, Carbonyl compounds and Annulenes. Pascal's triangle-low and high resolution, spectrum of ethanol. Karplus Curve, Diamagnetic and paramagnetic effects and magnetic anisotropy. Equivalence of protons-chemical and magnetic equivalence. Spin systems: First order and second order coupling of AB systems, Simplifications of complex spectra. Problems. Spin-spin interactions: AX, AX₂, AX₃, AMX, AB types. Vicinal, geminal and	13hrs	Employable Skills and analytical Skills EMP SKD EDP

		long range coupling-Spin decoupling. Chemical shift reagents and deuterium exchange. Stereochemistry and hindered rotations. Temperature effects.		
3	Unit-3	Nuclear magnetic resonance spectroscopy-II Nuclear Overhauser effect (NOE). Factors influencing coupling constants and Relative intensities. Protons attached to elements other than carbon. ¹³ C NMR Spectroscopy: Range and factors affecting chemical shifts of alkanes, alkyl halides, alkenes, alcohols, ethers, alkynes, carbonyl compounds and aromatics. Multiple resonance spectroscopy: Introduction to 2D-techniques: DEPT, COSY, and HETCOR. Explanation of the principle, applications to structure elucidation and stereochemistry of simple organic molecules. NMR spectroscopy of other nuclei with spin $I = \frac{1}{2}$. Introduction to ¹⁵ N, ¹⁹ F, ²⁹ Si and ³¹ P and their chemical shift values.	12hrs	Employable Skills EMP SKD EDP
4	Unit-4	Mass spectrometry and Composite Problems: Basic principles-instrumentation – ion production-ion analysis-magnetic sector instruments Quadrupole mass spectrometers. Mass spectrum-molecular ion-types of ions in mass spectra and effects of isotopes on mass spectra. Methods of ionization, EI, FAB mass and MALDI methods. Fragmentation of Alkanes, Alkenes, alkyl halides, alcohols, aldehydes, ketones, acids, esters, ethers, amines, nitro and halo compounds peptides, Nitrogen rule, Factors affecting cleavage patterns. McLafferty rearrangement. Determination of molecular formula. Composite problems. Use of HRMS to determine exact molecular formulae of compounds. Application of UV, IR, NMR and MS methods and chemical reactions in the structure elucidation of organic compounds.	12hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Applications of absorption spectroscopy to organic compounds, J. R. Dyer, Prentice-Hall, New Delhi, 1969.
2. Organic spectroscopy, P. Laszlo and P. Stang, Harper & Row, New York, 1971.
3. Organic spectroscopy, W. Kemp, ELBS London, 2000.
4. Spectrometric identification of organic compounds, R. M. Silverstien, and W. P. Weber, 2005.
5. Introduction to spectroscopy, 3rd Edn., D. L. Pavia, G. M. Laupman and G. S. Kriz, Harcourt College Publishers, 2001.
6. Organic mass spectroscopy, K. R. Dass & E. P. James, IBH New Delhi, 1976.

M.Sc III SEMESTER-CHEMISTRY
OPEN ELECTIVE: WRITE IT AND WRITE UP

COURSE	DETAILS
CODE	OPEN ELECTIVE
TITLE	WRITE IT AND WRITE
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	SOFT-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	
CObj_2	
CObj_3	

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	
CO_2	
CO_3	
CO_4	
CO_5	

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1										
CO_2										
CO_3										
CO_4										
CO_5										

M.Sc III SEMESTER-CHEMISTRY
MCH-304: ORGANIC CHEMISTRY PRACTICALS-I

COURSE	DETAILS
CODE	MCH-304
TITLE	ORGANIC CHEMISTRY PRACTICALS-I
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
MODULES	10
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PT presentations, Seminars and presentations
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

COBj_ID	Course Objectives
COBj_1	Laboratory set up, safe handling of chemicals, workup procedures and effective disposal of organic waste.
COBj_2	Various methods of preparing organic compounds in a single step.
COBj_3	Safety measurements used in the laboratory.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Design and carry out experiments, accurately record and analyze the results of such experiments.
CO_2	Prepare the solutions.
CO_3	Know to calculate the yield of the product obtained.
CO_4	Design the alternate mechanisms for the products.
CO_5	Calculate the theoretical yield and practical yield of the compound.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

ORGANIC CHEMISTRY PRACTICALS MCH-304 Organic Chemistry Practical-I

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Preparation (one stag 1.Preparation 2.Purification 3.Characterisation	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	1. Sandmeyer reaction: 4-Chlorotoluene from 4-toluidine. 2. Pechmann reaction: Resorcinol and ethylacetoacetate. 3. Oxidation of Cyclohexanol. 4. Preparation of S-Benzylisothiuronium chloride. 5.Synthesis of <i>p</i> -iodonitrobenzene 6. Synthesis of N-Phenyl-2,4-dinitroaniline. 7. Synthesis of 2,4,6-tribromoaniline. 8. Synthesis of 2,4-dichlorophenoxyacetic acid.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T R Govindachari, Allied Publishers, New Delhi, (1996).
2. Practical Organic Chemistry – Mann and Saunders, (1980).
3. Text Book of Practical Organic Chemistry- A. I. Vogel, (1996).

4. Test Book of Quantitative Organic Analysis- A. I. Vogel, (1996).
5. A Handbook of Organic Analysis – Clarke and Hayes, (1964).
6. Comprehensive practical organic chemistry: Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
7. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India), 2000.
8. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. Kr. Nad, New central book agency, Calcutta, 2000.

M.Sc III SEMESTER-CHEMISTRY
MCH-305: ORGANIC CHEMISTRY PRACTICALS –II

COURSE	DETAILS
CODE	MCH-305
TITLE	ORGANIC CHEMISTRY PRACTICALS –II
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
MODULES	10
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PT presentations, Seminars and presenPtations
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	The principles of separation and qualitative analysis of binary mixture of mono- and bifunctional organic compounds.
CObj_2	Using separation techniques.
CObj_3	Determining the melting points.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Carryout effective separation (pilot and bulk) of mixture of organic compounds.
CO_2	Determine the functional group of the unknown compounds by systematic analysis in a semi-micro scale.
CO_3	Study the physical constants of the compounds.
CO_4	Design various separation techniques.
CO_5	Isolate the products obtained.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-305 Organic Chemistry Practical-II

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Systematic analysis and identification of Various organic compounds.	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	Systematic analysis and identification of Bi-functional groups in an organic compounds.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T R Govindachari, Allied Publishers, New Delhi, (1996).
2. Practical Organic Chemistry – Mann and Saunders, (1980).
3. Text Book of Practical Organic Chemistry- A. I. Vogel, (1996).
4. Test Book of Quantitative Organic Analysis- A. I. Vogel, (1996).
5. A Handbook of Organic Analysis – Clarke and Hayes, (1964).
6. Comprehensive practical organic chemistry: Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
7. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India), 2000.
8. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. Kr. Nad, New central book agency, Calcutta, 2000.

M.Sc I SEMESTER-CHEMISTRY
MCH-306: ORGANIC CHEMISTRY PRACTICALS –III

COURSE	DETAILS
CODE	MCH-306
TITLE	ORGANIC CHEMISTRY PRACTICALS –III
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
MODULES	10
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PT presentations, Seminars and presenPtations
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Laboratory set up, safe handling of chemicals, workup procedures and effective disposal of organic waste.
CObj_2	Preparation of organic compounds in multiple steps.
CObj_3	Using separation techniques to isolate the compounds.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Design and carry out experiments, accurately record and analyze the results, calculate overall yield of the final product.
CO_2	Study the physical constants of the compounds.
CO_3	Design various separation techniques.
CO_4	Isolate the products obtained.
CO_5	Carryout effective separation (pilot and bulk) of mixture of organic compounds.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-306 Organic Chemistry Practical – III

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Preparation (Two and three stages) 1.Preparation 2.Purification 3.Characterisation	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	Preparation (Two and three stages) Preparation (Two and three stages) 1. 2,4-Dinitrophenylhydrazine from chloronitrobenzene. 2. Anthranilic acid from phthalic acid. 3. Benzanilide from benzophenone. 5. Synthesis of Acridone. 6. Synthesis of Hydantoin. 7. Preparation of P-Nitroaniline from acetanilide 4. Synthesis of Acridone. 5. Synthesis of Hydantoin. 6. Preparation of P-Nitroaniline from acetanilide	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T R Govindachari, Allied Publishers, New Delhi, (1996).
2. Practical Organic Chemistry – Mann and Saunders, (1980).
3. Text Book of Practical Organic Chemistry- A. I. Vogel, (1996).
4. Test Book of Quantitative Organic Analysis- A. I. Vogel, (1996).
5. A Handbook of Organic Analysis – Clarke and Hayes, (1964).
6. Comprehensive practical organic chemistry: Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
7. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India), 2000.
8. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. Kr. Nad, New central book agency, Calcutta, 2000.

M.Sc III SEMESTER-CHEMISTRY
MCH-307: ORGANIC CHEMISTRY PRACTICALS –IV

COURSE	DETAILS
CODE	MCH-307
TITLE	ORGANIC CHEMISTRY PRACTICALS –IV
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
MODULES	10
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PT presentations, Seminars and presenPtations
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

COBj_ID	Course Objectives
COBj_1	Quantitative estimation of organic compounds using various methods.
COBj_2	Principles of titre metric methods.
COBj_3	Precision and accuracy methods.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Carry out quantitative analysis of organic compounds systematically.
CO_2	Use various analytical methods.
CO_3	Design various quantitative methods.
CO_4	Know the precision and accuracy methods.
CO_5	Designing the data formats.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-307 Organic Chemistry Practical-IV

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Principles of Quantitative methods : 1. Titrimetric methods 2. Determination of molecular formula of the compound 3. Extraction 4. Precipitation 5. Experimental analysis	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	Quantitative analysis 1. Titrimetric estimation of amino acids. 2. Saponification value of oil. 3. Estimation of glucose by Feighling's method. 4. Estimation of keto group. 5. Estimation of phenols. 6. Iodine value of oil (chloramine-T method).	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Laboratory manual of Organic Chemistry- B. B. Dey, M V Sitaraman and T R Govindachari, Allied Publishers, New Delhi, (1996).
2. Practical Organic Chemistry – Mann and Saunders, (1980).
3. Text Book of Practical Organic Chemistry- A. I. Vogel, (1996).
4. Test Book of Quantitative Organic Analysis- A. I. Vogel, (1996).
5. A Handbook of Organic Analysis – Clarke and Hayes, (1964).
6. Comprehensive practical organic chemistry: Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
7. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India), 2000.
8. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. Kr. Nad, New central book agency, Calcutta, 2000.

M.Sc IV SEMESTER-CHEMISTRY

MCH-401: ORGANOMETALLIC AND HETEROCYCLIC CHEMISTRY

COURSE	DETAILS
CODE	MCH-401
TITLE	ORGANOMETALLIC AND HETEROCYCLIC CHEMISTRY
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ FOURTH
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

COBj_ID	Course Objectives
COBj_1	σ -bonded and π -bonded ligands, metal-carbon bonding, 18- and 16-electron rules, Green rules for nucleophilic addition, complexation and decomplexation of organometallic compounds. Application of various organometallic compounds in organic synthesis.
COBj_2	Transition metal complexes as protecting and stabilizing groups, electrophiles and nucleophiles in organic transformations, as catalysts in isomerization, oxidation, reduction, carbonylation and coupling reactions.
COBj_3	Synthesis, properties and reactions of 3-, 4-, 5-, 6-, 7- and 8-membered heterocyclic compounds. Classification, synthesis and applications of mesoionic compounds.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Understand the scope, diversity and applications of organometallic compounds.
CO_2	Predict the stability, reactivity of metal complexes and stereochemistry of products formed
CO_3	Rationalize the synthesis, structure and applications of organometallic compounds for organic transformations
CO_4	Analyze the properties and reactions of 3-, 4-, 5-, 6-, 7- and 8-membered heterocyclic compounds.
CO_5	Design the synthesis of industrially important compounds

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

ORGANIC CHEMISTRY SPECIALISATION
FOURTH SEMESTER

MCH-401: ORGANOMETALLIC AND HETEROCYCLIC CHEMISTRY

52 Hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Organometallic Compounds in Organic Synthesis-I <i>Chemistry of Organotransition metal complexes:</i> General introduction. 18- and 16-Electron rules. General rules. <i>Complexation and De-complexation Reactions:</i> s-Bonded systems including h1 ligands. p-Bonded systems involving dihapto to octahapto ligands such as- olefins, acetylenes, allyl moieties, butadiene, cyclobutadiene, arenes, cyclopenta, cyclohexa and cycloheptadienyl moieties; cyclohepta, cyclooctatrienes, and cyclooctatetraene moieties. <i>Use of organotransition metal complexes as protecting and stabilizing groups:</i> Protection of olefins, acetylenes and dienes. Stabilization of cyclobutadienes and norbornadienones. <i>Organometallics as electrophiles and nucleophiles:</i> Nucleophilic addition to h2, h5 and h6 complexes. Electrophilic addition to h4, h6 and carbene complexes. <i>Organometallics in coupling and cyclization reactions:</i> Coupling and cyclization of organic nucleophiles with olefins (including Heck reaction), and coupling of olefins with acetylenes (including Felkin's reaction). <i>Organometallics in isomerization, oxidation and reduction reactions:</i> Isomerization of olefins, allylic alcohols and allylic ethers. Oxidation of olefins (including Wacker's process and epoxidation) and reduction of olefins and α,β-unsaturated compounds (including Wilkinson's reaction).	4hrs 3hrs 3hrs 4hrs	Employable Skills EMP SKD EDP
2	Unit -2	Organometallic Compounds in Organic Synthesis-II <i>Carbonylation reactions:</i>		

	Use of zirconium complexes in the synthesis of esters, acids, aldehydes or acyl halides from alkyl halides and in the hydroformylation of olefins and dienes. Use of iron complexes for the insertion of CO group into organic molecules such as dienes, alkyl halides, and vinyl epoxides. Use of cobalt complexes in the synthesis of ketones from epoxides, lactones from allylic alcohols and in the hydroformylation of olefins. Use of palladium complexes for the carbonylation of alkyl halides, dienes and allenes. <i>Application of the following organometallics in Organic Synthesis:</i> <i>Organozincs:</i> Preparation, reaction with compounds containing acidic protons, reaction with C-C multiple bonds, trans-metallation, addition reactions of zinc reagents with carbonyl compounds. Simmons Smith, and Reformatsky reaction. <i>Organolithiums:</i> Preparation. Deprotonation reactions, nucleophilic addition reactions, reactions with imines, nitriles and isonitriles. <i>Organocopper reagents:</i> (Gilman reagents-lithium dialkyl cuprates): Preparation, reactions with alkyl, allyl, vinyl, benzyl and aryl halides, aldehydes, ketones (including α,β-unsaturated carbonyl compounds) and epoxides. <i>Organoseleniums:</i> preparation. Use of organoseleniums in the synthesis of alkenes from alkyl halides, α,β-unsaturated carbonyl compounds from carbonyl compounds. <i>Organotelluriums:</i> Debromination of vic-dibromides, deoxygenation of epoxides, oxidation of hydroquinone and synthesis of biaryls. <i>Organoaluminiums:</i> Preparation, hydroalumination and carboalumination of alkenes. Nucleophilic addition reactions with carbonyl compounds and Hydrocyanation. Preparation of alkenyldialkylalanes and their reactions.	4hrs 4hrs 4hrs	Employable Skills and analytical Skills EMP SKD EDP

3	Unit-3	Organometallic Compounds in Organic Synthesis-III <i>Organosilicons:</i> Introduction, preparation and general reactions of trialkylsilyl halides. Peterson olefination. <i>Organotins:</i> Preparation and reactions of tri-<i>n</i>-butyltin hydride, Barton decarboxylation and Barton-McCombie reaction. <i>Organocerates:</i> Preparation and reactions of organocerates. <i>Organomercurials:</i> Preparation. Electrophilic substitution reactions. Solvomercuration-demercuration and cyclopropanation of alkenes. Heterocyclic Chemistry-I <i>Small ring heterocycles:</i> Properties and reactions of 3- and 4- membered heterocycles:-oxiranes, thiranes, aziridines, azetidines, oxetanes and thietanes. <i>Benzo-fused heterocycles:</i> Synthesis and reactions of benzofurans, benzothiophenes, benzoxazoles, benzothiazoles and benzimidazoles. <i>Six-membered heterocycles with two or more heteroatoms:</i> Synthesis of Diazines, triazines, tetrazines and thiazines.	4hrs 4hrs 3hrs 2hrs	Employable Skills EMP SKD EDP
4	Unit-4	Heterocyclic Chemistry-II <i>Seven and large membered heterocycles:</i> Synthesis and reactions of azepanes, oxepines, thiepinines, diazepines, thiazepines, azocines, diazocines, ioxocines and dithiocines <i>Heterocycles containing P, As, Sb and Bi:</i> Synthesis of 5- and 6- membered heterocycles with P, As, Sb and Bi. <i>Mesoionic compounds:</i> General classification, chemistry of some important meso-ionic heterocycles of type-A and type-B and their applications.	13hrs	Employable Skills EMP SKD EDP

REFERANCE BOOKS:

1. Organometallic Chemistry, R. C. Mehrotra and A. Singh, Wiley Eastern, 1991.
2. The Organometallic Chemistry of the transition metals, R. H. Crabtree, 1988.
3. Principles and application of the organotrnsition metal chemistry, J. P. Collman, L. S. Hegedus, University Science books, 1980.
4. An introduction to Organometallic Chemistry, A. W. Parkins and R. C. Poller, Macmillan, 1986.
5. Modern Synthetic Reactions, H. O. House, W.A. Benjamin, California, 2nd Edn. 1972. 98
6. Organometallics, Vol. 1 & 2, M. Bochmann, Oxford Chemistry primers, Oxford University Press, 1994.
7. Advanced Organic Chemistry, J. March, 4th Edn. John Wiley, 2008.
8. Organotransition metal chemistry, S. G. Davies, Pergamon Press, Oxford, 1982.
9. Heterocyclic Chemistry, Vols. 1-3, R. R. Gupta, M. Kumar and V. Gupta, Springer Verlag.
10. The Chemistry of Heterocycles, T. Eicher and S Hauptmann, Thieme.
11. Heterocyclic Chemistry, J. A. Joule, K. Mills and G. F. Smith, Chapman and Hill.
12. Heterocyclic Chemistry, T. L. Gilchrist, Longman Scientific Tech.
13. Contemporary Heterocyclic Chemistry, G. R. Newkome, and W. W. Paudler, Wiley-Inter Science.
14. An introduction to Heterocyclic Compounds, R. M. Acheson, John Wiley.
15. Comprehensive Heterocyclic Chemistry, A. R. Katritzky and C. W. Rees, Eds. Pergamon Press.
16. Stereochemistry of Organic Compounds, D Nasipuri, New-Age International, (1999).

M.Sc IV SEMESTER-CHEMISTRY

MCH-402: STEREOCHEMISTRY AND RETROSYNTHETIC ANALYSIS

COURSE	DETAILS
CODE	MCH-402
TITLE	STEREOCHEMISTRY AND RETROSYNTHETIC ANALYSIS
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ FOURTH
TYPE	<i>HARD-CORE</i>
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Stereochemistry of organic compounds exhibiting atropisomerism and chirality due to the presence of heteroatoms.
CObj_2	Methods used in determining absolute configuration by various techniques. Disconnection approach to organic synthesis.
CObj_3	Protecting and deprotecting of functional groups in organic synthesis. Strategies needed to devise routes for the synthesis of simple to complex target compounds.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Identify stereogenic centers and provide R/S designations for atropisomers and compounds with heteroatoms.
CO_2	Determine absolute configuration of organic by various rules and techniques.
CO_3	Analyze target compounds by retro synthetic strategy and devise suitable anionic, cationic and radical synthons.
CO_4	Analyze the Disconnection approach in organic synthesis.
CO_5	Apply the knowledge and understanding of essential facts, concepts, principles and theories relating to retrosynthetic analysis for the synthesis of organic target molecules.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-402: STEREOCHEMISTRY AND RETROSYNTHETIC ANALYSIS

52 Hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Optical activity in the absence of chiral atoms Chirality in biphenyls, adamantanes, ansa compounds, cyclophanes, <i>trans</i>-cyclooctene, catenanes, and rotaxanes. Assignment of R, S- configuration to these classes of compounds. Optical activity due to the presence hetero atoms Chirality of organic compounds due to the presence of silicon, nitrogen, phosphorous, arsenic and sulphur atoms. Determination of R,S-configuration of these compounds using CIP rules. Transannular reactions Conformational analysis of medium rings. Trasnannular reactions: Hydrolysis of medium ring epoxides and bromination of C₈–C₁₀ cyclic dienes.	5hrs 4hrs 3hrs	Employabl e Skills EMP SKD EDP
2	Unit -2	Determining absolute and relative configuration i). <u>Chemical correlation of configuration</u>: Methods without involving the chiral centre. Chemical transformation involving the chiral centre. Chemical correlation involving diastereomers. ii). <u>Methods based on comparison of optical rotation</u>: Distance rule, Rule of shift, Mill's rule, iii) The method of quasi-racemate. iv). <u>Use optical rotatory dispersion curves</u>: α-axial haloketone rule and its applications, octant rule (application of these rules in the determination of absolute configuration of substituted cyclohexanones, decalones and cholestanones). v). Method based on anomalous X- ray scattering. RETROSYNTHETIC ANALYSIS	10hrs	Employabl e Skills and analytical Skills EMP SKD EDP

		Disconnection approach Introduction to synthons, and synthetic equivalents, disconnection approach. Basic principles and terminologies used in disconnection approach. One group C-X and two group C-X disconnections. Chemoselectivity, reversal of polarity, cyclisation reactions.	6hrs	
3	Unit-3	Protecting groups Principle of protection of alcohols, amines, acids and carbonyl groups C-C one group and C-C two group disconnections Synthesis of alcohols, carbonyl compounds and alkenes. Use of acetylides and aliphatic nitro compounds in organic synthesis. Diels-Alder reaction, 1,3-difunctionalised compounds, α,β -unsaturated compounds, carbonyl compounds condensations, 1,5-difunctionalised compounds. Micheal addition and Robinson annelation.	4hrs 10hrs	Employabl e Skills EMP SKD EDP
4	Unit-4	Ring Synthesis Synthesis of saturated heterocycles and 3-, 4-, 5- and 6-membered rings. Synthesis of some complex molecules using disconnection approach Aromadendrene, longifloene, vitamin-D, reserpine, juvabione, and Lycorane.	10hrs	Employabl e Skills EMP SKD EDP

REFERENCE BOOKS:

1. Stereochemistry of carbon compounds, E. L. Eliel, S. H. Wilen and L. N. Mander, John Wiley & Sons, 1994.
2. Stereochemistry, Potapov, MIR, Moscow, 1984.
3. Stereochemistry, Nasipuri, D, New Age, 1999.
4. Advanced organic chemistry, J. March, 4th Edn. John Wiley, 2008.

5. Organic Chemistry, R. E. Ireland Prentice-Hall India, New Delhi, 1975.
6. Some modern methods of Organic Synthesis, W. Caruthers, Cambridge Uni. Press
London, 2nd Edn., 1998.
7. Stereochemistry of organic compounds- Principle and applications, D. Nasipuri, 2nd Edn.,
New Age International Publishers, 2001.
8. Organic synthesis: The synthon approach, S. Warren, John Wiley & Sons, New York, 1st.
Edn. 1983
9. Designing organic synthesis: A disconnection approach, S. Warren, John Wiley & Sons,
New York, 2nd Edn. 1987
10. Organic synthesis, C. Willis and M. Wills, Oxford University Press, 1995

M.Sc IV SEMESTER-CHEMISTRY

MCH-403: ORGANIC SYNTHESIS

COURSE	DETAILS
CODE	MCH-403
TITLE	ORGANIC SYNTHESIS
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ FOURTH
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Principles and terminologies in asymmetric synthesis and the importance of chirality in organic synthesis. Multi-component reactions as a tool for efficient atom economical reactions.
CObj_2	Stereoselective, diastereoselective and enantioselective strategies and the use of chiral auxiliary components for asymmetric synthesis.
CObj_3	Ultrasound, microwave, ionic liquids, phase transfer catalysts, polymer supports in organic synthesis

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Understand the importance of asymmetric synthesis and propose syntheses of molecules with control of the stereochemistry.
CO_2	Design chemical processes and products that eliminate the use or generation of hazardous substances
CO_3	Use ultrasound, microwave, ionic liquids, phase transfer catalysts, polymer supports and multi-component reactions for various organic transformations.
CO_4	Analyze the reagents used in organic synthesis.
CO_5	Design the C-C and C-N bond formation reactions.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-403: ORGANIC SYNTHESIS-II

52 Hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	C-C and C-N bond forming reactions Darzen's reaction, Use of acetylides in C-C bond formation reactions. Acid-catalyzed self condensation of olefins, Prins reaction, Shapiro reaction, Dieckmann cyclization, Robinsonannulations, Hofmann-Loeffler-Freytag reaction. Hofmann-Martius reaction. Acyloincondensation. Houben-Hoesch reaction.Stork-enamine synthesis. Meyer synthesis. Use of nucleophilic nitrogen and electrophiliccarbon (NH_3 , amines and nitrite as nucleophiles in substitution, NH_3 and amines in addition to ketones and aldehydes) and electrophilic nitrogen and nucleophilic carbon (nitration, nitrosation)for the bond formation reactions (including Chichibabin reaction, Skraup synthesis, Mitsunobureaction, Fisher-Hepp reaction. Japp- Klingemann reaction.	12hrs	Employable Skills EMP SKD EDP
2	Unit -2	Reagents in organic synthesis Use of the following in organic synthesis and functional group tansformations. Aluminium iso-propoxide, NBS, LDA, DCC, DDQ, Corey-Chaykovsky reagent, Raney-Nickel,diazomethane, TMS-chloride, 1,3-Dithiane (reactivity and umpolung), PPA. Woodward and Prevost hydroxylation. Oxidations-I Cr (VI) oxidants, Mn (VII) oxidants, OsO_4 , SeO_2 , Pb (OAc) $_4$, HIO_4 , Ag_2O , DMSO	7hrs 5hrs	Employable Skills and analytical Skills EMP SKD EDP

3	Unit-3	Oxidations-II Ozone, peroxides (H_2O_2, $t\text{-BuOOH}$,) and peracids as oxidizing agents. Dess-Martin oxidation, Oppeneaur oxidation. Reductions Complex metal hydrides, dissolving metal reductions (including Birch, Benkeser, Clemmensen reductions), diimide reduction, MPV reduction, organoboranes as reducing agents. Wolf-Kishner reduction, McMurry reaction. Pummer, Willgerdot, and Tishchenko reactions.	4hrs 9hrs	Employable Skills EMP SKD EDP
4	Unit-4	Asymmetric Synthesis 'ee' and methods of determination of 'ee'. <u>Stereoselectivity</u>: classification, terminology and principle. Asymmetric synthesis and asymmetric induction. Double diastereoselection and double asymmetric induction. <u>Acyclic stereoselection</u>: Addition of nucleophiles to carbonyl compounds (1,2- 1,3- and 1,4- asymmetric induction). Asymmetric aldol condensation. <u>Diastereoselection in cyclic systems</u>: Nucleophilic addition to cyclic ketones (formation of axial and equatorial alcohols, catalytic hydrogenation, lkylation, diastereoselective oxidations). <u>Enantioselective synthesis</u>: Reduction with chiral hydride donors [(S)-PBMgCl, (-)-$i\text{-BOAlCl}_2$, (S)-BINAL-H, (R,R)-DIOP, and (S,S)-CHIRAPHOS). Enantioselective alkylation of ketones <i>via</i> hydrazones. Enantioselective alkylation with chiral PTC. Enantioselective Michael addition. Enantioselective intramolecular aldol condensation. Use of (+)- and (-)- DET in asymmetric epoxidation. Polymer-bound chiral catalysts in asymmetric induction.	15hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Advanced organic chemistry, J. March, 4th Edn. John Wiley, 2008.
- Organic synthesis, R.E. Ireland, Prentice-hall India, New Delhi, 1975.

2. Understanding organic reaction mechanisms, A. Jacob, Cambridge Univ Press, 1997.
3. Introduction to organic chemistry, A. Streitweiser, Jr and C. H. Heathcock, Macmillan, 1985.
4. Physical and mechanistic organic chemistry, R. A.Y. Jones, 1st Edn. Cambridge Univ Press, 1979.
5. Modern synthetic reactions, H. O. House, W. A. Benjamin, California, 2nd Edn. 1972.
6. Some modern methods of organic synthesis, W. Carruthers, Cambridge Univ. Press, London, 2nd Edn. 1978.
7. Mechanisms of molecular migration, Vols I & II, B.S. Thyagarajan, Pergamon Press, Oxford, 1979.
8. Comprehensive organic chemistry, D. Barton and W. D. Wallis, Pergamon Press, Oxford, 1983.
9. Organic chemistry Vol. II, I. L. Finar 6th Edn. Longman, 1992.
10. Organic reaction Mechanisms, 3rd Edn., V. K. Ahluwalia and R. K. Prashar, Narosa, New Delhi, 2005.

M.Sc IV SEMESTER-CHEMISTRY
MCH-404: MEDICINAL ORGANIC CHEMISTRY

COURSE	DETAILS
CODE	MCH-404
TITLE	MEDICINAL ORGANIC CHEMISTRY
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ FOURTH
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	52
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	3
MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	4
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PPT presentations, Seminars and presentations.
EVALUATION METHOD	Two internal assessments, one mid-term examination, one end Semester examination, Class participation.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Basic biological and pharmacological interactions of drugs with their targets. Process of drug discovery. Development of nanomedicine.
CObj_2	The relation of structure and physical properties of drugs to their pharmacological activity.
CObj_3	Synthesis and mode of action of the different classes of drugs.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Use of the knowledge gained for the development of biologically and clinically active drugs.
CO_2	Describe the current challenges and opportunities in medicinal chemistry in light of contemporary developments in the field of drug discovery.
CO_3	Design the mode of action of different drugs.
CO_4	Analyze the structural and physical properties of drugs and their pharmacological action.
CO_5	Understand the pharmacological action of different drugs.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-404: MEDICINAL ORGANIC CHEMISTRY

52 Hours

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Concepts of Medicinal Chemistry:</u> Important terminology in medicinal Chemistry, Drug, Pharmacy, Pharmaceutics, Toxicology, Pharmacodynamics agents, Pharmacophore, pharmacodynamics, metabolites and anti-metabolites, chemotherapy. Mechanism of chemotherapeutic actions: 1) Biological defences. 2) Chemical defences. a) Surface active agents; b) Metabolic antagonism. Assay of Drugs: Chemical Assay, Biological Assay, Immunological Assay, LD ₅₀ , ED ₅₀ , IC ₅₀ and ID ₅₀ .	3hrs	Employable Skills EMP SKD EDP
		<u>Concept of Prodrugs and soft drugs.</u> a. Prodrugs: i) Prodrugs designing, types of prodrugs; ii) Prodrug formation of compounds containing various chemical groups, Prodrugs and Drug delivery system .b.Soft drugs: i) soft drug cocept; ii) Properties of soft drugs.	4hrs	
		<u>Theories of drug activity & Drug design</u> Basics of drug receptor interactions. Theories of drug activity (Occupancy theory, Rate theory, Perturbation theory, Receptor theory,). Hansch equation. <u>Antibiotics</u> Structure elucidation and synthesis of penicillins, chloromycetin and tetracyclins (terramycin and aureomycin).	7hrs	
2	Unit -2	<u>Steroids</u> Occurrence. Nomenclature, basic skeleton, Diels hydrocarbon and stereochemistry. Isolation, structure and structural elucidation of sterols and bile acids (determination of ring size, nature of side chain, position of angular methyl and stereochemistry of ring junctions). Sex hormones and corticosteroids. Synthesis of cholesterol,	13hrs	Employable Skills and analytical Skills EMP

		estrone, progesterone, androsterone, testosterone. Photoproducts of ergosterol-vitamins D. Barton reaction for the synthesis of aldosterone. Marker degradation. Brief discussion of homosteroids, norsteroids and oral contraceptives. Synthesis of (dl)-norgestrel and ethinyl oestradiol.		SKD EDP
3	Unit-3	<u>Mechanism of drug action and synthesis of the following classes of drugs, with recent developments:</u> <i>Antipyretics, analgesics and non-steroidal anti-inflammatory drugs</i>, phenacetin, novalgin, phenylbutazone and ibuprofen. <i>Antidiabetics</i>: Sequence of A- & B- chains of insulin, glibenclamide, metformin, ciglitazone. <i>Antihistamines</i>: Methapyrilene, chlorpheniramine. <i>Antivirals</i>: Acyclovir, amantidine, rimantidine and zidovudine. <i>Antineoplastic agents</i>: Introduction, cancer chemotherapy, role of alkylating agents and antimetabolites in treatment of cancer. Synthesis of mechlorethamine, cyclophosphamide, melaphan, uracil mustards and 6-mercaptopurine. Hormone and natural products. <i>Cardiovascular drugs</i>: Introduction, cardiovascular diseases. Synthesis of amyl nitrite, sorbitrate, diltiazem, quinidine, verapamil, methyl dopa, atenolol, oxyprenol.	13hrs	Employable Skills EMP SKD EDP
4	Unit-4	<u>Local anti-infective agents:</u> Introduction and general mode of action. Synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, dapsone, aminosalicyclic acid, isoniazide, ethionamide, ethambutal, fluconazole, econazole, griseofulvin, and chloroquin <u>Psychoactive drugs- chemotherapy of the mind:</u> Introduction, benzodiazepines, buspirone. Antipsychotic drugs- butyrophenones, Synthesis of chlorpromazine, oxazepam, chlorazepam, alprazolam, phenytoin, ethosuximide, trimethadione, barbiturates, thiopental sodium, glutethimide.	12hrs	Employable Skills EMP SKD EDP

REFERENCE BOOKS:

1. Burger's Medicinal Chemistry and Drug Discovery, Vols. 1-6 Ed. D.J. Abraham, John Wiley, 2003
2. Foye's Principles of Medicinal Chemistry, 6th Edn., T L Lemke and D A Williams Eds., Lippincott, Williams and Wilkins, 2007
3. An Introduction to Medicinal Chemistry, P Graham, III Ed., Oxford, 2006
4. Medicinal Chemistry, N Weaver, Oxford, 2006
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, 11th Edn., Tata McGraw-Hill, 2005.
6. The Organic Chemistry of Drug Design and Drug Action, R B Silverman, II Edn, Academic Press, Amsterdam, 2004.
7. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical chemistry, J H Block and J M Beale, Jr., Eds., Lippincott, Williams and Wilkins, 2003.
8. Medicinal Chemistry – G R Chatwal, Himalaya, New Delhi, 2002
9. Instant Notes Medicinal Chemistry, P Graham, Viva, New Delhi, 2002
10. Medicinal Chemistry, A Kar, Wiley, 2000.
11. An Introduction to Drug Design, S.S. Pandey and J.R. Dimmock, New Age International, 1999.
12. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley, 1998.
13. Synthetic drugs, G. R. Chatwal, Himalaya, New Delhi, 1995.
14. Natural Products Chemistry Vol 1 and 2, G R Chatwal, Himalaya, New Delhi, 1990
15. Comprehensive Organic Chemistry, Vol. 5 (Antibiotics), D. H. R. Barton, W. D. Ollis, Pergamon Press, NY, 1979.
16. Organic chemistry Vol.II, I. L. Finar, 6th Edn. Longman, 1992.
17. Total synthesis of natural products: The chiral approach Vol.III, S. Hanessian Pergamon Press, 1983.
18. Total synthesis of steroids, Akhaun & Titov, Jerusalem, 1969.
19. Medicinal natural products: A biosynthetic approach, P. M. Dewick. John Wiley, Chichester, 1997.
20. Natural products: Their chemistry and biological significance-J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthorpe & J. B. Harborne, Longman, UK, 1994.
21. Natural products chemistry Vol. I & II, K. Nakanishi, T. Goso, S. Ito., S. Natori & S. Nozoe, Academic Press, NY, 1974.
22. Chemistry of natural products Vol. I & II, O. P. Aggarwal, Goel Publishing House, 6th Edn. 1982.
23. Total synthesis of natural products: The chiral approach Vol.III, S. Hanessian Pergamon Press, 1983.
24. Interpretation of the UV spectra of natural products, A.I. Scott, Pergamon Press, Oxford, 1964.

M.Sc IV SEMESTER-CHEMISTRY
MCH-405: ORGANIC CHEMISTRY PRACTICALS –V

COURSE	DETAILS
CODE	MCH-405
TITLE	ORGANIC CHEMISTRY PRACTICALS –V
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXIMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PT presentations, Seminars and presenPtations
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Preparation of organic compounds by various methods.
CObj_2	Preparations of laboratory solutions.
CObj_3	The safety methods used to prepare solutions.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Design and carry out experiments employing suitable techniques, accurately record and analyze the results, calculate overall yield of the final product.
CO_2	Know what type of precautions should take during the preparation of compounds.
CO_3	Understand to calculate the theoretical yield and practical yields.
CO_4	Design the mechanisms for the reactions carried.
CO_5	Handled the separation methods.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-405-ORGANIC CHEMISTRY PRACTICALS – V

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Preparations:</u> 1.Preparation of NBS from succinic acid and its application in allylic bromination reactions. 2.Preparation of benzpinacolone from benzophenone. 3.Preparation of 2,4,5-triphenyloxazole from benzoin 4.Synthesis of Methyl Red 5.Synthesis of 1-bromo-2-naphthol from 2-naphthol	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	<u>Qualitative analysis:</u> Separation of a binary mixture of organic compounds and identification of the separated components by systematic qualitative organic analysis	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

- 1.Semi-micro qualitative organic analysis, Cheronis, Entrikin & Hoanett.
2. Preparation of organic intermediates, D. A. Hirley, John Wiley.
3. Text book of practical organic chemistry, A. I. Vogel, Pearson, 5th Edition, Delhi, 2004.
4. A laboratory manual of qualitative organic analysis, H.T. Openshaw, Univ. Press, 1999.
5. Organic Synthesis collective Vols. I to X, 1956-1999.
6. Laboratory Techniques in Organic Chemistry, V K Ahluwalia, Pooja Bhagat and Renu Aggarwal, I K international Publishing House, New Delhi, 2005.
7. Intermediates for Organic Synthesis, V K Ahluwalia, Pooja Bhagat, Ramesh Chandra and Renu Aggarwal, I K international Publishing House, New Delhi, 200

M.Sc IV SEMESTER-CHEMISTRY
MCH-406: ORGANIC CHEMISTRY PRACTICALS –VI

COURSE	DETAILS
CODE	MCH-406
TITLE	ORGANIC CHEMISTRY PRACTICALS –VI
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ THIRD
TYPE	HARD-CORE
TOTAL CREDITS	2
TOTAL CONTACT HOURS	60
COTACT HOURS PER WEEK	4
EXAMINATION DURATION	4
MAXOMUM MARKS	15(IA) + 35 = 50
TOTAL MODULES	10
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PT presentations, Seminars and presenPtations
EVALUATION METHOD	Lab performance, Observation and Mock tests will be given.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Recording of spectral data using various spectroscopic techniques.
CObj_2	Methods employed for extraction/isolation of important natural products.
CObj_3	Chromatographic separation of mixtures.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	Carry out spectral analysis and confirmation of structure of organic compounds.
CO_2	Design extraction, isolation and purification (using chromatographic techniques) of natural products.
CO_3	Handling separation techniques.
CO_4	Process and isolation of various plant materials.
CO_5	Know the different chromatography techniques used.

CO-PO Mapping:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-406: ORGANIC CHEMISTRY PRACTICALS – VI

60hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	<u>Extractions & Isolations:</u> 1.Extraction of caffeine from tea leaves. 2.Extraction of limonene from citrus rinds. 3.Isolation of essential oil from rose petals. 4. Isolation and separation of pigments chlorophyll and β -carotenes from spinach.	30hrs	Employable Skills EMP SKD EDP
2	Unit -2	<u>Instrumental methods in organic analysis:</u> 1. Recording/predicting/downloading from web sites the UV, IR, NMR and GC-MS/mass spectra of the compounds prepared in III & IV semesters. 2. Structural elucidation of organic compounds with the help of spectra provided by the instructors/examiners.	30hrs	Employable Skills and analytical Skills EMP SKD EDP

REFERENCE BOOKS:

1. Natural products, Laboratory manual, Ikan, 2000.
2. Organic experiments, L. F. Fieser, 2nd Edn. D. C. Heath & Co. USA, 1974-2000.
3. Practical organic chemistry F.G. Mann and B. C. Saunders 4th Edn. Longman, 2002.
4. Comprehensive practical organic chemistry: Preparation and quantitative Analysis, V. K. Ahluwalia, R. Aggarwal, Universities Press (India), 2000.
5. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India), 2000.
6. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. K. Nad, New central book agency, Calcutta, 2000.
7. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992.
8. Practical organic chemistry (Quantitative analysis), B. B. Dey, M V Sitaraman and T. R. Govindachari, Allied Publishers, New Delhi, 1992, 200

M.Sc IV SEMESTER-CHEMISTRY
MCH-407: PROJECT WORK

COURSE	DETAILS
CODE	MCH-407
TITLE	PROJECT WORK
PROGRAMME	M.Sc ORGANIC CHEMISTRY
YEAR/SEMESTER	SECOND/ FOURTH
TYPE	HARD-CORE
TOTAL CREDITS	4
TOTAL CONTACT HOURS	80
COTACT HOURS PER WEEK	8
EXAMINATION DURATION	4
TOTAL MAXIMUM MARKS	30(IA) + 70 = 100
TOTAL MODULES	6 MONTH PROJECT
PEDAGOGY	Lecture with practical problems being Worked out, Chalk and talk PT presentations, Seminars and presentations
EVALUATION METHOD	Project performance, Research skills and viva voce performance will be taken under consideration.

COURSE OBJECTIVES

This course aims to impart to the student, knowledge of:

CObj_ID	Course Objectives
CObj_1	Selecting the topics of the research project work.
CObj_2	Writing the thesis part.
CObj_3	Interpreting the results.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to:

CO_ID	COURSE OUTCOMES
CO_1	To design the project by collecting required background material by referring the literature.
CO_2	To understand the functioning and safety features in the industry.
CO_3	To improve the experimental and soft skills.
CO_4	Know the methodology of preparing the synopsis of the project work.
CO_5	To learn various analytical and instrumental techniques and interpretation of analytical data.

CO-PO MAPPING:

	PO_1	PO_2	PO_3	PO_4	PO_5	PSO_1	PSO_2	PSO_3	PSO_4	PSO_5
CO_1		X					X			
CO_2	X					X				
CO_3		X					X			
CO_4	X					X				
CO_5			X				X			

MCH-407: ORGANIC CHEMISTRY PRACTICALS – VII
80hrs

S. No	Module title	Module Content	Number of Hours	Skills Developed
1	Unit -1	Research Project	80hrs	Employable Skills EMP SKD EDP



Affiliated to Bangalore North University

REGULATIONS, SCHEME AND SYLLABUS

For the Programme

**MASTER OF SCIENCE IN DATA
SCIENCE (M.Sc. (DS))**

I to IV Semesters

(Choice Based Credit System)

w.e.f. Academic Year 2021-22 onwards

DEPARTMENT OF COMPUTER SCIENCE

Indian Academy Degree College Autonomous

Hennur Cross, Hennur Main Road, Bangalore

SCHEME OF STUDY AND SCHEDULE OF EXAMINATION

1. Title of the programme: M. Sc Data Science.
2. Duration of the programme: 2 years (4 semesters)
3. Eligibility:
 - A. A candidate who has passed Bachelor of Computer Applications (BCA) with 50% aggregate marks from any UGC recognized University in India or abroad.
 - B. A candidate who has passed an Under Graduate degree examination in Science with 50% aggregate from any UGC recognized University in India or abroad and has studied any two of the following subjects/courses as major or minor:
 - a. Computer Science
 - b. Mathematics
 - c. Statistics
4. Admission: A category wise merit list will be prepared with marks obtained in all optionals in all the three years of UG programme.
 - a) The minimum requirements for SC / ST candidates are relaxed in accordance with University regulations.
 - b) Intake: As per guidelines from Parent University.
5. Attendance: Minimum 75% attendance in each subject is required.
6. Medium of instruction: English.
7. Scheme of study:

Each semester is of 4 months duration.

I semester: Theory papers- 4, Practicals- 2

II semester: Theory papers- 4, Practicals- 2

III semester: Theory papers- 4, Practicals- 1, Internship- 1

IV semester: Theory paper- 1, Practicals- 1, Project Work- 1.
8. Scheme of examination:

There shall be a final examination at the end of each semester.

Appearance for the examination and provision for repeaters:
As per regulations of the Office of Controller of Examinations, Indian Academy Degree College Autonomous and guidelines from Parent University, for P.G. Courses.

Result declaration:
As per regulations of the Office of Controller of Examinations, Indian Academy Degree College Autonomous, for P.G. Courses.
9. Miscellaneous:
 - a) Continuous Internal Assessment:
 - Seminars -10
 - Assignments/ activity -10
 - Internal exam (Mid Semester, Pre final) -10
 - b) Lectures from experts in the field of Data Science are highly desirable.
 - c) 8 hours of experiential learning must be done in each course in the program.
10. Any other issue not envisaged above shall be resolved by the appropriate bodies of the Institution/University, which shall be final and binding.

**SCHEME OF STUDY AND EXAMINATION FOR MASTER OF
SCIENCE IN DATA SCIENCE (M.Sc. (DS))**

Semester	Subject code	Subjects	Hrs / week	Marks			Credits
				IA	exam	Total	
I SEM	MDS101	Introduction to Data Science	4	30	70	100	4
	MDS102	Mathematical and Statistical foundation for Data Science	4	30	70	100	4
	MDS103	Python Programming	4	30	70	100	4
	MDS104	Big Data Analytics	4	30	70	100	4
	MDS105	Python Programming Lab	8	30	70	100	4
	MDS106	Big Data Analytics Lab	8	30	70	100	4
							Total:24
II SEM	MDS201	Advanced Algorithms	4	30	70	100	4
	MDS202	Machine Learning	4	30	70	100	4
	MDS203	Cloud computing	4	30	70	100	4
	MDS204	Advanced Algorithms Lab	8	30	70	100	4
	MDS205	Machine Learning Lab using Python	8	30	70	100	4
	MDS206	Non-Core: Professional Ethics and Corporate Governance	2	30	70	100	2
							Total:22
III SEM	MDS301	Deep Learning	4	30	70	100	4
	MDS302	Research Methodology	4	30	70	100	4
		Elective:	4	30	70	100	4
	MDSE31	Web scraping					
	MDSE32	Natural Language Processing					
	MDSE33	Forecasting and Optimization					
	MDSOPE	Open Elective	2	30	70	100	2
	MDS303	Deep Learning Lab	8	30	70	100	4
	MDS304	Internship	-	30	70	100	4
							Total:22
IV SEM	MDS401	Data Storytelling	4	30	70	100	4
	MDS402	Julia programming Lab	8	30	70	100	4
	MDS403	Main Project work	-	100	200	300	14
							Total:22
TOTAL CREDITS: 90							

M.Sc. DATA SCIENCE

PEO_ID	MSC-Programme Educational Objectives
PEO1	To develop in-depth understanding of the key technologies in Data Science
PEO2	To gain ability to design integrated solutions to problems by applying principles of Data Science
PEO3	To provide strong core training both theoretically and practically to create adept data scientists
PEO4	To gain exposure to real-world problems in order to adapt easily to the industry demands
PEO5	To inculcate values and make students realize the significance of ethics in a professional environment

PO_ID	MSC-Programme Outcomes
On completion of the MSc programme, the student will be able to:	
PO1	Apply Quantitative modeling and Data analysis techniques to solve real-world problems, communicate findings, and effectively present results
PO2	Apply Data-driven insights to enhance business and develop applications that would reduce human effort.
PO3	Employ cutting edge tools and technologies to analyze data particularly, large volume of data
PO4	Apply appropriate algorithms and build intelligent machines by following ethical practices and adapt to industry demands
PO5	Pursue quality research in Data Science by following ethical and moral values and develop solutions to societal needs

MDS101 – INTRODUCTION TO DATA SCIENCE

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives:

CObj_ID	Course Objectives
CObj_1	To understand the applications of Data Science
CObj_2	To provide in-depth knowledge of principles of Data Science, techniques and applications
CObj_3	To gain an insight into data driven programming

Course Outcomes:

CO_ID	Course Outcomes
CO_1	Explore data science and data engineering
CO_2	Apply Data-Driven Insights to Business and Industry
CO_3	Create and analyze Data through Visualizations
CO_4	Build Models that Operate Internet-of-Things Devices
CO_5	Apply Domain Expertise to Solve Real World Problems Using Data Science

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*		*	
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Getting Started with Data Science – Facets of Data- structured data, Unstructured data, Natural language, Machine-generated data, Graph based or network data, Audio, image, video streaming data. Data Science Process: setting research goal-retrieving data- Data Preparation, Data Exploration,	12 Hrs	Research/ Analytical/ Employable Skills

		Data modelling or model building- Presentation and Automation. Who Can Make Use of Data Science, Analyzing the pieces of the Data Science Puzzle, Exploring the Data Science Solution Alternatives, Letting Data Science Make You More Marketable.		
2	Unit- II	Exploring Data Engineering - Pipelines and Infrastructure -Grasping the Difference between Data Science and Data Engineering- Identifying Big Data Sources-Making Sense of Data in Hadoop-Identifying Alternative Big Data Solutions. Applying Data-Driven Insights to Business - Defining Business-Centric Data Science - Differentiating between Business and Data Driven Business- Benefiting from Business-Centric Data Science - Converting Raw Data into Actionable Insights with Data Analytics -Taking Action on Business Insights - Distinguishing between Business Intelligence and Data Science.	10 Hrs	Employable Skills
3	Unit- III	Using Data Science to Extract Meaning from Your Data: Machine Learning - Learning from Data with Your Machine, Defining Machine Learning and Its Processes Considering Learning Styles. Building Models That Operate Internet-of-Things Devices - Overviewing the Vocabulary and Technologies Digging into the Data Science Approaches, Advancing Artificial Intelligence Innovation	10 Hrs	Employable Skills
4	Unit- IV	Creating Data Visualizations: Following the Principles of Data Visualization Design, Data Visualizations - The Big Three Designing to Meet the Needs of Your Target Audience, Picking the Most Appropriate Design Style, Choosing How to Add Context, Selecting the Appropriate Data Graphic Type, Choosing a Data Graphic. Using D3.js for Data Visualization - Introducing the D3.js Library-Knowing When to Use D3.js-Getting Started in D3.js-	10 Hrs	Employable Skills

		Implementing More Advanced Concepts.		
5	Unit- V	Doing Data Science with Excel and Knime - Making Life Easier with Excel, Using KNIME for Advanced Data Analytics. Applying Domain Expertise to Solve RealWorld Problems Using Data Science - Data Science for driving growth in e-commerce.	10 Hrs	Employable Skills

Textbooks and References:

1. *Introducing Data Science* by Davy Cielen, Arno D.B.Meysman, Mohamed Ali, dream tech press.
2. *Data Science For Dummies (For Dummies (Computers)) 2nd Edition* by Lillian Pierson
3. *An Introduction to Data Science* by Jeffrey S. Saltz and Jeffrey M. Stanton
4. *A Hands-On Introduction to Data Science* by Chirag Shah

MDS102 – MATHEMATICAL AND STATISTICAL FOUNDATION FOR DATA SCIENCE**Total Teaching Hours: 52****No. of Hours / Week: 04****Course Objectives:**

CObj_ID	Course Objectives
CObj_1	To introduce students to the fundamental mathematical concepts required for Data Science
CObj_2	To enable students in applying the fundamentals of statistics to assess descriptive measures and probability for data analysis
CObj_3	Able to apply mathematics and statistics in Data Science applications

Course Outcomes:**Upon completion of the course, students will be able to:**

CO1	Apply Linear algebra and graph theory to develop applications in Data Science
CO2	Demonstrate the use of Eigenvalues, Eigenvectors and Inner Product Space in data processing
CO3	Apply the concept of correlation, linear and non-linear regressions to analyze data science problems
CO4	Become competent to analyze data using descriptive statistics
CO5	Apply the knowledge of probability distribution for various events

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*			*	*
CO_2	*			*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*

CO_5	*	*	*	*	*

	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Introduction: Typology of problems; Importance of linear algebra, statistics and optimization from a data science perspective; Structured thinking for solving data science problems. Linear Algebra : Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Matrix factorizations; Inner products; Distance measures; Projections; Notion of hyperplanes; half-planes.	14 Hrs	Research/ Analytical/ Employable Skills
2	Unit- II	Graph Theory : Graphs - subgraphs - factors - Paths - cycles - connectedness - trees - Euler tours - Hamiltonian cycles - Planar Graphs - Digraphs.	6 Hrs	Research/ Analytical/ Employable Skills
3	Unit- III	Organization and Presentation of Data : Descriptive Statistics Sampling Techniques – Data Classification – Tabulation – Frequency and graphic Representation – Measures of Central Tendency – Measures of Variation – Quartiles and Percentiles – Moments -Skewness and Kurtosis.	10 Hrs	Research/ Analytical/ Employable Skills
4	Unit- IV	Correlation and Regression : Correlation and Regression Scatter Diagram – Karl Pearson’s Correlation Coefficient – Rank Correlation - Correlation Coefficient for Bivariate Frequency	10 Hrs	Research/ Analytical/ Employable Skills

		Distribution – Regression Coefficients – Fitting of Regression Lines.		
5	Unit- V	Basics of Probability : Probability Theory Random Experiment – Sample Space – Events – Axiomatic Definition of Probability – Addition Theorem – Multiplication Theorem – Baye’s Theorem - Applications. Distribution functions : Continuous and Discrete Random Variables – Distribution Function of a Random Variable – Probability Mass Functions and Probability Density Functions – Characteristic Functions – Central Limit Theorems.	12 Hrs	Research/ Analytical/ Employable Skills

Text books & References:

1. Gupta, S.C. and Kapoor, V.K.: “Fundamentals of Mathematical Statistics”, Sultan & Chand & Sons, New Delhi, 11th Ed, 2002.
2. Hastie, Trevor, et al. “The elements of Statistical Learning”, Springer, 2009.
3. Ross, S.M., “Introduction to Probability and Statistics”, Academic Foundation, 2011.
4. Papoulis, A. and Pillai, S.U. , “Probability, Random Variables and Stochastic Processes”, TMH, 2010.
5. G. Strang (2016). Introduction to Linear Algebra, Wellesley-Cambridge Press, Fifth edition, USA.
6. Bendat, J. S. and A. G. Piersol (2010). Random Data: Analysis and Measurement Procedures. 4th Edition. John Wiley & Sons, Inc., NY, USA:
7. Montgomery, D. C. and G. C. Runger (2011). Applied Statistics and Probability for Engineers. 5th Edition. John Wiley & Sons, Inc., NY, USA:
8. David G. Luenberger (1969). Optimization by Vector Space Methods, John Wiley & Sons (NY)
9. Cathy O’Neil and Rachel Schutt (2013). Doing Data Science, O’Reilly Media

MDS103 - PYTHON PROGRAMMING

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives:

CObj_ID	Course Objectives
CObj_1	Understand the concept of functions, list, dictionaries
CObj_2	Acquire skills to create object oriented programs in Python
CObj_3	Gain ability to access database and handle files from python programs

Course Outcomes:

CO_ID	Course Outcomes
CO_1	Gain knowledge of the concepts of list, dictionaries, tuples and sets
CO_2	Create and use functions, user defined modules functions and apply regular expressions in appropriate situations.
CO_3	Gain ability to perform file handling and database operations using Python.
CO_4	Become competent in using numpy and pandas and apply in project development
CO_5	Become proficient in object oriented programming using python

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Introduction To Python Installation and Working with Python- Understanding Python variables- Python basic Operators- Understanding python blocks- Declaring and using Numeric data types: int, float, complex. Using string data type and string operations- Defining list and list slicing -Use of Tuple data type. Conditional blocks using if, else and elif -Simple for loops in python-For loop using ranges, string, list and dictionaries-Use of while loops in python-Loop manipulation using pass, continue, break.	[10 hours]	Research/ Analytical/ Employable Skills
2	Unit- II	Functions, Modules, list, dictionary, regular expressions Organizing python codes using functions-Organizing python projects into modules-Importing own module as well as external modules. Understanding string in built methods-List manipulation using in built methods-Dictionary manipulation -Programming using string, list and dictionary in built functions Regular expression: Powerful pattern matching and searching-Power of pattern searching using regex in python, Pattern finding programs using regular expression,	10 Hrs	Research/ Analytical/ Employable Skills
3	Unit- III	Object Oriented Programming Concept of class, object and instances-Constructor, class attributes and destructors-Inheritance, overlapping and overloading operators -Adding and retrieving dynamic attributes of classes Programming using OOps - exception handling -Safe guarding file operation using exception handling - Programming using Exception handling.Understanding threads-Forking threads -Synchronizing the	10 Hrs	Research/ Analytical/ Employable Skills

		threads-Programming using multithreading		
4	Unit- IV	NumPy: Narray, numpy.matlib, numpy.linalg: Dot product of the two arrays, Dot product of the two vectors, Inner product of the two arrays, Matrix product of the two arrays, Computes the determinant of the array, Solves the linear matrix equation, Finds the multiplicative inverse of the matrix. Pandas: pandas series, dataframes, read csv, read JSON, clean data, explore data, correlation, plotting.	12 Hrs	Research/ Analytical/ Employable Skills
5	Unit- V	Using files and Database Files: Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, The Pickle Module, Reading and Writing CSV Files, Python os and os.path Modules. Using Databases in Python: Python MySQL Database Access -Install the MySQLdb and other Packages -Create Database Connection - CREATE, INSERT, READ, UPDATE and DELETE Operation- DML and DDL operation with Databases -Performing Transactions- Handling Database Errors.	10 Hrs	Research/ Analytical/ Employable Skills

References :

1. Ashok Namdev Kamthane, Amit Ashok Kamthane, “Programming And Problem Solving With Python”, 2nd Edition, Mc Graw Hill, 2020.
2. Gowrishankar S, Veena A, “Introduction to Python Programming”, 1st Edition, CRC Press/Taylor & Francis, 2018.
3. Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, CreateSpace Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf)
4. Jake VanderPlas, “Python Data Science Handbook: Essential Tools for Working with Data”, 1st Edition, O'Reilly Media, 2016.

Web References:

1. <https://www.w3resource.com/python-exercises/>

2. <https://docs.python.org/3/tutorial/index.html>

MDS104 – BIG DATA ANALYTICS

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives

CObj_ID	Course Objectives
CObj_1	To provide an overview of fundamental concepts of big data and analytics
CObj_2	To gain knowledge of the tools required for working with big data like Hadoop, NoSql MongoDB
CObj_3	To gain ability to integrate large amounts of data

Course Outcomes

CO_ID	Course Outcomes
CO_1	Understand the fundamentals of various big data analytics techniques
CO_2	Work with big data analysis techniques and develop Big Data Solutions using Hadoop Eco System
CO_3	Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics
CO_4	Become competent to create databases using mongodb and apply appropriate operations in real world applications
CO_5	Become proficient to create projects using spark

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*		*	*	*
CO_2	*		*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Introduction to Big Data Introduction to Big Data, Evolution of Big data, Best Practices for Big data Analytics, Big data characteristics, Scalability and Parallel Processing, Designing Data Architecture, Data Sources, Quality, Pre-Processing and Storing, Data Storage and Analysis	10 Hrs	Cognitive/ Research/ Analytical Skills
2	Unit- II	Hadoop: Introduction, HDFS Concepts, Hadoop Distributed File System, MapReduce Framework and Programming Model, Composing MapReduce for Calculations and Algorithms Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures	10 Hrs	Research/ Analytical/ Employable Skills
3	Unit- III	NoSQL Big Data Management Introduction, NoSQL Datastore, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared Nothing Architecture for Big data Tasks,.	5 Hrs	Research/ Analytical/ Employable Skills
4	Unit- IV	MongoDB Database :MongoDB CRUD operation – Collections, MongoDB CRUD operations. Bulk write operations. MongoDB import and export. Embedded documents, Working with arrays, Array of embedded documents, Projection, Dealing with null and missing values, Working with limit() and skip(), Working with Node.js and MongoDB. Data modelling and aggregation : Data models, Data model relationship between documents, Modeling tree structures, Aggregation operations, SQL aggregation terms and corresponding MongoDB aggregation operations. Indexes : Indexes, Types of indexes, Index properties, The various indexing strategies to be considered. Replication and sharding, Multidocument translations,	15 Hrs	Research/ Analytical/ Employable Skills

		MongoDB security.		
5	Unit- V	Spark: Overview- Linking with Spark, Initializing Spark - Using the Shell. Resilient Distributed Datasets (RDDs) - Parallelized Collections, External Datasets, RDD Operations - Basics, Passing Functions to Spark, Understanding closures, Example, Local vs. cluster modes, Printing elements of an RDD, Working with Key-Value Pairs, Transformations, Actions, Shuffle operations - Background, Performance Impact. RDD Persistence - Which Storage Level to Choose?, Removing Data. Shared Variables- Broadcast Variables, Accumulators, Deploying to a Cluster.	12 Hrs	Research/ Analytical/ Employable Skills

References:

1. Raj Kamal and Preeti Saxena, Big Data Analytics Introduction to Hadoop, Spark, and Machine-Learning, McGraw Hill Education, 2018 ISBN: 9789353164966, 9353164966
2. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
3. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
4. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
5. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/El sevier Publishers, 2013.
6. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press, 2010.
7. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers " CRC Press, 2015.
8. Jimmy Lin and Chris Dyer, "Data-Intensive Text Processing with MapReduce", Synthesis Lectures on Human Language Technologies, Vol. 3, No. 1, Pages 1-177, Morgan Claypool publishers, 2010.
9. Matei Zaharia, Mosharaf Chowdhury, Tathagata Das, Ankur Dave, Justin Ma, MurphyMcCauley, Michael J. Franklin, Scott Shenker, Ion Stoica, Resilient Distributed Datasets: A Fault-Tolerant Abstraction for In-Memory Cluster Computing, NSDI 2012, April 2012.

MDS105: PYTHON PROGRAMMING LAB

PRACTICALS

Total Teaching Hours: 60

No. of Hours per Week: 8

CObj	Course Objectives
CObj_1	To provide practical knowledge of the concept of functions, list, dictionaries
CObj_2	To instill skills to create object oriented programs in Python
CObj_3	To enable easy understanding of accessing database and handling files from python programs

CO	Course Outcomes After completion of this module, students should be able to:
CO1	Gain practical knowledge of the concepts of functions, list, dictionaries
CO2	Analyze the usage of Python libraries and apply them appropriately
CO3	Become competent in file handling using Python
CO4	Create Python programs to access databases
CO5	Create object oriented programs in Python

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

List of Programs	Skills Developed
1. Write a program to demonstrate list and tuple in python. 2. Write a program to count the numbers of characters in the string and store them in a dictionary data structure. 3. Python program to remove all the lines that contain the character 'a' in a file and write it to another file. 4. Write a Python function sin(x, n) to calculate the value of sin(x) using its Taylor series expansion up to n terms. Compare the values of sin(x) for different values of n with the correct value 5. Write Python program to random number generator that generates random numbers between 1 and 6 (simulates a dice). 6. Write a Python program to implement a stack and queue using a list data-structure. 7. Write a Python program to plot the function $y = x^2$. 8. Write a Python program to create a line plot. 9. Write a Python program to copy odd lines of one file to another file in Python 10. Write a Python program to create Histogram using Pylab in Python 11. Write a Python program to create an Employee table, insert 5 tuples and delete a particular employee from the table. 12. Write a Python program to create student table and find the min, max, sum, and average of the marks in a student marks table. 13. Write a Python program to create a customer table and find the total number of customers from each country in the table (customer ID, customer name, country) using group by. 14. Write a Python program to generate QR code.	Employable / Analytical/ Synthesis Skills

Scheme of evaluation:

CIA	30 Marks
Writing two programs	20 Marks

Execution	40 Marks
Viva-Voce	10 Marks
Total	100 Marks

MDS106 – BIG DATA ANALYTICS LAB

Total Teaching Hours: 60

No. of Hours per Week: 8

Course Objectives

CObj_ID	Course Objectives
CObj_1	To provide an overview of fundamental concepts of big data and analytics
CObj_2	To gain knowledge of the tools required for working with big data like Hadoop, NoSql MongoDB
CObj_3	To gain ability to integrate large amounts of data

Course Outcomes

CO_ID	Course Outcomes
CO_1	Solve Big Data problems using HADOOP
CO_2	Gain ability to use Spark
CO_3	Ability to Comprehend query processing using map-reduce
CO_4	Become competent in CRUD operations on MongoDB
CO_5	Acquire skills to handle big data projects

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*		*	*	*
CO_2	*		*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*

CO_5	*		*	*	*

List of Experiments	
Part-A 1. Perform various HDFS commands 2. File Management commands in Hadoop i. Create a directory in HDFS at given path(s). ii. List the contents of a directory. iii. Upload and download a file in HDFS. iv. See contents of a file v. Copy a file from source to destination vi. Copy a file from/To Local file system to HDFS vii. Move file from source to destination. viii. Remove a file or directory in HDFS. ix. Display last few lines of a file. x. Display the aggregate length of a file. 3. Word Count Map Reduce program to understand Map Reduce Paradigm 4. Implementing Matrix Multiplication with Hadoop Map Reduce 5. Implement Map reduce in spark 6. Implement Page ranking using Spark 7. Implement CRUD operations in mongo db Part-B The students are supposed to develop a mini industry level application for the lab. The students can do the activity in a group (team) consisting of not more than 2 students.	

Scheme of evaluation:

CIA	30 Marks
Writing one program	10 Marks
Execution	20 Marks
Mini project Demonstration	30 Marks

Viva-Voce	10 Marks
Total	100 Marks

MDS201 – ADVANCED ALGORITHMS

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives:

CObj_ID	Course Objectives
CObj_1	Analyze variety of algorithms with practical applications emphasizing optimal Solution of each algorithm
CObj_2	Identify most suitable algorithm for a given task in order to save time and cost Resources
CObj_3	To be aware of complex problems such as NP Hard and NP-complete problems

Course Outcome:

CO_ID	Course Outcomes
CO_1	Gain knowledge of various designing paradigms in formulating algorithm
CO_2	Understand approximation algorithms and implement in solving the problems
CO_3	Explore various string matching/pattern matching algorithm widely used in machine learning automation
CO_4	Gain exposure to parallel algorithms, parallel time and processors time complexity
CO_5	Acquire knowledge and implement probabilistic and randomized algorithms

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*		*	*	*
CO_2	*		*	*	*
CO_3	*	*	*	*	*
CO_4	*		*	*	*

CO_5	*		*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Introduction: Algorithm Specification – Analysis of Insertion sort – Performance Analysis - Space complexity – Time Complexity – Asymptotic notations. Divide and Conquer – Binary search – Quick sort – Maxmin algorithm.	12 Hrs	Research/ Analytical/ Employable Skills
2	Unit- II	Greedy Approach - Knapsack problem – Minimum cost spanning tree – PRIM's and Kruskal's Algorithm – single source shortest path problem (Dijkstra's Algorithm). String Matching - Introduction to string-matching problem, Naïve algorithm, Rabin Karp, Knuth Morris Pratt, Boyer-Moore algorithms	10 Hrs	Research/ Analytical/ Employable Skills
3	Unit- III	Dynamic Programming – 0/1 Knapsack problem - All pairs shortest path – Travelling Salesperson problem – Multistage graph. Backtracking - The general method – 8 Queens problem Branch and Bound - Sum of subsets, Graph colouring.	10 Hrs	Research/ Analytical/ Employable Skills
4	Unit- IV	Approximation Algorithms Approximation algorithms for vertex cover, set cover, TSP, knapsack. Parallel Algorithms: Introduction, Models, speedup and efficiency, Some basic techniques, PRAM Algorithms – Computational model.	10 Hrs	Research/ Analytical/ Employable Skills
5	Unit- V	Theory of NP- Hard and NP-Complete Problems: P, NP and NP-Complete complexity classes; A few NP-Completeness proofs. Probabilistic Algorithms & Randomized Algorithms: Las Vegas and Monte Carlo algorithms, Game-theoretic	10 Hrs	Research/ Analytical/ Employable Skills

		techniques.		

References:

1. T. H Cormen, C E Leiserson, R L Rivest and C Stein: “Introduction to Algorithms”, 3rd Edition, Prentice-Hall of India, 2011.
2. Mark Allen Weiss, Data Structures and Algorithm analysis in C++, 3rd edition, PEA, 2011.
3. Ellis Horowitz, Sartaj Sahni, S.Rajasekharan: “Fundamentals of Computer Algorithms”, 1st edition, University Press, 2012.

Course objectives:

CObj_ID	Course Objectives
CObj_1	To understand the concepts and techniques of Machine Learning
CObj_2	To gain knowledge of classification and regression models
CObj_3	To apply the various dimensionality reduction techniques

Course outcomes: Upon completion of the course, the students will be able to:

CO_ID	Course Outcomes
	Upon completion of the course, the students will be able to:
CO_1	Gain ability to comprehend supervised, unsupervised and reinforcement learning.
CO_2	Acquire skills to apply the appropriate machine learning strategy for any given problem
CO_3	Modify existing machine learning algorithms to improve classification efficiency
CO_4	Create Ensemble models to improve performance of the classifier
CO_5	Competency to apply dimensionality reduction on high dimensional datasets

CO-PO MAPPING

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed

1	Unit- I	Foundations for ML Learning – Machine Learning-Types of Machine Learning – Supervised Learning –unsupervised learning-reinforcement learning-ML Technique overview: build model, Train, validate, Test,evaluate. - Cross-Validations -confusion matrix, Evaluation metrics: precision, recall, f1 score, accuracy, ROC, AUC, sensitivity, specificity, MSE, MAE.	10 Hrs	Research/ Analytical/ Employable Skills
2	Unit- II	Clustering Distance measures - Different clustering methods (Distance, Density, Hierarchical) - Iterative distance-based clustering; - Dealing with continuous, categorical values in K-Means - Constructing a hierarchical cluster - K-Medoids, k-Mode-density-based clustering - Measures of quality of clustering.	10 Hrs	Research/ Analytical/ Employable Skills
3	Unit- III	Classification and Regression Linear Regression, Logistic Regression, Classifiers: K-Nearest Neighbors - Naïve Bayes Classifier - Support Vector Machines - SVM for classification and regression problems, Decision Tree.	10 Hrs	Research/ Analytical/ Employable Skills
4	Unit- IV	Dimensionality Reduction Curse of dimensionality – Dimensionality Reduction- Techniques for Dimensionality Reduction: Feature Selection Methods: filter methods- chi square, correlation, wrapper method- RFE, Matrix Factorization- PCA, Manifold Learning- SOM, t-Distributed Stochastic Neighbor Embedding (t-SNE)- Genetic algorithm used in feature selection.	12 Hrs	Research/ Analytical/ Employable Skills

5	Unit- V	Ensemble Learning and Reinforcement Learning Ensemble methods - Bagging - boosting -stacking- impact on bias and variance - Random forest - Gradient Boosting Machines - XGBoost. Reinforcement Learning – Analogy- process– Markov Decision Process- Q learning.	10 Hrs	Research/ Analytical/ Employable Skills

References:

1. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, h The Elements of Statistical Learning, 2nd edition, springer series in statistics.
3. Ethem Alpaydin, “Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)”, Third Edition, MIT Press, 2014
4. Christopher M. BishopPattern Recognition andMachine Learning, Springer 2006.
5. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, First Edition, Cambridge University Press, 2012.
6. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

MDS203 – CLOUD COMPUTING

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives:

CObj_ID	Course Objectives
CObj_1	To make students to be aware of various cloud computing models, strength and weakness of cloud
CObj_2	Enabling students to understand security, privacy and interoperability
CObj_3	To help and motivate students to undertake projects in cloud environment

Course Outcome:

CO_ID	Course Outcomes
CO_1	Analyze various cloud programming models and apply them to solve problems on the cloud
CO_2	Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
CO_3	Explain the core issues of cloud computing such as security, privacy, and interoperability
CO_4	Acquire knowledge of system, network and storage virtualization and outline their role in enabling the cloud computing system model
CO_5	Ability to comprehend Service Oriented Architecture[SOA] and its services in Business and IT in cloud environment

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*		*	*	*
CO_2	*		*	*	*
CO_3	*		*	*	*
CO_4	*		*	*	*
CO_5	*		*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Introduction: Essentials, Benefits and need for Cloud Computing -Business and IT Perspective-Cloud and Virtualization -Cloud Services Requirements -Cloud and Dynamic Infrastructure - Cloud Computing Characteristics Cloud Adoption. Cloud Models: Cloud Characteristics - Measured Service -Cloud Models - Security in a Public Cloud Public versus Private Clouds.	10 Hrs	Research/ Analytical/ Employable Skills
2	Unit- II	Cloud Infrastructure Self Service - Cloud as a Service: Gamut of Cloud Solutions -Principal Technologies - Cloud Strategy Cloud Design and Implementation using SOA - Conceptual Cloud Model -Cloud Service Defined.	6 Hrs	Research/ Analytical/ Employable Skills
3	Unit- III	Cloud Solutions: Cloud Ecosystem - Cloud Business Process Management -Cloud Service Management -Cloud Stack -Computing on Demand (CoD) -Cloud sourcing. Cloud Offerings: Information Storage, Retrieval, Archive and Protection -Cloud Analytics Testing under Cloud - Information Security -Virtual Desktop Infrastructure -Storage Cloud. Cloud Management: Resiliency - Provisioning -Asset Management - Cloud Governance -High Availability and Disaster Recovery -Charging Models, Usage Reporting, Billing and Metering.	14 Hrs	Research/ Analytical/ Employable Skills
4	Unit- IV	Cloud Virtualization Technology: Virtualization Defined -Virtualization Benefits - Server Virtualization - Virtualization for x86 Architecture - Hypervisor Management Software - Logical Partitioning (LPAR) -VIO Server -Virtual Infrastructure	10 Hrs	Research/ Analytical/ Employable Skills

		Requirements. Cloud Virtualization: Storage virtualization -Storage Area Networks -Network-Attachedstorage -Cloud Server Virtualization - Virtualized Data Center.		
5	Unit- V	Cloud and SOA: SOA Journey to Infrastructure -SOA and Cloud -SOA Defined -SOA and IaaS - SOA-based Cloud Infrastructure Steps -SOA Business and IT Services. Cloud Infrastructure Benchmarking: OLTP Benchmark -Business Intelligence Benchmark -e-Business Benchmark - ISV Benchmarks -Cloud Performance Data Collection and Performance Monitoring Commands-Benchmark Tools.	12 Hrs	Research/ Analytical/ Employable Skills

References

1. Cloud Computing –Insight into New Era Infrastructure, Dr. Kumar Saurabh, Wiley India, 2011.
2. Cloud Computing, Roger Jennings, Wiley India, 2009.
3. Cloud Computing Explained, John Rhoton, Recursive Press,2009. 4.Cloud Computing Bible, Barry Sosinsky, Wiley, 2011.
4. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Wiley, 2011.
5. Cloud Computing for Dummies, Judith Hurwiz, Wiley Publishing, 2009.
6. The Cloud at yourservice, Rosenberg and Matheos, Manning Publications, 2010.

MDS204 - ADVANCED ALGORITHMS LAB

Total Teaching Hours: 60

No. of Hours per Week: 8

Course Objectives:

CObj_1	To research a specific algorithm with different set of values and to plot graph to understand its behavioral patterns with respect to input size n
CObj_2	To handle string matching problems using naïve Bayes classification and KMP problems in order to compare performance
CObj_3	To make the students to find out optimized solution in algorithms using research statistics

Course Outcome:

CO_1	Gain knowledge of different design techniques and their implementation.
CO_2	Understand algorithm efficiency computation and write effective algorithms
CO_3	Implement pattern matching algorithm
CO_4	Apply sorting algorithms to improve program performance
CO_5	Implement Parallel algorithm to improve efficiency

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*		*	*	*
CO_2	*		*	*	*
CO_3	*	*	*	*	*
CO_4	*		*	*	*
CO_5	*		*	*	*

List of Experiments

1. Write a Program to Implement recursive binary search and linear search and determine the time required to search an element. Repeat the experiment for different values of n , the number of elements in the list to be searched and plot a graph of the time taken versus n .
2. Write a Program to Sort a given set of elements using the Quicksort method and determine the time required to sort the elements. Repeat the experiment for different values of n , the number of elements in the list to be sorted and plot a graph of the time taken versus n . The elements can be read from a file or can be generated using the random number generator.
3. Write a Program to Sort a given set of elements using heap sort method and determine the time required to sort the elements. Repeat the experiment for different values of n , the number of elements in the list to be sorted and plot a graph of the time taken versus n .
4. Write a Program to Implement 0/1 Knapsack problem using Dynamic Programming.
5. Write a Program to find shortest paths from a given vertex in a weighted connected graph to other vertices using Dijkstra's algorithm.
6. Write a Program to solve the string pattern matching problem using Rabin Karp approach.
7. Write a Program to Find a subset of a given set $S = \{s_1, s_2, \dots, s_n\}$ of n positive integers whose sum is equal to a given positive integer d . For example, if $S = \{1, 2, 5, 6, 8\}$ and $d = 9$ there are two solutions $\{1, 2, 6\}$ and $\{1, 8\}$. A suitable message is to be displayed if the given problem instance doesn't have a solution.
8. Write a Program to solve the string matching problem using Boyer-Moore approach.
9. Write a Program to solve the string matching problem using naïve approach and the KMP algorithm.
10. Write a Program to Implement a parallelized Merge Sort algorithm to sort a given set of elements and determine the time required to sort the elements. Repeat the experiment for different values of n , the number of elements in the list to be sorted and plot a graph of the time taken versus n . The elements can be read from a file or can be generated using the random number generator.
11. Write a Program to Implement All-Pairs Shortest Paths Problem using Floyd's algorithm.

12. Write a program to implement a Monte Carlo algorithm.

Scheme of evaluation:

CIA	30 Marks
Writing two programs	20 Marks
Execution	40 Marks
Viva-Voce	10 Marks
Total	100 Marks

MDS205 – MACHINE LEARNING LAB USING PYTHON

Total Teaching Hours: 60

No. of Hours per Week: 8

Course objectives:

CObj_ID	Course Objectives
CObj_1	To understand practically the concepts and techniques of Machine Learning
CObj_2	To gain practical knowledge of classification and regression models
CObj_3	To apply the various dimensionality reduction techniques and ensemble models in ML Projects

Course outcomes:

CO_ID	Course Outcomes
CO_1	Gain practical knowledge of fundamental concepts and methods of machine learning, statistical pattern recognition and its applications.
CO_2	Gain ability to analyze and evaluate algorithms for pattern classification
CO_3	Gain ability to comprehend simple models and Ensemble models
CO_4	Acquire skills to design ML algorithms for classification in Python and test them with benchmark data sets
CO_5	Become competent to develop ML projects

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

List of Experiments

Part-A

1. Data Preprocessing Techniques
2. Feature Selection using GA
3. Dimensionality reduction using PCA
4. Regression Analysis using Linear regression
5. Regression Analysis using Logistic Regression
6. Classification using Decision tree
7. Classification using SVM
8. Classification Techniques- Naïve Bayes, KNN
9. Clustering using K- Means clustering
10. Ensemble method- Bagging
11. Ensemble method- Boosting
12. Ensemble method- Stacking

Part-B

Mini Project

The students are supposed to develop a mini application for the lab. The students can do the activity

in a group (team) consisting of not more than 2 students

Scheme of evaluation:

CIA	30 Marks
Writing one program	10 Marks
Execution	20 Marks
Mini project Demonstration	30 Marks
Viva-Voce	10 Marks
Total	100 Marks

MDS206 – Non Core: PROFESSIONAL ETHICS AND CORPORATE GOVERNANCE

Total Teaching Hours: 30

No. of Hours per Week: 2

CObj	Course Objectives
CObj_1	To instill Moral, Social Values and Loyalty in a professional environment
CObj_2	To create an awareness on Professional Ethics, Human Values and the impact of unethical practices
CObj_3	To understand organizational culture and to adapt to changing cultures without compromising ethical values

CO	Course Outcomes
	After completion of this module, students should be able to:
CO1	Recognize the significance of human values and practice the same
CO2	Understand and control the excessive desires of the mind
CO3	Interpret and apply professional code of ethics in real world
CO4	Assess the benefits of restraining from unethical practices while designing software solutions to problems
CO5	Critically examine ethical dilemmas and to understand the importance of governance mechanisms in a globalized economy

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2			*		*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5					*

Course Content

Sl. No.	Unit/chapter title	Content	Number of hours	Skills Developed
1	Unit- I	Introduction To Terminology In Ethics : Integrity, Honesty, Courage, Empathy, Personality, Character, Self-Confidence, Respect for Others – Work culture, Social responsibility, Responsibilities as a citizen, Cooperation and commitment – Religion vs.Spirituality, Philosophy, Customs and practices – Self-interest, Fear, Deception, Ignorance, Ego, Uncritical acceptance of authority.	6 Hrs	Ethical Skills
2	Unit- II	Mind And Its Mysteries What is Mind? Mind and body, Mind and food – Mental faculties – Theory of perception, Memory, Imagination, Thought-Culture, Desires – Cultivation of Virtues, Control of Senses and Mind – Concentration, Meditation and Enlightenment.	6 Hrs	Professionalism
3	Unit- III	Non-Ethical Practices In Vogue Conflict of Interest, Occupational crime – How multinational corporations influence government decisions, public policy – Data Scientists as advisors and experts, Data Scientists as moral leaders – Problem of bribery, extortion, grease payments, nepotism – Nexus between politicians and industrialists.	6 Hrs	Ethical Skills, Professionalism
4	Unit- IV	Ethics in Data Science Data Collection, Representation and Privacy: Data Sampling and Collection, Managing Datasets Responsibility and Data Cannibalism – Flaws in the premise of data science – Machine Bias: How can a	6 Hrs	Ethical Skills, Professionalism

		machine be biased? - Bias vs Correlation vs Causation - What is fair? - What is discrimination? - Fairness in Deep Learning – Accountability - Who is responsible when a machine takes a decision? - Doing ethical data analysis		
4	Unit- V	Corporate Governance Meaning, Aspects of Corporate Governance, Historical perspective, Organization for corporate governance, Corporate operations, Governance of country and company, Governance Mechanism.	6 Hrs	Cognitive Skills

Reference Books:

1. Subramanian, R. (2013). Professional ethics. OUP India.
2. Sivananda, S. (1986). Mind: Its mysteries and control. Divine Life Society.
3. Loukides, M., Mason, H., & Patil, D. (2018). Ethics and data science. O'Reilly Media.
4. Gaur, R., Sangal, R., & Bagaria, G. (2010). A foundation course in human values and professional ethics: Presenting a universal approach to value education - Through self-exploration.
5. Reynolds, G. W. (2007). Ethics in information technology. Course Technology.
6. Naagarazan, R. (2007). A textbook on professional ethics and human values. New Age International.

MDS301 – DEEP LEARNING

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives:

CObj_ID	Course Objectives
CObj_1	To understand and gain knowledge of Deep learning techniques.
CObj_2	To create Deep Learning Applications.
CObj_3	To learn and design RNN applications.

Course Outcomes:

CO_ID	Course Outcomes
CO_1	Gain knowledge of Deep learning techniques.
CO_2	Familiarize with TensorFlow/Keras in Deep Learning Applications.
CO_3	Design and implement RNN applications.
CO_4	Gain knowledge of optimization in Deep Learning.
CO_5	Design and implement Convolutional Neural Networks.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Basics Of Neural Networks And Deep Learning Basic concept of ANN – Perceptron and activation function – Feed Forward Neural Networks – Gradient Descent – Back Propagation Algorithm – Vanishing and exploding Gradient problem. What is Deep learning- – ReLU Heuristics for Avoiding Bad Local Minima – Heuristics for Faster Training – Nestors Accelerated Gradient Descent –	10 Hrs	Research/ Analytical/ Employable Skills

		Regularization – Dropout.		
2	Unit- II	Convolutional Neural Networks CNN Architectures – Convolution – Pooling Layers – Transfer Learning – Image Classification using Transfer Learning	10 Hrs	Research/ Analytical/ Employable Skills
3	Unit- III	Optimization And Generalization Optimization in deep learning– Non-convex optimization for deep networks- Stochastic Optimization -Generalization in neural networks- Spatial Transformer Networks- Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs , F-RNN, Deep Reinforcement Learning - Computational & Artificial Neuroscience	10 Hrs	Research/ Analytical/ Employable Skills
4	Unit- IV	Other Deep Learning Architectures Encoder/Decoder Architectures – Autoencoders – Standard- Sparse – Denoising – Contractive- Variational Autoencoders – Adversarial Generative Networks – Autoencoder, Deep Belief Networks.	12 Hrs	Research/ Analytical/ Employable Skills
5	Unit- V	Applications Of Deep Learning Imagenet- Detection-Audio WaveNet- Natural Language Processing Word2Vec - Joint Detection - Face Recognition- Scene Understanding- Gathering Image Captions	10 Hrs	Cognitive/ Research/ Analytical / Employable Skills

References:

1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.

2. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018.
3. Phil Kim, “Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence”, Apress , 2017.
4. Ragav Venkatesan, Baoxin Li, “Convolutional Neural Networks in Visual Computing”, CRC Press, 2018.
5. Navin Kumar Manaswi, “Deep Learning with Applications Using Python”, Apress, 2018.
6. Joshua F. Wiley, “R Deep Learning Essentials”, Packt Publications, 2016.

MDS302 – RESEARCH METHODOLOGY

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives:

CObj_ID	Course Objectives
CObj_1	To motivate students to do research in computer science by understanding research process and methodologies
CObj_2	To prepare students to writing articles with originality in content
CObj_3	To provide an awareness on IPR and copyrights

Course Outcomes:

CO_ID	Course Outcomes
CO_1	Explore research types, objectives and techniques of defining research problem
CO_2	Gain Good knowledge of types of reasoning, hypothesis and research designs

CO_3	Gain awareness of IPR and ethics to be practiced in research
CO_4	Implement report writing in order to publish a research/review paper
CO_5	Become competent in scientific writing

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*			*	*
CO_2	*			*	*
CO_3	*			*	*
CO_4	*				*
CO_5				*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Science and Research Definition – History – Evolution of Scientific Inquiry, Scientific Research: Definition, Characteristics, types of research, need of research. Identification of the problem, assessing the status of the problem, formulating the objectives, preparing design (experimental or otherwise), Actual investigation.	10 Hrs	Cognitive/ Research/
2	Unit- II	Introduction to Research Methodology Meaning and importance of Research – Types of Research – Selection and techniques in formulation of Research Problem. Research Design – Need – Features.	10 Hrs	Cognitive/ Research/Analytical skill

		Developing a Research Plan – Exploration, Descriptive, Diagnostic, Experimental, Determining Experimental and Sample Designs. Analysis of Literature Review – Primary and Secondary Sources, Web sources – critical Literature Review. Hypothesis – Different Types – Significance – Development of Working Hypothesis, Null hypothesis. Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive – Inductive logical process – Different types of inductive logical methods.		
3	Unit- III	Data Collection and Analysis Sources of Data – Primary, Secondary and Tertiary – Types of Data – Categorical, nominal & Ordinal. Methods of Collecting Data: Observation, field investigations, Direct studies Reports, Records or Experimental observations. Sampling methods – Data Processing and Analysis strategies- Graphical representation – Descriptive Analysis – Inferential Analysis- Correlation analysis. Least square method - Data Analysis using statistical package – Hypothesis testing – Generalization and Interpretation – Modeling.	10 Hrs	Cognitive/ Research/Analytical skill

4	Unit- IV	Scientific Writing Structure and components of Scientific Reports – types of Report – Technical Reports and Thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports - Illustrations and tables – Bibliography, Referencing and foot notes –Importance of Effective Communication. Preparing Research papers for journals, Seminars and Conferences – Design of paper using TEMPLATE, Calculations of Impact factor of a journal, citation Index, ISBN & ISSN. Preparation of Project Proposal - Title, Abstract, Introduction – Rationale, Objectives, Methodology – Time frame and work plan – Budget and Justification – References. Documentation and scientific writing Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs,citation styles, writing a review of paper, Bibliography.	12 Hrs	Cognitive/ Research/Analytical skill
5	Unit- V	Ethics Ethical Issues – APA ethics code- Ethical Committees – Commercialization – copy right – royalty – Intellectual Property rights and patent law – Track Related aspects of intellectual property Rights – Reproduction of published material – Plagiarism – Citation and Acknowledgement – Reproducibility	10 Hrs	Cognitive/ Research/Analytical skill

		and accountability		

References:

1. Kothari, C.R. (2008). Research Methodology: Methods and Techniques. Second Edition. New Age International Publishers, New Delhi.
2. Sinha, S.C. and Dhiman, A.K. (2002). Research Methodology, Ess Publications.
3. Gupta S.P. (2008). Statistical Methods. 37th ed. (Rev) Sultan Chand and Sons. New Delhi. 1470 p.
4. Garg.B.L., Karadia, R., Agarwal,F. and Agarwal, U.K., (2002). An introduction to research Methodology, RBSA Publishers.
5. Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
6. Research Methodology Dr P M Bulakh, Dr P. S. Patki and Dr A S Chodhary. (2010). Expert Trading Corporation, Mumbai

MDSE31 - WEB SCRAPING

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives:

COBJ_ID	Course Objectives
CObj_1	To understand the concept of web scraping using Python
CObj_2	Gain knowledge on data extraction and processing
CObj_3	Gain ability to handle data with NLTK

Course Outcomes:

Upon completion of this course, students will be able to :

CO_ID	Course Outcomes
CO_1	To comprehend the concept of web scraping using Python
CO_2	Gain Knowledge of the legalities of Web scraping
CO_3	Acquire skills on data extraction from web pages and processing the data
CO_4	Acquire skills to process CAPTCHA using python
CO_5	Gain ability to scrape dynamic websites

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*		*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Introduction – What is web scraping, origin of web scraping, web crawling vs web scraping, uses of web scraping, components of a web scraper. Python Modules for Web Scraping - Python Development Environments using virtualenv, requests, Urllib3, Selenium, Scrapy.	10 Hrs	Cognitive/ Research/ Analytical Skills
2	Unit- II	Legality of Web Scraping – Introduction, research required prior to scraping. Data Extraction – web page analysis, viewing page source, Inspecting Page Source by Clicking Inspect Element Option. Different Ways to Extract Data from Web Page, Regular Expression. Beautiful soup, Lxml	10 Hrs	Research/ Analytical/ Employable Skills

3	Unit- III	Data Processing – introduction, CSV and JSON data processing, Data processing using AWS S3, Data processing using MySQL, Data processing using PostgreSQL. Processing Images and Videos – Introduction, getting media content from web page, extracting file name from URL, information about type of content from URL, generating thumbnail for images, screenshot from website, thumbnail generation for video, ripping an MP4 video to MP3	10 Hrs	Research/ Analytical/ Employable Skills
4	Unit- IV	Dealing with Text – Introduction, getting started with NLTK, stemming, Lemmatization, Chunking, Bag of Word (BoW) Model Extracting and converting the Text into Numeric Form, Building a Bag of Words Model in NLTK, Topic Modeling: Identifying Patterns in Text Data, Topic Modeling Algorithms. Scraping Dynamic Websites – Introduction, dynamic website example, approaches for Scraping data from Dynamic Websites, Rendering JavaScript	10 Hrs	Research/ Analytical/ Employable Skills
5	Unit- V	Scraping Form based Websites - Introduction, Interacting with Login forms, Loading Cookies from the Web Server, Automating forms with Python. Processing CAPTCHA - What is CAPTCHA? Loading CAPTCHA with Python, Pillow Python Package, OCR: Extracting Text from Image using Python. Testing with Scrapers - Introduction, Testing using Python, Unit test – Python Module, Testing with Selenium, Comparison: unittest or Selenium.	12 Hrs	Research/ Analytical/ Employable Skills

References:

1. Web Scraping with Python: Successfully scrape data from any website with the power of Python (Community Experience Distilled) Paperback – October 28, 2015 by Richard Lawson.
 2. Web Scraping with Python: Collecting More Data from the Modern Web Paperback – April 24, 2018 by Ryan Mitchell.
 3. Python Web Scraping Cookbook: Over 90 proven recipes to get you scraping with Python, micro services, Docker and AWS Paperback – February 9, 2018 by Michael Heydt
1. <https://www.datacamp.com/community/tutorials/web-scraping-using-python>

MDSE32 - NATURAL LANGUAGE PROCESSING

Total Teaching Hours: 52

No. of Hours / Week: 04

Course objectives:

CObj_ID	Course Objectives
CObj_1	To learn about NLP techniques and key issues
CObj_2	To gain knowledge about the data structures and algorithms used in NLP
CObj_3	To understand how key concepts from NLP and linguistics are used to describe and analyze language

Course Outcomes:

Upon completion of the course, students will be able to

CO_ID	Course Outcomes
CO_1	Gain good understanding of the NLP techniques and NL interfaces
CO_2	Gain ability to analyze data stored in standard formats.
CO_3	Acquire skills to understand the methods and algorithms used to process different types of textual data
CO_4	Gain ability to understand semantics and pragmatics of English language for processing
CO_5	Demonstrate the Extraction of information from text and classification of text

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*		*	*
CO_2	*	*	*	*	*
CO_3	*	*		*	*
CO_4	*	*			*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Introduction Application of NLP techniques and key issues- MT grammar checkers- dictation–document generation- NL interfaces- Natural language processing key issues- the different analysis level used for NLP: morpho-lexical-syntactic-semantic-pragmatic-markup(TEI, UNICODE)-finite state automata- Recursive and augmented transition networks- open problems.	10 Hrs	Cognitive/ Research/ Analytical Skills
2	Unit- II	Processing Raw Text Accessing Text from the Web and from Disk – Strings - Text Processing with Unicode - Regular Expressions for Detecting Word Patterns - Useful Applications of Regular Expressions - Normalizing Text - Regular Expressions for Tokenizing Text – Segmentation – Formatting. Writing Structured Programs – Sequences - Questions of Style – Functions - Doing More with Functions - Program Development - Algorithm Design - A Sample of Python Libraries.	12 Hrs	Research/ Analytical/ Employable Skills
3	Unit- III	Categorizing and Tagging Words Using a Tagger - Tagged Corpora - Mapping Words to Properties Using Python Dictionaries - Automatic Tagging - N-Gram Tagging - Transformation-Based Tagging - How to Determine the Category of a Word. Learning to Classify Text: Supervised Classification – Evaluation - Decision Trees - Naive Bayes Classifiers - Maximum Entropy Classifiers - Modeling Linguistic Patterns	10 Hrs	Research/ Analytical/ Employable Skills

4	Unit- IV	Extracting Information from Text Information Extraction – Chunking - Developing and Evaluating Chunkers - Recursion in Linguistic Structure - Named Entity Recognition - Relation Extraction. Analyzing Sentence Structure: Some Grammatical Dilemmas - Context-Free Grammar - Parsing with Context- Free Grammar - Dependencies and Dependency Grammar - Grammar Development.	10 Hrs	Research/ Analytical/ Employable Skills
5	Unit- V	Building Feature-Based Grammars: Grammatical Features - Processing Feature Structures - Extending a Feature-Based Grammar. Analyzing the Meaning of Sentences: Natural Language Understanding - Propositional Logic - First-Order Logic - The Semantics of English Sentences - Discourse Semantics.	10 Hrs	Research/ Analytical/ Employable Skills

References:

1. Daniel J and James H. Martin, speech and language processing , an introduction to natural language processing, computational linguistics & speech recognition, prentice hall,2009.
2. Steven Bird, Ewan Klein, and Edward Loper, “Natural Language Processing with Python”, O’Reilly,2009.
3. Nitin Indurkha, Fred J. Damerau, “Handbook of Natural Language Processing”, CRC Press, 2010.
4. Dwight Gunning, Sohom Ghosh, Natural Language Processing Fundamentals, Packt Publishers, 2019.
5. Brian McMahan and Delip Rao, “Natural Language Processing with PyTorch: Build Intelligent
6. Language Applications Using Deep Learning”, O’Reilly, Firs edition, 2019.
7. Hobson Lane, Hannes Hapke, and Cole Howard, “Natural Language Processing in Action:
8. Understanding, analyzing, and generating text with Python”, Manning Publications, First edition, 2019.
9. Adarsha Shivananda and Akshay Kulkarni, “Natural Language Processing Recipes: Unlocking Text
10. Data with Machine Learning and Deep Learning Using Python”, APress, 2019.

MDSE33 – FORECASTING AND OPTIMIZATION

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives:

CObj_ID	Course Objectives
CObj_1	To provide a comprehensive introduction of the forecasting methods
CObj_2	To study the various regression models and perform forecasting
CObj_3	To understand the autoregressive models and its variants for forecasting
CObj_4	To get an overview of various numerical methods of optimization
CObj_5	To get an insight into advanced optimization techniques.

Course Outcomes:

Upon completion of this course, the student will be able to:

CO_ID	Course Outcomes
CO_1	Identify and understand the types of forecasting techniques
CO_2	Implement time series modeling and forecasting
CO_3	Measure and evaluate the performance of forecasting models
CO_4	Implement regression analysis using different regression models
CO_5	Deliberate the concept of advanced optimization techniques using soft computing techniques and apply them to various problems.

CO-PO Mapping

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*		*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*		*	*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed

1	Unit- I	Introduction To Forecasting: The Nature and Uses of Forecasts- The Forecasting Process- Resources for Forecasting- Types of Forecasting Techniques - Graphical Displays- Time Series Plots- Plotting Smoothed Data- Numerical Description of Time Series Data- Stationary Time Series- Auto covariance and Autocorrelation Functions- Use of Data Transformations and Adjustments- Transformations- Trend and Seasonal Adjustments- General Approach to Time Series Modeling and Forecasting- Evaluating and Monitoring Forecasting Model Performance- Forecasting Model Evaluation- Choosing Between Competing Models- Monitoring a Forecasting Model	10 Hrs	Cognitive/ Research/ Analytical Skills
2	Unit- II	Autoregressive Integrated Moving Average (Arima) And Other Models First Order Exponential Smoothing- Second Order Exponential Smoothing- Higher Order Exponential Smoothing- Exponential Smoothing for Seasonal Data- Linear Models for Stationary Time Series Finite Order Moving Average (MA) Processes- Finite Order Autoregressive Processes- Mixed Autoregressive-Moving Average Processes- Nonstationary Processes- Time Series Model Building Forecasting ARIMA Processes- Seasonal Processes- Exponential Smoothers and ARIMA Models Multivariate Stationary Process- Vector ARIMA Models- Vector AR (VAR) Models- Direct Forecasting of Percentiles- Neural Networks and Forecasting	12 Hrs	Research/ Analytical/ Employable Skills

3	Unit- III	Linear Programming Introduction and formulation of Linear Programming problems, Graphical solution method, Simplex Algorithm, Duality in linear programming. Nonlinear Programming - Sample Applications, Graphical Illustration of Nonlinear Programming Problems	10 Hrs	Research/ Analytical/ Employable Skills
4	Unit- IV	Sequencing Introduction, processing N jobs through two/three/M machines; Game Theory: Two person zero-sum game, Game with mixed strategies, Graphical method and solution by linear programming.	10 Hrs	Research/ Analytical/ Employable Skills
5	Unit- V	Modern Methods Of Optimization – Metaheuristic Techniques Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization. Simulation - Introduction & steps of simulation method, distribution functions and random number generation.	10 Hrs	Research/ Analytical/ Employable Skills

References:

1. Spyros Makridakis and Steven C. Wheelwright, "Forecasting: Methods and Applications". Wiley 1997.
1. A. Hamdy Taha "Operations research: An introduction". Pearson Education India, 2017.
2. Hillier and Lieberman "Introduction to Operations Research", TMH
3. S. S. Rao. Engineering optimization: theory and practice. John Wiley & Sons, 2009.
4. J K Sharma, Operations Research Theory and Applications, MacMillan India Ltd.
5. An introduction to Optimization by Edwin P K Chong, Stainslaw Zak
6. C. B. Gupta, "Optimization Techniques in Operation Research".I.K. International Publishing House, Pvt Ltd., 2nd Edition, 2012.
7. George Athanasopoulos and Rob J. Hyndman, "Forecasting: Principles and Practice".O texts, WWW. otexts.org
8. L. R. Foulds, "Optimization Techniques: An Introduction". Springer-Verlag New York, 1981
5. Ronald L. Rardin, "Optimization in operations research". Prentice Hall, 1998
- 6.

MDSOPE- OPEN ELECTIVE

Total Teaching Hours: 30

No. of Hours / Week: 02

Open elective course is chosen from the list of courses offered by the Institution for all PG courses.

MDS303 – DEEP LEARNING LAB

Course Objectives:

CObj_ID	Course Objectives
CObj_1	To understand and gain practical knowledge of Deep learning techniques
CObj_2	To create Deep Learning Applications
CObj_3	To design RNN applications

Course Outcomes:

CO_ID	Course Outcomes
CO_1	On completion of the course, the students will be able to:
CO_2	Gain practical knowledge of Deep learning techniques.
CO_3	Familiarize with TensorFlow/Keras in Deep Learning Applications
CO_4	Design and implement RNN applications

CO_5	Gain knowledge of optimization in Deep Learning.
CO_6	Design and implement Convolutional Neural Networks

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Part-A

1. Implement vector addition in TensorFlow.
2. Implement regression model in Keras.
3. Implement a perceptron in TensorFlow/Keras Environment.
4. Implement a Feed-Forward Network in TensorFlow/Keras.
5. Implement an Image Classifier using CNN in TensorFlow/Keras.
6. Implement a Transfer Learning concept in Image Classification.
7. Implement an Autoencoder in TensorFlow/Keras.
8. Implement a Simple LSTM using TensorFlow/Keras.
9. Implement an Opinion Mining in Recurrent Neural network.
10. Implement an Object Detection using CNN.

Part-B

Mini Project

The students are supposed to develop a mini industry level application for the lab. The students can do the activity in a group (team) consisting of not more than 2 students.

Scheme of evaluation:

CIA	30 Marks
Writing one program	10 Marks
Execution	20 Marks
Mini project Demonstration	30 Marks
Viva-Voce	10 Marks
Total	100 Marks

MDS304 – INTERNSHIP

Students will have to take up summer internship at the end of Second semester. The report of the same is to be submitted in the third semester. The Internship will be evaluated through a practical examination at the end of the third semester.

Scheme of evaluation:

CIA	30 Marks
Demonstration and presentation	40 Marks
Validation	10 Marks
Viva-Voce	10 Marks
Report	10 Marks

Total	100 Marks

MDS401 - DATA STORYTELLING

Total Teaching Hours: 52

No. of Hours / Week: 04

Course Objectives

CObj_ID	Course Objectives
CObj_1	To focus on how to tell stories with data to create social change with tools and technologies
CObj_2	To introduce basic methods for research, cleaning and analyzing datasets, but the focus is on creative methods and media for data presentation and storytelling
CObj_3	To consider the emotional, aesthetic and practical effects of different presentation methods as well as how to develop metrics for assessing impact

Course Outcomes:

CO_ID	Course Outcomes
CO_1	CO1: Learn techniques for finding a story in data, building a basic set of tool-assisted data analysis skills.
CO_2	CO2: Think like a designer

CO_3	CO3: Build things that tell data-driven stories with a rich set of digital and non-digital tools, online and offline.
CO_4	CO4: Learn to connect data stories to meaningful, situated social action.
CO_5	CO5: Understand basic techniques for measuring the impact of data-driven storytelling.

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

Sl. No.	Unit/chapter title	Content	Number of hours	Skills developed
1	Unit- I	Understand the context : Get to know your audience, Narrow your audience, Complete big idea worksheet, Refine and reframe, Critique the big idea. Choose an effective visual : Improve the table, Lets draw, Practice your tool, How should you show this data, Visualize the weather	12 Hrs	Cognitive/ Research/ Analytical Skills
2	Unit- II	Identify and eliminate cluster : Gestalt principles in play, Tying words to graph, Harness alignment and whitespace, De-clutter. Focus Attention: Where are your eyes drawn, Direct attention, Visualize all data, Direct attention many ways, Practice differentiating in your tool.	12 Hrs	Research/ Analytical/ Employable Skills

3	Unit- III	Think like a designer: Use words wisely, Do better, Pay attention to detail, Examine and emulate, Make minor changes for major impact.	8 Hrs	Analytical/ Employable Skills
4	Unit- IV	Tell a story: Use takeaway titles, Put it into words, Identify tension, Utilize components of story. Practice more with cole: New advertiser revenue, Sales channel update, Back to school shopping, Diabetes rates.	12 Hrs	Analytical/ Employable Skills
5	Unit- V	Practice more at work : Create your plan of attack, Set good goals, Cultivate a feedback culture, Refer to SWD process, Make use of assessment rubrics, set yourself for successful data story.	8Hrs	Analytical/ Employable Skills

References:

1. Effective Data Storytelling: How to Drive Change with Data, Narrative and Visuals Hardcover – 23 January 2020 by Brent Dykes.
2. Wickham, H. "Tidy Data." (PDF) Journal of Statistical Software 59 no. 10 (August 2014).
3. Leskovec, J., A. Rajaraman and J. D. Ullman. "Data Mining." (PDF) Chapter 1 (author's manuscript version) in Mining of Massive Datasets. Cambridge University Press, 2011.
4. Zer-Aviv, M. "Disinformation Visualization: How to lie with datavis." Visualizing Information for Advocacy (blog), January 31, 2014.
5. Edward R. Tufte. "Graphical Excellence." Chapter 1 in The Visual Display of Quantitative Information. 2nd edition. Graphics Press, 2001. ISBN: 9781930824133. pp 13-52
6. Ware, C. "Visual and Verbal Narrative." Chapter 7 in Visual Thinking for Design. Morgan

Kaufmann, 2008. ISBN: 9780123708960. [Preview with Google Books]

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MDS402 - JULIA PROGRAMMING LAB

No. of Hours / Week: 08

Course Objectives:

CObj_ID	Course Objectives
CObj_1	o To understand and gain practical knowledge of Julia Programming
CObj_2	o To solve math problems using Julia Programming
CObj_3	o To understand recipes and implement them

Course Outcomes:

CO_ID	Course Outcomes
CO_1	Gain practical knowledge of Julia Programming
CO_2	Familiarize with Clustering.jl

CO_3	Implement dimensionality reduction in Julia
CO_4	Gain knowledge of animation of plots.
CO_5	Familiarize with recipes

	PO_1	PO_2	PO_3	PO_4	PO_5
CO_1	*	*	*	*	*
CO_2	*	*	*	*	*
CO_3	*	*	*	*	*
CO_4	*	*	*	*	*
CO_5	*	*	*	*	*

1. Write a Julia program to solve the ForwardDiff Problems using linear algebra
2. Write a Julia program to solve the Lorenz Problem
3. Write a Julia program to solve the Ball Bounce Problem
4. Write a Julia program to solve the Optimization Problems
5. Write a Julia program to solve the Nonlinear Solver Problems
6. Use Clustering.jl to cluster the SepalLength, PetalLength, and PetalWidth features via K-means clustering in Iris database. Make a scatter plot of the resulting clusters.
7. Perform advanced clustering task by using a subset of Word Embedding, trained using Word2Vec.jl. Use Affinity Propagation from Clustering.jl, to cluster word2vec word embeddings, according to meaning.
8. Make binomial stock price trees. Use them to model future stock prices.
9. Use PCA from MultivariateStats.jl, to reduce 100 dimensional word embedding down to 3,2 and 1 dimensions. Plot these using Plots.jl, coloring according to class
10. Perform an Animation of Any plot
11. Interpret the data of an abstract type using Type Recipes.
12. Build a set of series plots and defaults using Plot Recipes.
13. Demonstrate series recipe in Julia programming.

MDS402 – MAIN PROJECT WORK

It is an individual project. Students should implement their project in the Institution/Industry. Internal marks can be awarded by the guide by evaluating the performance of the students during the course of project work. In viva-voce the questions must be directed only on the project work to access the involvement and understanding of the problem by the students.

The **project carries 300 marks** is distributed as follows:

Internal Assessment: 100 marks

External Assessment is as follows:

Demonstration and presentation	100 Marks
Validation	30 Marks
Viva-Voce	40 Marks
Report	30 Marks
Total	200 Marks