CORE COURSES SEMESTER I

Core Course I: Microbiology and Phycology - 100 marks

Unit-I	Introduction to microbial world, microbial nutrition, growth and metabol
	Viruses:-Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.
Unit-II	Bacteria: - Discovery, general characteristics, types-archaebacteria, eubacteria, wall-less forms(mycoplasma and spheroplasts), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentationand medicine).
Unit-III	Algae:- General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. lyengar) Role of algae in the environment, agriculture, biotechnology and industry.
Unit-IV	Cyanophyta:- Ecology and occurrence, range of thallus organization, cell structure, heterocyst, reproduction.economic importance; role in biotechnology. Morphology and life-cycle of Nostoc. Chlorophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of Chlamydomonas, Volvox, Oedogonium, Coleochaete.
Unit-V	Evolutionarysignificance of <i>Prochloron</i> . Charonhyta:- General characteristics; occurrence, morphology, cell
	structure and life-cycle of <i>Chara</i> ; evolutionary significance. Xanthophyta:- General characteristics; range of thallus organization; Occurrence, morphology and life-cycle of <i>Vaucheria</i>
	Phaeophyta:- Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-
	Rhodophyta:- General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of Polysiphonia.

Microbiology	Electron micrographs/Models of viruses - T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
	3. Gram staining. 4. Endospore staining with malachite green using the (endospores taken from soil bacteria).
Phycology	Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia, Procholoron through electron micrographs, temporary preparations and permanent slides.

- 1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
- 2. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
- 3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
- Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
- Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
- 6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

SEMESTER I

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Core Course II: Biomolecules and Cell Biology – 100 marks

	Biomolecules:- Types and significance of chemical bonds; Structure and properties of water; pH and buffers.
	Carbohydrates: Nomenclature and classification; Role of monosaccharides(glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides(sucrose, maltose, lactose), Oligosaccharides and polysaccharides(structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, insulin)
	Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties.
	Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quarternary; Isoelectric point; Protein denaturation and biological roles of proteins.
	Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.
Unit-II	Bioenergenetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.
	Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), Michaelis - Menten equation, enzyme inhibition and factors affecting enzyme activity.
Unit-III	The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).
	Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.
Unit-IV	Cell organelles: Nucleus; Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin;
	nucleolus. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.
	Chloroplast, mitochondria and peroxisomes: Structural organization Function: Semiautonomous nature of mitochondria and chloroplast
	Endoplasmic Reticulum, Golgi Apparatus, Lysosomes Cell division: Eukaryotic cell cycle, different stages of mitosis and

- 1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
- 2. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
- 3. Demonstration of the phenomenon of protoplasmic streaming in
- 4. Measurement of cell size by the technique of micrometry.
- 5. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
- 6. Study of cell and its organelles with the help of electron micrographs.
- 7. Study the phenomenon of plasmolysis and deplasmolysis.
- 8. Study different stages of mitosis and meiosis using aceto carmine and

- 1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
- 2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill
- 3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed.,
- 4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
- 5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H.
- 6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
- 7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education
- 8. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
- 9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Semester-II

Core Course III: Mycology and Phytopathology - 100 marks

Unit-I	Introduction to true fungi: Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification. Chytridiomycetes: General account
	Zygomycota: General characteristics; Ecology; Thallus organisation: Life cycle with reference to Rhizopus.
	Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to Saccharomyces, Aspergillus, Penicillium, Alternaria and Neurospora
Unit-II	Basidiomycota: General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat Puccinia (Physiological Specialization), loose and covered smut (symptoms only). Agaricus: and Mushroom Cultivation.
	Allied Fungi: General characterises; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.
	Oomycota: General characteristic; Ecology; Life cycle and classification with reference to Phytophthora, Albugo.
Unit-III	Symbiotic associations: Lichen - Occurrence; General characteristics; Growth forms and range of thallus organization. Nature of associations of algal and fungal partners. Reproduction. Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.
Unit-IV	Applied Mycology: Role of fungi in biotechnology, Application of fungi in food industry (Flavour & texture, Fermentation Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.
Unit-V	Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host- Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot disease of Cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, white rust of crucifers.

- 1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps & basidiocarps).
- 2. Rhizopus: study of asexual stage from temporary mounts and sexual structures through permanent slides.
- 3. Aspergillus and Penicillium: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
- 4. Peziza: sectioning through ascocarp.
- 5. Alternaria: Specimens/photographs and temporary mounts.
- 6. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; sections/ mounts of spores on wheat and permanent slides
- 7. Agaricus: Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus, fairy rings and bioluminescent mushrooms to be shown.
- 8. Albugo: Study of symptoms of plants infected with Albugo; asexual phase study throughsection/ temporary mounts and sexual structures through
- 9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endo mycorrhiza(Photographs)
- 10. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: TMV, Fungal diseases: Early blight of potato, and White rust

- 1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
- 2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons
- 3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press,
- 4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers
- 5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

Semester-II

Core Course IV: Archegoniate - 100 marks

Unit-I	Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations.
Unit-II	Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to Funaria; Reproduction and evolutionary trends in Riccia, Marchantia, Anthoceros and Funaria (developmental stages not included). Ecological andeconomic importance of bryophytes with special reference to Sphagnum.
Unit-III	Pteridophytes: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of <i>Psilotum</i> , <i>Selaginella</i> , <i>Equisetum</i> and <i>Pteris</i> .(Developmental details not to be included). Apogamy, and apospory, heterospory andseed habit, telome theory, stelar evolution. Ecological and economic importance.
Unit-IV	Gymnosperms: General characteristics, classification (up to family), morphology, anatomy and reproduction of Cycas, Pinus, Ginkgo and Gnetum. (Developmental details not to be included). Ecological and economic importance.
Unit-V	Fossils: Geographical time scale, fossils and fossilization process Morphology, anatomy and affinities of Rhynia, Calamites, Lepidodendron, Lyginopteris and Cycadeoidea.

1. Riccia - Morphology of thallus.

2. Marchantia- Morphology of thallus, whole mount of rhizoids & Scales, vertical sectionof thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte(all permanent slides).

3. Anthoceros- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of

4. Pellia, Porella- Permanent slides.

5. Sphagnum- Morphology of plant, whole mount of leaf (permanent slide only).

6. Funaria- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.

7. Psilotum- Study of specimen, transverse section of synangium (permanent

8. Selaginella- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).

9. Equisetum- Morphology, transverse section of internode, longitudinal section ofstrobilus, transverse section of strobilus, whole mount of sporangiophore,

whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).

10. Pteris- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte(permanent slide).

11. Cycas- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll,transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores(temporary slides), longitudinal section of ovule, transverse section of root(permanent slide).

12. Pinus- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and femalecones), transverse section of Needle, transverse section of stem, longitudinal section of transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).

13. Gnetum- Morphology (stem, male & female cones), transverse section of stem, verticalsection of ovule (permanent slide)

14. Botanical excursion.

Suggested Readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers,

3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot.

4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

5. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

Semester-III

Core Course V: Anatomy of Angiosperms - 100 marks

Unit-I	Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy.
	Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.
Unit-II	Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem.
	Leaf: Structure of dicot and monocot leaf, Kranz anatomy.
	Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescentcentre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin oflateral root.
Unit-III	Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem.
	Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood,tyloses; Dendrochronology.
	Periderm: Development and composition of
Unit-IV	periderm,rhytidome and lenticels. Adaptive and Protective Systems Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation;Anatomical adaptations of xerophytes and hydrophytes.
Unit-V	Secretory System: Hydathodes, cavities, lithocysts and laticifers.

- 1. Study of anatomical details through permanent slides/temporary stain mounts/macerations/ museum specimens with the help of suitable examples.
- 2. Apical meristem of root, shoot and vascular cambium.
- 3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
- 4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
- 5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
- 6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
- 7. Epidermal system: cell types, stomata types; trichomes: non-glandular
- 8. Root: monocot, dicot, secondary growth.
- Stem: monocot, dicot primary and secondary growth; periderm;
- 10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
- 11. Adaptive Anatomy: xerophytes, hydrophytes.
- 12. Secretory tissues: cavities, lithocysts and laticifers.

- 1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
- 2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
- 3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
- 4. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

Semester-III

Core Course VI: Economic Botany - 100 marks

Unit-I	Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversty.
Unit-II	Cereals: Wheat and Rice (origin, morphology, processing & uses), brief account of millets.
	Legumes: General account, importance to man and ecosystem.
	Sugars & Starches: Morphology and processing of sugarcane, roducts and by-products of sugarcane industry. Potato – morphology, propagation & uses.
Unit-III	Spices:Listing of important spices, their family and part used, economic importance with specialreference to fennel, saffron, clove and black pepper
	Beverages: Tea, Coffee (morphology, processing & uses)
	Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis.
	Tobacco: Tobacco (Morphology, processing, uses and health hazards)
Unit-IV	Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and Brassica and Coconut (Botanical name, family & uses)
Fe ⁻	Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.
Unit-V	Natural Rubber: Para-rubber: tapping, processing and uses.
	Timber plants: General account with special reference to teak and pine.
	Fibres: Classification based on the origin of fibres, Cotton and Jute(morphology, extraction and uses).

- 1. Cereals: Rice (habit sketch, study of paddy and grain, starch grains,
- 2. Legumes: Soya bean, Groundnut, (habit, fruit, seed structure, micro-
- 3. Sugars & Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
- 4. Spices: Black pepper, Fennel and Clove (habit and sections).
- 5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen,
- 6. Oils & Fats: Coconut- T.S. nut, Mustard-plant specimen, seeds; tests for
- 7. Essential oil-yielding plants: Habit sketch of Rosa, Vetiveria, Santalum and Eucalyptus(specimens/photographs).
- 8. Rubber: specimen, photograph/model of tapping, samples of rubber
- 9. Drug-yielding plants: Specimens of Digitalis, PapaverandCannabis.
- 10. Tobacco: specimen and products of Tobacco.
- 11. Woods: Tectona, Pinus: Specimen, Section of young stem.
- 12. Fibre-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fibre).

- 1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
- 2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,
- 3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture. Jones & Bartlett

Semester-III

Core Course VII: Genetics - 100 marks

Unit-I	Mendelian genetics and its extension Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.
Unit-II	Extrachromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity-Kappa particles in <i>Paramecium</i> .
Unit-III	Linkage, crossing over and chromosome mapping: Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.
Unit-IV	Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy
	Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens - physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation.DNA repair mechanisms
Unit-V	Fine structure of gene: Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rll Locus.
	Population and Evolutionary Genetics: Allele frequencies, Genotype frequencies, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

- 1. Meiosis through temporary squash preparation.
- 2. Mendel's laws through seed ratios. Laboratory exercises in probability
- 3. Chromosome mapping using test cross data.
- 4. Pedigree analysis for dominant and recessive autosomal and sex linked
- 5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
- 6. Blood Typing: ABO groups & Rh factor.
- 7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
- 8. Photographs/Permanent Slides showing Translocation Ring, Laggards

- 1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons,
- 2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India.
- 3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings,
- 4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis.

Semester-IV

Core Course VIII: Molecular Biology - 100 marks

Unit-I	Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty.
Unit-II	The Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure- Organelle DNA - mitochondria and chloroplast DNA. The Nucleosome - Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.
	The replication of DNA: Chemistry of DNA synthesis(Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.
Unit-III	Central dogma and genetic code: Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNAtemplate).
	Mechanism of Transcription: Transcription in prokaryotes; Transcription in eukaryotes
	Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes, RNA editing and mRNA transport.
Unit-IV	Translation (Prokaryotes and eukaryotes): Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Inhibitors of protein synthesis; Post-translational modifications of proteins.
Unit-V	Regulation of transcription in prokaryotes and eukaryotes Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in E.coli. Eukaryotes: transcription factors, Gene silencing.

- 1. Preparation of LB medium and raising E.Coli.
- 2. Isolation of genomic DNA from E.Coli.
- 3. DNA isolation and RNA estimation by orcinol method.
- 4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
- 5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
- 6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
- 7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
- 8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

- 1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
- 2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A.
- 3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings.
- 4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
- 5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis.

Semester-IV

Core Course IX: Plant Ecology and Phytogeography - 100 marks

Unit-I	Introduction Concept of ecology, Autoecology, Synecology, system ecology, Levels of organization. Inter-relationships between the living world and the environment, the components of environmental, concept of hydrosphere and lithospgere, homeostasis.
Unit-II	Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.
	Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrologica Cycle: Water in soil.
	Light, temperature, wind and fire: Variations; adaptations of plants to their variation.
Unit-III	Biotic interactions:
	Population ecology: Characteristics and Dynamics .Ecological Speciation
	Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Dynamics: succession – processes, types; climax concepts.
Unit-IV	Ecosystems: Structure; Processes; Trophic organisation; Food chains
	Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.
Unit-V	Phytogeography: Principles; Theory of tolerance; Brief description of major terrestrial biomes (one each from tropical temperate & tundra); Phytogeographical division of India; Local Vegetation.

- 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
- 2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
- 3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field
- 4. Determination of organic matter of different soil samples by Walkley
- 5. Comparison of bulk density, porosity and rate of infiltration of water
- 6. Determination of dissolved oxygen of water samples from polluted
- 7. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).
- (b). Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite(Orobanche) Epiphytes, Predation (Insectivorous plants).
- 8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
- 9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
- 10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
- 11. Field visit to familiarise students with ecology of different sites.

- 1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th
- 2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation.
- 3. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th
- 4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach.
- 5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Semester-IV

Core Course X: Plant Systematics - 100 marks

Unit-I	Plant identification, Classification, Nomenclature; Biosystematics.
	Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access
Unit-II	Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic biological, evolutionary).
	Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.
Unit-III	Systematics- an interdisciplinary science: Evidence from palynology, cytology, phytochemistry and molecular data.
	Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III classification.
Unit-IV	Biometrics, numerical taxonomy and cladistics: Characters; Variations; OTUs, character weighting and coding; cluster analysis; Phenograms, cladograms (definitions and differences).
Unit-V	Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).origin& evolution of angiosperms; coevolution of angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral

formula/e and systematic position according to Bentham &

Hooker's system of classification):

Ranunculaceae - Ranunculus, Delphinium

Brassicaceae - Brassica, Alyssum / Iberis

Myrtaceae - Eucalyptus, Callistemon

Umbelliferae - Coriandrum / Anethum / Foeniculum

Asteraceae - Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax Solanaceae - Solanum nigrum/Withania

Lamiaceae - Salvia/Ocimum

Euphorbiaceae - Euphorbia hirta/E.milii, Jatropha

Liliaceae - Asphodelus/Lilium/Allium

Poaceae - Triticum/Hordeum/Avena

2. Field visit (local) - Subject to grant of funds from the university.

3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label(to be submitted in the record book)

- 1. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi.
- 2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press,
- 3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic 4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.
- 5. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.

Semester-V Core Course XI: Reproductive Biology of Angiosperms - 100 marks

Unit-I	Introduction: History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.
Unit-II	Anther: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.
	Pollen biology: Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.
Unit-III	Ovule: Structure; Types; Special structures-endothelium, obturator, aril, caruncle and hypostase; Female gametophyte-megasporogenesis(monosporic, bisporic and tetrasporic) and megagametogenesis (details of <i>Polygonum</i> type); Organization and ultrastructure of mature embryo sac.
	Endosperm: Types, development, structure and functions.
	Embryo: Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryoendosperm relationship; Nutrition of embryo; Unusual features; Embryo development in <i>Paeonia</i> .
Unit-IV	Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.
	Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome selfincompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization.
Unit-V	Seed: Structure, importance and dispersal mechanisms
N-1/2-12-11	Polyembryony and apomixes: Introduction; Classification; Causes and applications.
	Germline transformation: Pollen grain and ovules through pollen tube pathway method/ Agrobacterium/ electrofusion/floral dip/biolistic.

- 1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
- 2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test.germination: Calculation of percentage germination in different media using hanging drop method.
- 3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanentslides/specimens/photographs).
- 4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
- 5. Intra-ovarian pollination; Test tube pollination through photographs.
- 6. Endosperm: Dissections of developing seeds for endosperm with free-
- 7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

- 1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing
- 2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt.
- 3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
- 4. Johri, B.M. I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Semester-V

Core Course XII: Plant Physiology - 100 marks

Unit-I	Plant water relationship:Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap- cohesion-tension theory.Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.	
	Translocation in the phloem: Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.	
Unit-II	Mineral nutrition: Essential and beneficial elements macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, minera deficiency symptoms, roles of essential elements, chelating agents.	
Unit-III	Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, transport, symport, antiport.	
Unit-IV	Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene.Brassinosteroids and Jasmonic acid.	
Unit-V	Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.	
	Phytochrome: Discovery, chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.	

- 1. Determination of osmotic potential of plant cell sap by plasmolytic
- 2. Determination of water potential of given tissue (potato tuber) by
- 3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
- 4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
- 5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
- 6. To study the phenomenon of seed germination (effect of light).
- 7. To study the induction of amylase activity in germinating barley

Demonstration experiments

- 1. To demonstrate suction due to transpiration.
- 2. Fruit ripening/Rooting from cuttings (Demonstration).
- 3. Bolting experiment/Avena coleptile bioassay (demonstration).

- 1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.
- 2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6th edition.
- 3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa

Semester-VI

Core Course XIII: Plant Metabolism - 100 marks

Unit-1	Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).	
Unit-II	Unit 3: Carbohydrate metabolism: Synthesis and catabolism of sucrose and starch.	
Unit-III	Carbon assimilation: Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C4pathways; Crassulacean acid metabolism; Factors affecting CO2 reduction.	
	Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanideresistant respiration, factors affecting respiration.	
	ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model.	
Unit-IV	Lipid metabolism: Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation	
Unit-V	Nitrogen metabolism: Nitrate assimilation, biological nitrogen fixation(examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.	
	Mechanisms of signal transduction: Calcium, phospholipids cGMP, NO.	

- 1. Chemical separation of photosynthetic pigments.
- 2. Experimental demonstration of Hill's reaction.
- To study the effect of light intensity on the rate of photosynthesis.
- 4. Effect of carbon dioxide on the rate of photosynthesis.
- 5. To compare the rate of respiration in different parts of a plant.
- 6. To demonstrate activity of Nitrate Reductase in germinationg leaves
- 7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
- 8. Demonstration of fluorescence by isolated chlorophyll pigments.
- 9. Demonstration of absorption spectrum of photosynthetic pigments.

- 1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.
- 2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development.
- 3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

Semester-VI

Core Course XIV: Plant Biotechnology - 100 marks

Unit-I	Plant Tissue Culture: Historical perspective; Aseptic tissueculture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones).	
Unit-II	Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications(micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).	
Unit-III	Recombinant DNA technology-I: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning).	
Unit-IV	Recombinant DNA technology-II: Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probesoligonucleotide, heterologous, PCR; Methods of gene transfe Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics- selectable marker.	
Unit-V	Applications of Biotechnology: Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products-Human Growth Hormone; Humulin; Biosafety concerns.	

- 1. (a) Preparation of MS medium.
 - (b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, Datura, Brassica etc.
- 2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs. 3. Isolation of protoplasts.
- 4. Construction of restriction map of circular and linear DNA from the
- 5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
- 6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs. 7. Isolation of plasmid DNA.
- 8. Restriction digestion and gel electrophoresis of plasmid DNA.

- 1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier
- 2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of
- 3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication
- 4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th
- 5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and
- 6. Chawla, H.S. (2010). Introduction to Plant Biotechnology.Oxford & IBH Publishing Co.Pvt. Ltd.,
- 7. Singh, B. D. (2010) Biotechnology: Expanding Horizon. Kalyani Publishers. New Delhi.

DISCIPLINE SPECIFIC ELECTIVE COURSES

Semester-V

Discipline Specific Elective (DSE -1): Analytical Techniques in Plant Sciences - 100 marks

Unit-I	Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining.	
Unit-II	Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, analytical centrifugation, ultracentrifugation, marker enzymes.	
Unit-III	Radioisotopes: Use in biological research, auto- radiography, pulse chase experiment. Spectrophotometry: Principle and its application in	
	biological research. Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.	
Unit-IV	Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE	
Unit-V	Biostatistics: Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.	

- 1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs. 2. Demonstration of ELISA.
- To separate nitrogenous bases by paper chromatography.
- 4. To separate sugars by thin layer chromatography.
- Isolation of chloroplasts by differential centrifugation.
- 6. To separate chloroplast pigments by column chromatography.
- 7. To estimate protein concentration through Lowry's methods. 8. To separate proteins using PAGE.
- 9. To separation DNA (marker) using AGE.
- 10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
- 11. Preparation of permanent slides (double staining).
- 12. Estimation of plant pigments.

- 1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill
- 2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York.
- 3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
- 4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Semester-V

Discipline Specific Elective (DSE -2): Biostatstics - 100 marks

Unit-I	Biostatistics - definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.	
Unit-II	Collection of data primary and secondary - types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.	
Unit-III	Measures of central tendency - mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.	
Unit-IV	Correlation - types and methods of correlation, regression, simple regression equation, fitting prediction, similarities an dissimilarities of correlation and regression.	
Unit-V	Statistical inference - hypothesis - simple hypothesis - studen 't' test - chi square test.	

- 1) Calculation of mean, standard deviation and standard error
- 2) Calculation of correlation coefficient values and finding out the
 - 3) Calculation of 'F' value and finding out the probability value for the

F value.

Suggested Readings

1. Biostatistic, Danniel, W.W., 1987. New York, John Wiley Sons.

2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian

3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press. 4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.

5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.

6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

Semester-VI

DSE - 3

Discipline Specific Elective (DSE -2A): Plant Breeding - 100 marks

Unit-I	Plant Breeding: Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.	6 lectures
Unit-II	Methods of crop improvement: Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.	15 lectures
Unit-III	Quantitative inheritance: Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance.	6 lectures
Unit-IV	Inbreeding depression and heterosis: History, genetic basis of inbreeding depression and heterosis; Applications.	6 lectures
Unit-V Crop improvement and breeding: Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.		7 lectures

Practical (20 classes, each class of 2h)

Practical related to theory Practical

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford - IBH. 2ndedition.

3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Semester-VI

DSE-4

Discipline Specific Elective (DSE - 3€): Research Methodology - 100 marks

Unit-I	Basic concepts of research: Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs emperical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.	6 lectures
	General laboratory practices: Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.	8 lectures
Unit-II	Data collection and documentation of observations: Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photography.	4 lectures
	Overview of Biological Problems: History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics- Transcriptional regulatory network.	4 lectures
Unit-III	Methods to study plant cell/tissue structure: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.	4 lectures
Unit-IV	Plant microtechniques: Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.	8 lectures
Unit-V	The art of scientific writing and its presentation: Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.	6 lectures

Practical (20 classes, each class of 2h)

		inal calculations.
Practical	Experiments based on chem Plant microtechnique exper The art of imaging of sample	inents. es through microphotography and field
An es	photography. 4. Poster presentation on defi 5. Technical writing on topics	ined topics.

- 1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
- 2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists - a training reference manual. West Africa Rice Development
- 3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

SKILL ENHANCEMENT COURSES

Semester-IV

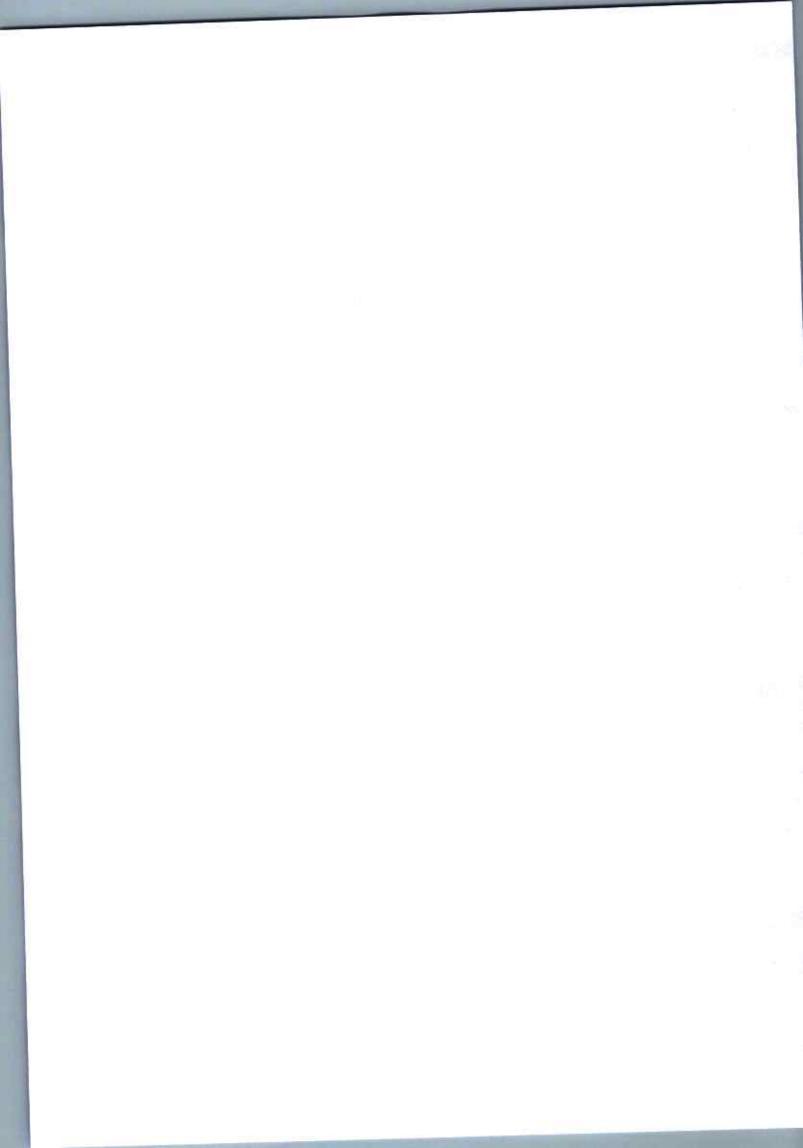
Skill Enhancement Courses : 1 Nursery and Gardening - 50 marks

(Credits-2: Lectures: 30) THEORY (Each class 1 hour) [50 marks (Mid Sem 10 + End Sem 40)]

Unit-I	Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.	
Unit-II	Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed bank factors affecting seed viability, genetic erosion - Seed production technology, seed to see the seed storage.	
Unit-III	Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house.	
Unit-IV	Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.	
Unit-V	Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.	

Suggested Readings

- 1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
- 2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
- 3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
- 4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
- 5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
 - 6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.



CORE COURSE: ZOOLOGY Paper I DIVERSITY AND EVOLUTION OF NON-CHORDATA (PROTISTA TO PSEUDOCOELOMATES) (CREDITS: THEORY-4, PRACTICALS-2) THEORY

LECTURES: 60 Marks 75

Unit 1: Phylum Protozoa and Metazoa

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Plasmodium vivax, Trypanosoma gambiense* and *Entamoeba histolytica*; Locomotion and reproduction in Protozoa; Evolution of Metazoa.

Unit 2: Phylum Porifera and Ctenophora

General characteristics and classification up to classes; Canal system in sponges; General characteristics and evolutionary significance.

Unit 3: Phylum Cnidaria

General characteristics and classification up to classes; Metagenesis in *Obelia*; Polymorphism in Cnidaria; Corals and coral reefs.

Unit 4: Phylum Platyhelminthes

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of Fasciola hepatica and Taenia solium; Parasitic adaptations.

Unit 5: Phylum Nemathelminthes

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of Ascaris lumbricoides and Wuchereria bancrofti; Parasitic adaptations.

Note: Classification to be followed from "Barnes RD (1982) Invertebrate Zoology. 5th Edition."

PRACTICALS Marks 25

Phylum Protozoa

- Morphology of Paramecium, Binary fission and Conjugation in Paramecium.
- 2. Life stages of *Plasmodium vivax*, *Trypanosma gambiense* and *Entamoeba histolytica* (Slides/Micro-photographs).
- 3. Examination of pond water for protists.

Phylum Porifera

- 4. Study of Sycon (including T.S. and L.S.), Hyalonema, and Euplectella.
- 5. Temporary mounts of spicules, gemmules and spongin fibres.

Phylum Cnidaria

6. Study of Obelia, Physalia, Millepora, Aurelia, Ephyra larva, Tubipora, Corallium, Alcyonium, Gorgonia and Metridium (including T.S. and L.S.).

Phylum Ctenophora

7. Any one specimen/slide.

Phylum Platyhelminthes

8. Study of adult Fasciola hepatica, Taenia solium and their life stages (Slides/microphotographs).

Phylum Nemathelminthes

 Study of adult Ascaris lumbricoides, Wuchereria bancrofti and their life stages (Slides/ microphotographs).

Note: Classification to be followed from "Barnes RD (1982) Invertebrate Zoology. 5th Edition."

- 1. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House, New Delhi.
- 2. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House, New Delhi.
- Barnes RD (1982) Invertebrate Zoology. 6th Edition. Holt Saunders International Edition.
- Barnes RSK, Calow P, Olive PJW, Golding DW & Spicer JI (2002) The Invertebrates: A New Synthesis. 3rd Edition. Blackwell Science, USA.
- Barrington EJW (1979) Invertebrate Structure and Functions. 2nd Edition. ELBS and Nelson.
- Boradale LA and Potts EA (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
- Jordan EL and Verma PS (1963) Invertebrate Zoology. Revised Edition. S. Chand, New Delhi.
- 8. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

CORE COURSE: ZOOLOGY PAPER II PERSPECTIVES IN ECOLOGY (CREDITS: THEORY-4, PRACTICALS-2) THEORY

LECTURES: 60 Marks 75

Unit 1: Introduction to Ecology

Relevance of studying ecology; History of ecology; Autecology and synecology; Levels of organization; Laws of limiting factors; Detailed study of temperature and light as physical factors.

Unit 2: Population

Unitary and modular populations; Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion;, Population regulation - density-dependent and independent factors; Population Transcription of the interactions,

Unit 3: Community

Community characteristics: dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession) with example and Theories pertaining to climax community.

Unit 4: Ecosystem

Types of ecosystem; Food chain, Detritus and grazing food chains, Linear and Y-shaped food chains; Food web; Energy flow through the ecosystem; Ecological pyramids and Ecological efficiencies; Nutrient and biogeochemical cycle, Nitrogen cycle and Sulphur cycle.

Unit 5: Conservation of Biodiversity

Types of biodiversity, its significance, loss of biodiversity; Conservation strategies (in situ and ex situ); Role of ZSI, WWF, IUCN; Wildlife (Protection) Act, 1972.

PRACTICALS Marks 25

- 1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
- 2. Determination of population density in a natural/hypothetical community by quadrate

- Study of an aquatic ecosystem: fauna and flora Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content(Winkler's method), Chemical Oxygen Demand and free CO₂.
- Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary.

- Colinvaux PA (1993) Ecology. II Edition. John Wiley and Sons, Inc., USA.
- 2. Dash MC (1993) Fundamentals of Ecology. McGraw Hill Book Company, New Delhi.
- Joshi N and Joshi PC (2012) Ecology and Environment. 1st Edition. Himalaya Publishing House, New Delhi.
- 4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
- 5. Odum EP (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
- 6. Ricklefs, R.E., (2000). Ecology. 5th Edition. Chiron Press.
- 7. Robert Leo Smith Ecology and field biology Harper and Row.
- Singh JS, Gupta SR and Singh SP (2014) Ecology, Environmental Science and Conservation. S. Chand, New Delhi.

CORE COURSE: ZOOLOGY

PAPER III

DIVERSITY AND EVOLUTION OF NON-CHORDATA (COELOMATE NONCHORDATES)

(CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60

Marks 75

Unit 1: Phylum Annelida

General characteristics and classification up to classes; Evolution of Coelom; Metamerism and Excretion in Annelida.

Unit 2: Phylum Arthropoda

General characteristics and classification up to classes; Vision in Arthropoda; Respiration in Arthropoda; Moulting in insects, Metamorphosis in insects; Social life in insects (bees and termites) and Larval forms in Crustacea.

Unit 3: Phylum Onychophora

General characteristics, evolutionary significance and affinities of Peripatus.

Unit 4: Phylum Mollusca

General characteristics and classification up to classes; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves and Evolutionary significance of trochophore larva.

Unit 5: Phylum Echinodermata

General characteristics and classification up to classes; Water-vascular system in Asteroidea; Larval forms in Echinodermata and Evolutionary significance (Affinities with Chordates).

Note: Classification to be followed from "Barnes, R.D. (1982). Invertebrate Zoology, 5th Edition, Holt Saunders International Edition."

PRACTICAL

Marks 25

Phylum Annelida

- Study of Aphrodite, Nereis, Heteronereis, Sabella, Terebella, Serpula, Chaetopterus, Pheretima and Hirudinaria.
- 2. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
- T.S. through crop of leech.

Phylum Arthropoda

 Study of Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, termite, louse, honeybee, silk moth, wasp and dragon fly.

Phylum Onychophora

5. Any one specimen/slide.

Phylum Mollusca

6. Study of Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Mytilus, Loligo, Sepia, Octopus and Nautilus and Cypraea (cowrie).

Phylum Echinodermata

7. Study of echinoderm larvae.

8. Study of Pentaceros, Asterias, Ophiura, Clypeaster, Echinus, Echinocardium, Cucumaria and Antedon.

Note: Classification to be followed from "Barnes, R.D. (1982). Invertebrate Zoology, 5th Edition, Holt Saunders International Edition".

- 1. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House, New Delhi.
- 2. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House, New Delhi.
- 3. Barnes RD (1982) Invertebrate Zoology. 6th Edition. Holt Saunders International Edition.
- Barnes RSK, Calow P, Olive PJW, Golding DW & Spicer JI (2002) The Invertebrates: A New Synthesis. 3rd Edition. Blackwell Science, USA.
- Barrington EJW (1979) Invertebrate Structure and Functions. 2nd Edition. ELBS and Nelson.
- Boradale LA and Potts EA (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
- Jordan EL and Verma PS (1963) Invertebrate Zoology. Revised Edition. S. Chand, New Delhi.
- 8. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

CORE COURSE: ZOOLOGY PAPER IV

PHYSIOLOGY: LIFE SUSTAINING SYSTEMS (CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60 Marks 75

Unit 1: Digestive System

Structural organization, histology and functions of gastrointestinal tract and its associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Role of gastrointestinal hormones on the secretion and control of enzymes of gastrointestinal tract.

Unit 2: Respiratory System

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volume and capacity; Transport of oxygen in the blood; Oxygen- hemoglobin and myoglobin, dissociation curve and the factors influencing it; Carbon monoxide poisoning; Carbon dioxide transport in the blood; buffering action of blood and haemoglobin and Control of respiration.

Unit 3: Excretory System

Structure of kidney and its histological details; Renal blood supply; Mechanism of urine formation and its regulation and Regulation of acid-base balance.

Unit 4: Blood

Components of blood and their functions; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis and Coagulation of blood and Disorders of blood.

Unit 5: Heart

Structure of heart; Coronary circulation; Structure of conducting and working of myocardial fibers; Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle;; Nervous and chemical regulation of heart rate; Blood pressure and its regulation and Electrocardiogram.

PRACTICAL Marks 25

- 1. Enumeration of red blood cells using haemocytometer.
- 2. Estimation of haemoglobin using Sahli's haemoglobinometer.
- 3. Preparation of haemin and haemochromogen crystals.
- Recording of blood pressure using a Sphygmomanometer.
- Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung and kidney.

CORE COURSE: ZOOLOGY PAPER V

DIVERSITY AND DISTRIBUTION OF CHORDATA (CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60 Marks 75

Unit 1: Protochordata and Origin of Chordates

General characters of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata; Dipleurula concept and the Echinoderm theory of origin of chordates.

Unit 2: Introduction to Vertebrata and Agnatha

Advanced features of vertebrates over Protochordata; General characters and classification of cyclostomes up to class; Structural peculiarities and affinities of Petromyzon and Myxine.

Unit 3: Pisces and Amphibia

General characters of Chondrichthyes and Osteichthyes and classification up to order; Migration; Osmoregulation and Parental care in fishes; Scales in fishes; Origin of Tetrapoda (Evolution of terrestrial ectotherms); General characters and classification up to order and Parental care in Amphibians.

Unit 4: Reptilia and Aves

General characters and classification up to order; Skull in Reptilia; Affinities of Sphenodon; Poison apparatus and Biting mechanism in snakes; General characters and classification up to order; Principles and aerodynamics of flight, Flight adaptations; Archaeopteryx- a connecting link and Migration in birds.

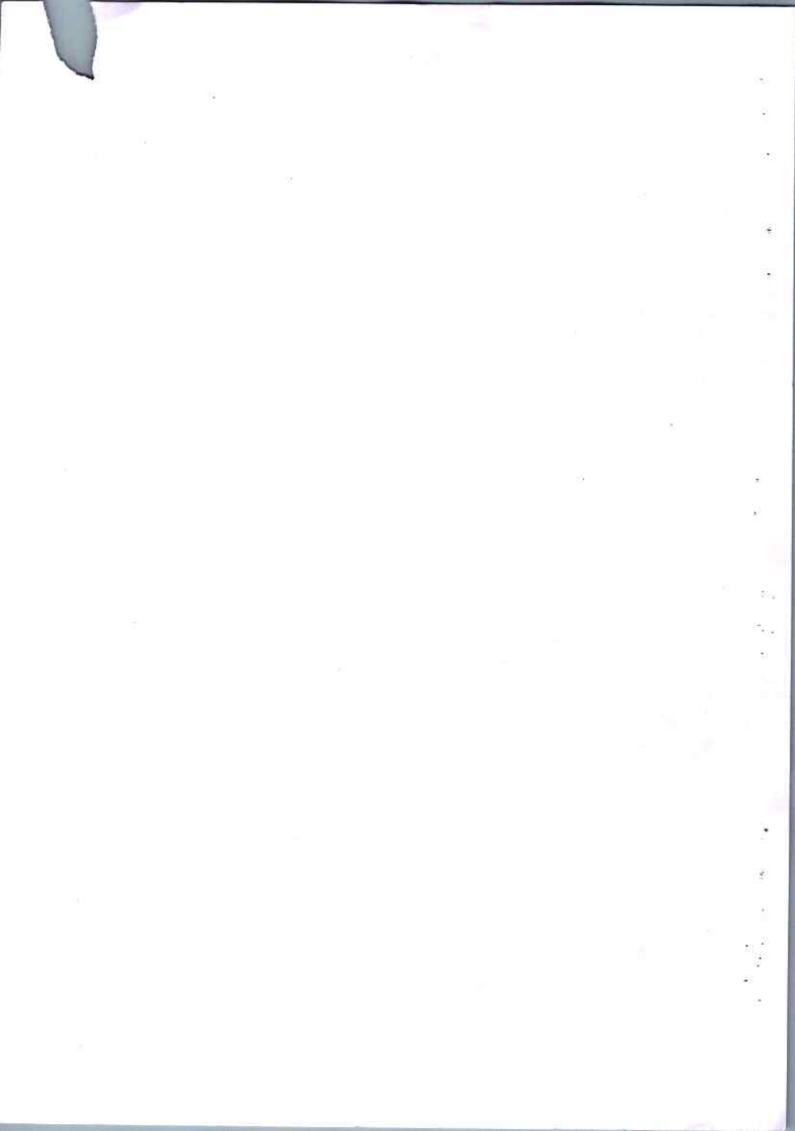
Unit 5: Mammals and Zoogeography

General characters and classification up to order; Affinities of Prototheria and Metatheria; Dentition in mammals; Adaptive radiation with reference to locomotory appendages; Zoogeographical realms; Theories pertaining to distribution of animals and Distribution of vertebrates in different realms.

PRACTICAL Marks 25

1. Protochordata

- Balanoglossus, Herdmania, Branchiostoma and Colonial Urochordata.
- 2. Sections of Balanoglossus through proboscis and branchiogenital regions.
- 3. Sections of Amphioxus through pharyngeal, intestinal and caudal regions
- 4. Permanent slide of spicules of Herdmania.



2.Agnatha

5. Petromyzon and Myxine.

3. Fishes

6. Sphyrna, Pristis, Trygon, Torpedo, Chimaera, Notopterus, Mystus, Heteropneustes, Hippocampus, Exocoetus, Echeneis, Anguilla, Tetrodon, Diodon, Anabas and Flat fish.

4.Amphibia

7. Ichthyophis/Ureotyphlus, Necturus, Duttaphrynus, Polypedates, Hyla, Alytes and Salamandra.

5. Reptiles

- 8. Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Draco, Ophiosaurus, Bungarus, Vipera, Naja, Hydrophis, Zamenis and Crocodylus.
- 9. Key for Identification of poisonous and non-poisonous snakes.

6. Aves

- 10. Study of six common birds from different orders.
- 11. Types of beaks and claws.
- 12. Types of feathers.

7. Mammalia

13. Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes and Hemiechenis.

- 1. Agarwal VK (2011) Zoology for degree students. S. Chand, New Delhi.
- 2. Arora MP (2006) Chordata-1. 1st Edition. Himalaya Publishing House, New Delhi.
- 3. Hall BK and Hallgrimsson B (2008) Strickberger's Evolution. 4th Edition. Jones and Bartlett Publishers Inc., USA.
- 4. Jordan EL and Verma PS (1963) Chordate Zoology. Revised Edition. S. Chand, New Delhi.
- 5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
- 6. Young JZ (2004) The Life of Vertebrates. 3rd Edition. Oxford University

CORE COURSE: ZOOLOGY PAPER VI PHYSIOLOGY – CONTROLLING AND COORDINATING SYSTEM (CREDITS: THEORY-4, PRACTICALS-2) THEORY LECTURES: 60 Marks 75

Unit 1: Tissues and Glands, Bone and cartilage

Structure, location, function and classification of Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue; Types of glands and their functions; Structure and types of bones and cartilages; Ossification, bone growth and resorption.

Unit 2: Nervous System

Structure of neuron, resting membrane potential; Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; types of synapsis, Synaptic transmission; Neuromuscular junction; Reflex action and its types, Reflex are and Physiology of hearing and vision.

Unit 3: Muscle

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Tetanus

Unit 4: Reproductive System

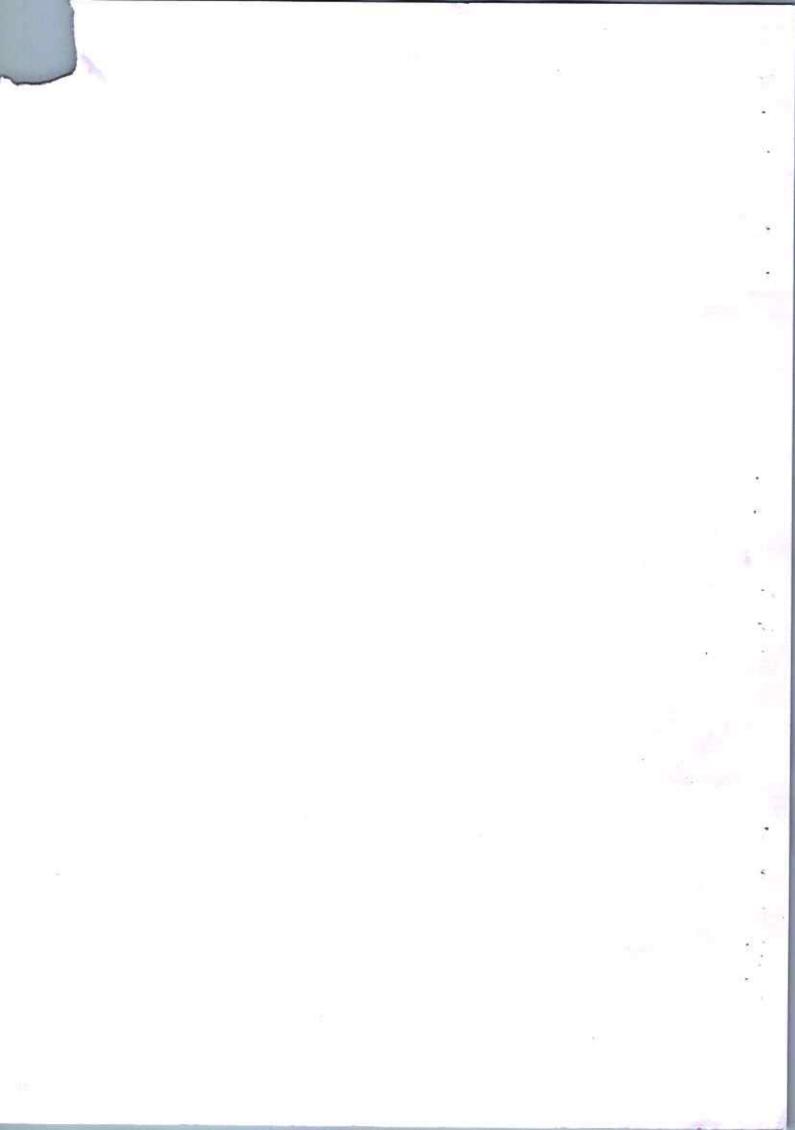
Histology of male and female reproductive systems; Puberty; Physiology of reproduction of male and female; Methods of contraception (depicted through flow chart).

Unit 5: Endocrine System

Functional Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, thymus, pancreas, adrenals; Hormones secreted by them and their mechanism of action; Gonadal hormones; Classification of hormones; Regulation of their secretion; Mode of hormone action; Signal transduction pathways utilized by steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland), principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system and Placental hormones.

PRACTICALS Marks 25

- 1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
- 2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells.
- 3. Examination of sections of mammalian skin, Cartilage, Bone, Spinal cord, Nerve Cell, Pituitary, Pancees, Testis, Orary, Adrenal, Thyroid and Panathyroid.



CORE COURSE: ZOOLOGY PAPER VII COMPARATIVE ANATOMY OF VERTEBRATES (CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60

Marks 75

Unit 1: Integumentary System and Skeletal System

Structure, functions and derivatives of integument; Axial and appendicular skeletons; Jaw suspensorium in vertebrates.

Unit 2: Digestive and Respiratory System

Alimentary canal and associated glands; Skin, gills, lungs and air sacs and Accessory respiratory organs in fishes.

Unit 3: Circulatory System

General plan of circulation; Evolution of heart and aortic arches.

Unit 4: Urinogenital System

Succession of kidney; Evolution of urinogenital ducts and Types of mammalian uteri.

Unit 5: Nervous System and Sense Organs

Comparative account of brain; Autonomic nervous system; Spinal Nerves; Spinal cord; Cranial nerves in Mammals; Classification of receptors; visual receptors, chemoreceptors and mechanoreceptors.

PRACTICAL

Marks 25

- Study of placoid, cycloid and ctenoid scales through permanent slides/photographs.
- 2. Disarticulated skeleton of Frog, Varanus, Fowl and Rabbit.
- 3. Carapace and plastron of turtle or tortoise.
- Mammalian skulls (One herbivorous and one carnivorous animal).

- 1. Hilderbrand M and Gaslow GE. Analysis of Vertebrate Structure. John Wiley and Sons.,
- Kardong KV (2005) Vertebrates' Comparative Anatomy, Function and Evolution. 4th Edition. McGraw-Hill Higher Education, New York.
- Kent GC and Carr RK (2000) Comparative Anatomy of the Vertebrates. 9th Edition. The McGraw-Hill Companies, New York.
- 4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
- Weichert CK and William Presch (1970) Elements of Chordate Anatomy. Tata McGraw Hill, New York.



CORE COURSE: ZOOLOGY PAPER VIII BIOCHEMISTRY OF METABOLIC PROCESSES (CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60

Marks 75

Unit 1: Biomolecules

Structures and properties of important mono-, di- and polysaccharides; Fatty acids, triglycerides and steroids; and amino acids and proteins.

Unit 2: Carbohydrate Metabolism

Glycolysis; Citric acid cycle; pentose phosphate pathway; Gluconeogenesis; Shuttle systems(Malate-aspartate shuttle, Glycerol 3-phosphate shuttle); Glycogenolysis; Glycogenesis.

Unit 3: Lipid Metabolism

β-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid and Ketogenesis and its regulation.

Unit 4: Protein Metabolism

Catabolism of amino acids: Transamination, Deamination; Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

Unit 5: Enzymes and Oxidative Phosphorylation

Kinetics and Mechanism of action of enzymes; Inhibition of enzyme action; Allosteric enzymes; Oxidative phosphorylation in mitochondria; Respiratory chain, ATP synthase, Inhibitors and Uncouplers.

PRACTICALS

Marks 25

- Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose).
- Colour tests of functional groups in protein solutions.
- Action of salivary amylase under optimum conditions.
- 4. Effect of pH on the action of salivary amylase.
- Effect of temperature on the action of salivary amylase.
- Estimation of total protein in given solutions by Lowry's method.

SUGGESTED READINGS

 Berg JM, Tymoczko JL and Stryer L (2007) Biochemistry. 6th Edition, W.H. Freeman and Co., New York.

CORE COURSE: ZOOLOGY PAPER IX CELL BIOLOGY (CREDITS: THEORY-4, PRACTICALS-2)

LECTURES: 60

THEORY

Marks 75

Unit 1: Cells and Plasma Membrane

Prokaryotic and Eukaryotic cells; Mycoplasma; Virus, Viroids, Virionsand Prions; Various models of plasma membrane; Transport across membranes; Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata.

Unit 2: Endomembrane System, Mitochondria and Peroxisomes

The Endoplasmic Reticulum; Golgi apparatus; Mechanism of vesicular transport; Lysosomes; Structure and function of mitochondria: Chemi-osmotic hypothesis; Semiautonomous nature of mitochondria; Endosymbiotic hypothesis and Peroxisomes.

Unit 3: Cytoskeleton and Nucleus

Structure and functions of intermediate filament, microtubules and microfilaments; Ultra structure of nucleus; Nuclear envelope: Structure of nuclear pore complex; Chromosomal DNA and its packaging; Structure and function of Nucleolus.

Unit 4: Cell Cycle and Cell Signaling

Cell cycle, Regulation of cell cycle; Signaling molecules and their receptors.

Unit 5: Apoptosis and Cancer

Extrinsic (Death Receptor) Pathway and Intrinsic (Mitochondrial) Pathway; Growth and development of tumors and Metastasis.

PRACTICAL

Marks 25

- Gram's staining technique for visualization of prokaryotic cells.
- Study various stages of mitosis from permanent slides.
- Study various stages of meiosis from permanent slides.
- Study the presence of Barr body in human female blood cells/cheek cells. (Preparation of permanent slides).
- Cytochemical demonstration (Preparation of permanent slides).
 - DNA by Feulgen reaction.
 - ii. Mucopolysaccharides by PAS reaction.
 - iii. Proteins by Mercurobromophenol blue.
 - DNA and RNA by Methyl Green Pyronin.

CORE COURSE: ZOOLOGY PAPER X

PRINCIPLES OF GENETICS

(CREDITS: THEORY-4, PRACTICALS-2)
THEORY

LECTURES: 60 Marks 75

Unit 1: Mendelian Genetics and its Extension

Principles of inheritance; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles; Epistasis; Pleiotropy; Sex-linked inheritance.

Unit 2: Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over; Cytological basis of crossing over; Molecular mechanisms of crossing over; Recombination frequency as a measure of linkage intensity; Two factor and three factor crosses; Interference and coincidence and Somatic cell hybridization.

Unit 3: Mutations

Gene mutations; Chromosomal mutations: Deletion, duplication, inversion, translocation; Aneuploidy and polyploidy; Induced versus spontaneous mutations; Backward and forward mutations; Suppressor mutations; Molecular basis of mutations in relation to UV light and chemical mutagens and DNA repair mechanisms.

Unit 4: Sex Determination and Quantitative Genetics

Chromosomal mechanisms of sex determination; Sex-linked, sex-influenced and sex limited characters; Polygenic inheritance and Transgressive variation.

Unit 5: Extra-chromosomal Inheritance

Criteria for extra-chromosomal inheritance; Antibiotic resistance in Chlamydomonas; Mitochondrial mutations and Maternal effects.

PRACTICAL Marks 25

- 1. To study the Mendelian laws and gene interactions and their verification by Chisquare analyses using seeds/beads/Drosophila.
- 2. Identification of various mutants of Drosophila.
- 3. To calculate allelic frequencies by Hardy-Weinberg Law.
- Linkage maps based on data from crosses of Drosophila.
- Study of human karyotype (normal and abnormal).
- 6. Pedigree analysis of some human inherited traits.
- 7. Preparation of polytene chromosomes from larva of Chironomous/Drosophila
- 8 To study mategericaty is Commented IE Colo by Ames Tost
 1. Study of Ententance of Dominant Microbian Trouts
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CORE COURSE: ZOOLOGY PAPER XI DEVELOPMENTAL BIOLOGY

(CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60

Marks 75

Unit 1: Introduction

History and basic concepts: Epigenesis, preformation, Mosaic and regulative development; Discovery of induction; Cell-Cell interaction; Pattern formation; Differentiation and growth; Differential gene expression; Cytoplasmic determinants and asymmetric cell division.

Unit 2: Early Embryonic Development

Gametogenesis (Spermatogenesis, Oogenesis); Types of eggs; Egg membranes; Fertilization: Changes in gametes, monospermy and polyspermy; Planes and patterns of cleavage; Early development of frog and chick up to gastrulation; Fate maps; Embryonic induction and organizers.

Unit 3: Late Embryonic Development

Fate of germ layers; Extra-embryonic membranes in birds; Implantation of embryo in humans and Placenta (Structure, types and functions of placenta).

Unit 4: Post Embryonic Development

Metamorphosis: Changes, hormonal regulations in amphibians; Regeneration: Modes of regeneration (epimorphosis, morphallaxis and compensatory regeneration); Ageing: Concepts and models.

Unit 5: Implications of Developmental Biology

Teratogenesis: Teratogenic agents and their effects on embryonic development; in vitro Fertilization; Stem cell culture and Amniocentesis.

PRACTICAL

Marks 25

- Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
- Study of whole mounts of developmental stages of chick through permanent slides:Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation(Hamilton and Hamburger stages).
- Study of developmental stages (above mentioned) by raising chick embryo in the laboratory.
- Study of the developmental stages and life cycle of *Drosophila* from stock culture.
- Study of different types of placenta.
- 6. Project report on Drosophila culture / chick embryo development. 20

CORE COURSE: ZOOLOGY PAPER XII MOLECULAR BIOLOGY (CREDITS: THEORY-4, PRACTICALS-2) THEORY

LECTURES: 60 Marks 75

Unit 1: Nucleic Acids and DNA Replication

Salient features of DNA double helix; Watson and Crick model of DNA; DNA denaturation and renaturation; DNA topology - linking number and DNA topo-isomerases; Structure of RNA, tRNA and DNA and RNA associated proteins; DNA Replication in prokaryotes and eukaryotes; Mechanism of DNA replication; Role of proteins and enzymes in replication; Licensing factors; Semi-conservative, bidirectional and semi-discontinuous replication; RNA priming; Replication of circular and linear ds-DNA and replication of telomeres.

Unit 2:Transcription

RNA polymerase and transcription Unit; Mechanism of transcription in prokaryotes and Eukaryotes; Synthesis of rRNA and mRNA; Transcription factors and regulation of transcription.

Unit 3:Translation

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

Unit 4: Post Transcriptional Modifications and Processing of Eukaryotic RNA

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing.

Unit 5: Gene Regulation and Regulatory RNAs

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencers elements; Gene silencing, Genetic imprinting;

PRACTICAL Marks 25

- 1. Study of DNA replication using Photographs or slides and special cases, e.g., Polyteny using permanent slides of polytene chromosomes.
- Preparation of liquid culture medium (LB) and raise culture of E. coli.
- 3. Estimation of the growth kinetics of E. coli by turbidity method

 Preparation of solid culture medium (LB) and growth of E. coli by spreading and streaking.

5. Demonstration of antibiotic sensitivity/resistance of E. coli to antibiotic pressure and

interpretation of results.

 Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter(Diphenylamine reagent) or spectrophotometer (A260 measurement).

7. Quantitative estimation of RNA using Orcinol reaction.

SUGGESTED READINGS

 Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell. 7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.

 Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2008) Molecular Biology of the Cell, 4th Edition. Garland publishing Inc., New York.

3. Cooper GM and Hausman RE (2007) The Cell: A Molecular Approach. 4th Edition, ASM

Press, USA.

 De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.

5. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John

Wiley and Sons. Inc., USA.

6. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

CORE COURSE: ZOOLOGY PAPER XIII IMMUNOLOGY

(CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60

Marks 75

Unit 1: Immune System and Immunity

Historical perspective of Immunology, Early theories of Immunology, Haematopoiesis, Cells and organs of the Immune system; Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity and Immune dysfunctions.

Unit 2: Antigens

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T - Cell epitopes.

Unit 3: Immunoglobulins

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Polyclonal sera, Monoclonal antibodies and Hybridoma technology.

Unit 4: Major Histocompatibility Complex and Complement System

Structure and functions of endogenous and exogenous pathway of antigen presentation; Components and pathways of complement activation.

Unit 5: Cytokines, Hypersensitivity and Vaccines

Properties and functions of cytokines; Cytokine-based therapies; Gell and Coombs' classification and Brief description of various types of hypersensitivities; Types of vaccines: Recombinant vaccines and DNA vaccines.

PRACTICAL

Marks 25

- Demonstration of lymphoid organs. 1.
- Ouchterlony's double immuno-diffusion method. 2.
- Determination of ABO blood group. 3.
- Preparation of single cell suspension of splenocytes from chick spleen, cell counting and viability test.
- ELISA/ dot Elisa (using kit). 5.
- Principles, experimental set up and applications of immuno-electrophoresis, RIA, F.

SUGGESTED READINGS

Abbas KA and Lechtman HA (2003) Cellular and Molecular Immunology. 5th Edition. Saunders Publication, Philadelphia.

2. David M, Jonathan B, David RB and Ivan R (2006) Immunology. 7th Edition. Elsevier

Publication, USA.

 Kindt TJ, Goldsby RA, Osborne BA and Kuby J (2006) Immunology. 6th Edition. W.H. Freeman and Company, New York.

4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.

CORE COURSE: ZOOLOGY PAPER XIV EVOLUTIONARY BIOLOGY (CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60

Marks 75

Unit 1: History of Life, theories of Evolution and Extinction

Chemogeny, Biogeny, RNA World, Major Events in History of Life; Lamarckism; Darwinism; Neo-Darwinism; Background of extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail) and Role of extinction in evolution.

Unit 2: Evidences of Evolution

Fossils and its types; Dating of fossils, Phylogeny of horse and human; Molecular evidences (Globin gene families as an example) and Molecular clock concept.

Unit 3: Processes of Evolutionary Change

Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide/Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection and Artificial selection.

Unit 4: Principles of population genetics

Concept of gene pool, Gene frequencies – equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequency without selection – Genetic drift, Mutation pressure and Gene flow and Shifts in gene frequencies with selection.

Unit 5: Species Concept and Evolution above species level

Biological concept of species (Advantages and Limitations); Sibling species, Polymorphic species, Polytypic species, Ring species; Modes of speciation (Allopatric, Sympatric); Macro-evolutionary Principles (Darwin's Finches); Convergence, Divergence and Parallelism.

PRACTICAL

Marks 25

- Study of fossil evidences from plaster cast models and pictures.
- Study of homology and analogy from suitable specimens/ pictures.
- Demonstration of changing allele frequencies with and without selection.
- Construction of cladogram based on morphological characteristics.
- Construction of phylogenetic tree with bioinformatics tools (Clustal X and Phylip).
- Interpretation of phylogenetic trees.

- 1. Barton NH, Briggs DEG, Eisen JA, Goldstein DB and Patel NH (2007) Evolution. Cold Spring Harbour Laboratory Press.
- 2. Campbell NA and Reece JB (2011) Biology. 9th Edition. Pearson Education Inc., New
- Douglas JF (1997) Evolutionary Biology. Sinauer Associates, USA.
 Hall BK and Hallgrimsson B (2008) Evolution. 4th Edition. Jones and Bartlett Publishers,
- 5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
- 6. Pevsner J (2009) Bioinformatics and Functional Genomics. 2nd Edition. Wiley-Blackwell, USA.
- Ridley M (2004) Evolution. 3rd Edition. Blackwell Publishing, USA.

CORE COURSE: ZOOLOGY PAPER XIV EVOLUTIONARY BIOLOGY (CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60

Marks 75

Unit 1: History of Life, theories of Evolution and Extinction

Chemogeny, Biogeny, RNA World, Major Events in History of Life; Lamarckism; Darwinism; Neo-Darwinism; Background of extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail) and Role of extinction in evolution.

Unit 2: Evidences of Evolution

Fossils and its types; Dating of fossils, Phylogeny of horse and human; Molecular evidences (Globin gene families as an example) and Molecular clock concept.

Unit 3: Processes of Evolutionary Change

Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide/Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection and Artificial selection.

Unit 4: Principles of population genetics

Concept of gene pool, Gene frequencies – equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequency without selection – Genetic drift, Mutation pressure and Gene flow and Shifts in gene frequencies with selection.

Unit 5: Species Concept and Evolution above species level

Biological concept of species (Advantages and Limitations); Sibling species, Polymorphic species, Polytypic species, Ring species; Modes of speciation (Allopatric, Sympatric); Macro-evolutionary Principles (Darwin's Finches); Convergence, Divergence and Parallelism.

PRACTICAL

Marks 25

- 1. Study of fossil evidences from plaster cast models and pictures.
- 2. Study of homology and analogy from suitable specimens/ pictures.
- 3. Demonstration of changing allele frequencies with and without selection.
- 4. Construction of cladogram based on morphological characteristics.
- 5. Construction of phylogenetic tree with bioinformatics tools (Clustal X and Phylip).
- Interpretation of phylogenetic trees.

- 1. Barton NH, Briggs DEG, Eisen JA, Goldstein DB and Patel NH (2007) Evolution. Cold Spring Harbour Laboratory Press.
- 2. Campbell NA and Reece JB (2011) Biology. 9th Edition. Pearson Education Inc., New
- Douglas JF (1997) Evolutionary Biology. Sinauer Associates, USA.
 Hall BK and Hallgrimsson B (2008) Evolution. 4th Edition. Jones and Bartlett Publishers,
- 5. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
- 6. Pevsner J (2009) Bioinformatics and Functional Genomics. 2nd Edition. Wiley-Blackwell, USA.
- 7. Ridley M (2004) Evolution. 3rd Edition. Blackwell Publishing, USA.

DISCIPLINE SPECIFIC ELECTIVE MICROBIOLOGY (CREDITS: THEORY-4, PRACTICALS-2)

THEORY LECTURES: 60

J. - 1

Marks 75

- Unit 1: History of Microbiology; Microbial World Characterization, Classification and identification of microbes.
- Unit 2: Prokaryotes: General morphology and classification of bacteria, their characters and economic importance; Gram-positive and Gram-negative bacteria.
- Unit 3: Eukaryotes: General morphology of Protista and Fungi classification and economic importance.
- Unit 4: Viruses: structure, genome, replication cycle; Epidemiology of infectious diseases with reference of human hosts - Bacterial (Tuberculosis), Viral (Hepatitis), Protozoan (Amoebiasis) and Fungal (any one) disease.
- Unit 5: Microbe interactions-Immune Responses-Antibiotics and other chemotherapeutic agents; Applied microbiology in the fields of food, agriculture, industry and environment.

PRACTICAL

Marks 25

- Cleaning of glasswares, sterilisation principle and methods moist heat dry heat and 1. filtration methods.
- Media preparation: Liquid media, Solid media, Agar slants, Agar plates. Basal, enriched, selective media preparation - quality control of media, growth supporting properties, 2. sterility check of media.
- Pure culture techniques: Streak plate, pour plate and decimal dilution.
- Cultural characteristics of microorganisms: Growth on different media, growth 3. 4. characteristics and description and demonstration of pigment production.
- Staining techniques: Smear preparation, simple staining, Gram's staining, Acid fast 5. staining and staining for metachromatic granules.
- Morphology of microorganisms. 6.
- Antibiotic sensitivity testing: Disc diffusion test Quality control with standard strains 7.
- Physiology characteristics: IMViC test, H2S, Oxidase, catalase, urease test, Carbohydrate fermentation, Maintenance of pure culture, Paraffin method, Stab culture and 8. maintenance of mold culture.

- Ahsan J and Sinha SP (2010) A Hand book on Economic Zoology. S Chand, New Delhi.
- 2. Arora DR and Arora B (2001) Medical Parasitology. 2nd Edition. CBS Publications and Distributers.
- 3. Atwal AS (1993) Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana.

DSE 9 IMMUNOLOGY

F.M=75 (Mid Sem=15+Sem=60)

THEORY (Credits 4)

Unit 1: Overview of Immune System

12 MARKS

Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system

Unit 2: Innate and Adaptive Immunity

12 MARKS

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and AIDS).

Unit 3: Immunoglobulins

12 MARKS

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology; Monoclonal antibodies in therapeutics and diagnosis

Unit 4

Major Histocompatibility Complex

12 MARKS

Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation

Vaccines 5

Various types of vaccines.

12 MARKS

in innate immunity. Adaptive atural 12 MARKS Active: Artificia community with efference?

Unit 5:

Cytokines

Properties and functions of cytokines, Therapeutics Cytokines Complement System

Components and pathways of complement activation.

12 MARKS

Intigen-antibody interactions,

Hypersensitivity

Gell and Coombs' classification and brief description of various type

12 VARES conous pathways of antigen.

DSE 3 BIOLOGY OF INSECTA THEORY (Credits 4)

Unit I: Introduction

General Features of Insects

Distribution and Success of Insects on the Earth

Unit II: Insect Taxonomy

Basis of insect classification; Classification of insects up to orders

Unit III: General Morphology of Insects

External Features; Head - Eyes, Types of antennae, Mouth parts w.r.t. feeding

Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat Abdominal appendages and genitalia

Unit IV: Insect Society

Group of social insects and their social life

Social organization and social behaviour (w.r.t. any one example)

Unit V: Insects as Vectors

Insects as mechanical and Biological vectors, Brief discussion on houseflies and mosquitoes as important insect vectors

BIOLOGY OF INSECTA PRACTICAL (CREDITS 2)

- 1. Study of one specimen from each insect order
- 2. Study of different kinds of antennae, legs and mouth parts of insects
- 3. Study of head and sclerites of any one insect
- Study of insect wings and their venation.
- Study of insect spiracles
- Methodology of collection, preservation and identification of insects.
- 7. Morphological studies of various castes of Apis, Camponotus and
- 8. Study of any three insect pests and their damages
- 9. Study of any three beneficial insects and their products

Field study of insects and submission of a project report on the insect diversity

Rwand

6 Ksemester

DSE 4

PARASITOLOGY THEORY (CREDITS 4)

Unit I: Introduction to Parasitology

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship

Unit II: Parasitic Protists

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani, Plasmodium vivax

Unit III: Parasitic Platyhelminthes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of Fasciolopsis buski, Schistosoma haematobium, Taenia solium.

Unit IV: Parasitic Nematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of Ascaris lumbricoides, Ancylostoma duodenale, Wuchereria bancrofti and Trichinella spiralis.

Unit V: Parasitic Vertebrates

A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbird and Vampire bat CBCS Undergraduate Program in Zoology

PRACTICAL (Credits2)

- Study of life stages of Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani and Plasmodium vivax through permanent slides/micro photographs
- Study of adult and life stages of Fasciolopsis buski, Schistosoma haematobium, Taenia solium through permanent slides/micro photographs
- Study of adult and life stages of Ascaris lumbricoides, Ancylostoma duodenale, Wuchereria bancrofti and Trichinella spiralis through permanent slides/micro photographs
- · Study of wood pests- termites and termitarium.
- Study of Pediculus humanus (Head louse and Body louse), Xenopsylla cheopis and Cimex lectularius through permanent slides/ photographs
- Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
- Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by product]
 Submission of a brief report on parasitic vertebrates

Durand

SKILL ENHANCEMENT COURSES PUBLIC HEALTH AND HYGIENE (Credits 2)

Lectures: 30

Marks 50

- Unit 1: Scope of Public health and Hygiene; nutrition and health; classification of foods; Nutritional deficiencies; Vitamin deficiencies.
- Unit 2: Pollution: water pollution, air pollution, soil pollution, noise pollution, thermal pollution and radioactive pollution.
- Unit 3: Environment and Health hazards; Environmental degradation and health hazards due to pollutants.
- Unit 4: Communicable diseases and their control measures such as Measles, Polio, Chikungunya, Rabies, Plague, Leprosy and AIDS.
- Unit 5: Non-Communicable diseases and their preventive measures such as Hypertension, Coronary Heart diseases, Stroke, Diabetes, Obesity and Mental ill-health.

- Arora DR and Arora B (2001) Medical Parasitology. 2nd Edition. CBS Publications and Distributers.
- Dubey RC and Maheshwari DK (2013) A text book of Microbiology. S. Chand, New Delhi.
- 3. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
- Pelczar MJ, Chan ECS and Krieg NR (1993) Microbiology. 5th Edition. Tata McGraw Hill Publishing Co. Ltd.

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PRACTICAL (Credits 2)		
1*. Demonstration of lymphoid organ	ns.	2 In 10 10 10 10 10 10 10 10 10 10 10 10 10
2. Histological study of spleen, them	us and lumph and a st	rough slides/ photographs
		of blood cells.
" a double immino-diff	fusion method.	
5. ABO blood group determination.		
6*. Cell counting and viability test from 7. Demonstration of	om splenocytes of farn	n bred animals/cell lines.
a. ELISA		
 b. Immunoelectrophoresis 		2-12-13-75-74-12-13-14-14-14-14-14-14-14-14-14-14-14-14-14-
* The experiments can be performed	depending upon usage	of animals in LIC sources
☐ Kindt, T. J., Goldsby, R.A., Osborn	ie, B. A. and Kuby, J (2006). Immunology, VI Edition, W.H.
Freeman and Company.		art is conton, with
David M. Jonathan B. David B.	D	
☐ David, M., Jonathan, B., David, R. Elsevier Publication.	B. and Ivan R. (2006).	Immunology, VII Edition, Mosby,
☐ Abbas, K. Abul and Lechtman H. A Edition. Saunders Publication.	andrew (2003.) Cellula	or and Molandon I
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		immunology, VI Edition, W.H.

CHEMISTRY CHONS) -SEMESTER-I - 2015 Semester-1 Dept. of Chemistry CHEMISTRY HONOURS CHEMISTRY-C I: INORGANIC CHEMISTRY-I End (Credits: Theory-04, Practicals-02) Sem-60 marks Mid Theory: 60 Lectures Sem-15 marks Unit-I ATOMIC STRUCTURE: 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, Variation of orbital energy with atomic number. Lectures)

> Unit-II **PERIODICITY OF ELEMENTS**

Periodicity of ekements:s, p, d, 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.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii (van der Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e)lonization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy.

(f) Electron gain enthalpy, trends of electron gain enthalpy.

(g) 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. Sanderson's electron density ratio. Lectures)

> Unit-III CHEMICAL BONDING-I

(16

(i) lonic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule,

Resonance and resonance energy.

Unit-IV CHEMICAL BONDING-II

Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N2, O2, C2, B2, F2, CO, NO, and their ions; HCl, BeF2, CO2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and

consequences of polarization.

10

lonic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(iii) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Unit-V CHEMICAL BONDING-III

(iv) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

(26 Lectures)

OXIDATION-REDUCTION

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class. Lectures)

(4

Reference Books:

Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.

. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970

. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.

. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

CHEMISTRY LAB- C I LAB:

F.M=25

(Expt.-15, Viva

voce-6

&Lab.Record-4)

Time-3hrs

(A) Titrimetric Analysis

(i) Calibration and use of apparatus

(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.

(ii) Estimation of carbonate and bicarbonate present together in a mixture.

(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

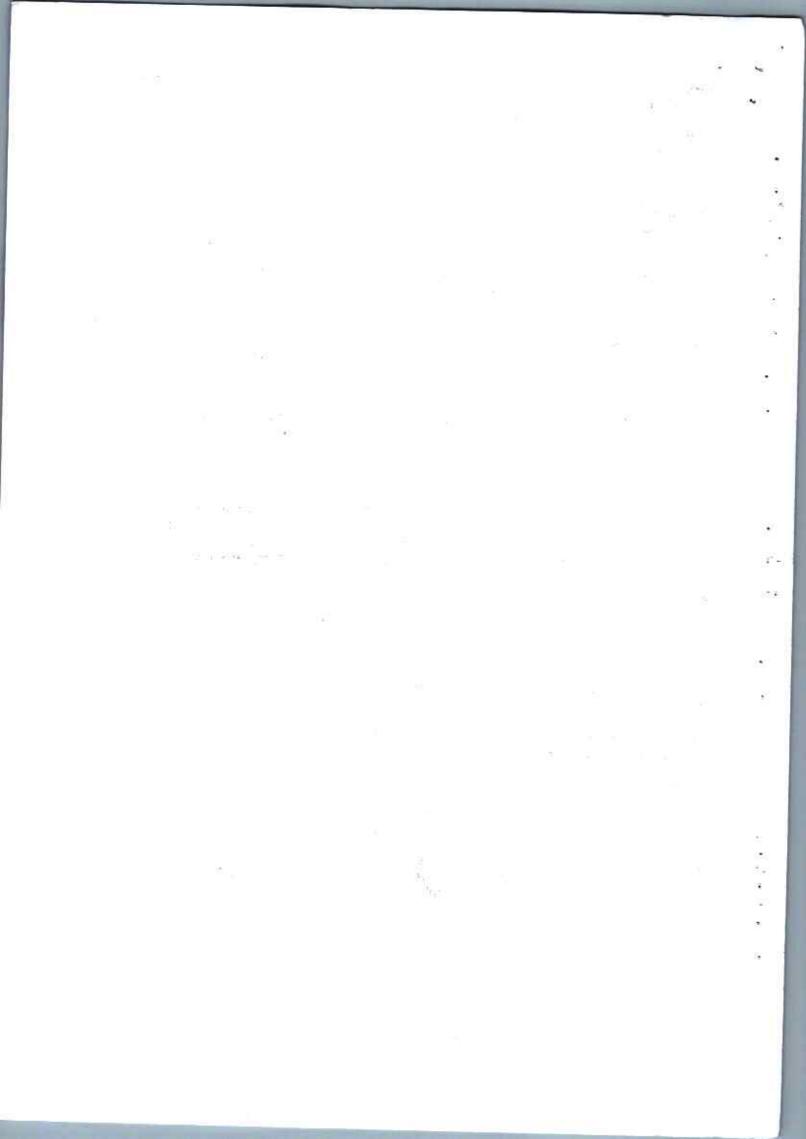
(i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.

(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.

(iii) Estimation of Fe(II) with K2Cr2O7 using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.



CHEMISTRY -C II: PHYSICAL CHEMISTRY-I

Sem-60 marks

(Credits: Theory-04, Practicals-02)

Sem-15 marks Theory: 60 Lectures End

Mid

Unit-I GASEOUS STATE-I

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η ; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

GASEOUS STATE-II

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. Van 11 der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

(18 Lectures)

Unit-II LIQUID STATE:

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water. (6)

Lectures)

Unit-III IONIC EQUILIBRIA-I

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).

IONIC EQUILIBRIA-II

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.

Unit-IV SOLID STATE:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and

powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. crystals. liquid Glasses and crystals. Defects in (16 Lectures)

> Unit-W SOLUBILITY AND SOLUBILITY PRODUCT

Solubility and solubility product of sparingly soluble salts - applications of solubility product principle. Qualitative treatment of acid - base titration curves (calculation of pH at various stages). Theory of acid-base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants. (20 Lectures)

Reference Books:

Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University

Press (2014).

Ball, D. W. Physical Chemistry Thomson Press, India (2007).

Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).

Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

Engel, T. & Reid, P. Physical Chemistry 3rd Ed. Pearson (2013).

CHEMISTRY LAB-C II LAB

60 Lectures

1. Surface tension measurements.

- a. Determine the surface tension by (i) drop number (ii) drop weight method.
- Study the variation of surface tension of detergent solutions with concentration.

Viscosity measurement using Ostwald's viscometer.

- a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
- b. Study the variation of viscosity of sucrose solution with the concentration of solute.
- Indexing of a given powder diffraction pattern of a cubic crystalline system.

4. pH metry

- a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- b. Preparation of buffer solutions of different pH

i. Sodium acetate-acetic acid

ii. Ammonium chloride-ammonium hydroxide

- c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
- d. Determination of dissociation constant of a weak acid.

Any other experiment carried out in the class.

Reference Books

Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R.

Chand & Co.: New Delhi (2011).

Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).

Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H.

Freeman & Co.: New York (2003).

SEMESTER-II

CHEMISTRY-C - III: ORGANIC CHEMISTRY I

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

End Sem- 60marks Mid Sem- 15marks

Unit -I BASICS OF ORGANIC CHEMISTRY:

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophileity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

CARBON-CARBON SIGMA BONDS

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

(12 Lectures)

Unit - II STEREOCHEMISTRY

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, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. (18 Lectures)

Unit – III CHEMISTRY OF ALIPHATIC HYDROCARBONS

A Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. 15 Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkanes.

1. Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

(18 Lectures)

Unit - WARD AROMATIC HYDROCARBONS

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

(12 Lectures)

Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- · Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

CHEMISTRY LAB-C IILAB

(F.M=25)

(Expt. -15, Viva Voce- 6 & Lab. Record- 4)

Time - 3hrs

- Checking the calibration of the thermometer
- 2 Purification of organic compounds by crystallization using the following solvents:
- a. Water
- b. Alcohol
- c. Alcohol-Water
- 3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
- 4. Effect of impurities on the melting point mixed melting point of two unknown organic compounds
- 5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
 - 6. Chromatography
 - a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
 - b. Separation of a mixture of two sugars by ascending paper chromatography
- c Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th
 Ed., Pearson (2012)

Mer

SEMESTER- II

CHEMISTRY -C IV: PHYSICAL CHEMISTRY II (Credits: Theory-04, Practicals-02)

End Sem- 60marks Mid Sem- 15 marks Time- 3hrs

Theory: 60 Lectures

Unit-I

CHEMICAL THERMODYNAMICS:

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

(14 Lectures)

Unit-II

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell 17 relations; thermodynamic equation of state.

(14 Lectures)

THE PARTY

SYSTEMS OF VARIABLE COMPOSITION

Partial molar quantities, dependence of thermodynamic parameters on composition; GibbsDuhem equation, chemical potential of ideal mixtures change in thermodynamic functions in mixing of ideal gases.

CHEMICAL EQUILIBRIUM

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

(18 Lectures)



Solutions and Colligative Properties: Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure. (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

(14 Lectures)

Reference Books

- Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- · Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will. S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- · Levine, I.N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

CHEMISTRY LAB- C IV LAB (F.M=25)

(Expt. -15, Viva- 6 & Lab. Record- 4)

Time - 3hrs

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

THERMOCHEMISTRY

- (b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
- (e) Calculation of the enthalpy of ionization of ethanoic acid.
 - (d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
- (e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
- Determination of enthalpy of hydration of copper sulphate.
- (g) Study of the solubility of benzoic acid in water and determination of ΔH.

Reference Books

- Khosia, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

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SEMESTER- IV

B.Sc. Hons. Students other than Chemistry Hons. will opt. four Chemistry GE Papers.

GE-I (Theory)

GE: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

(Credits: Theory-04, Practicals-02)

End Sem- 60marks Mid Sem- 15 marks Time- 3hrs

Theory: 60 Lectures

SECTION A: INORGANIC CHEMISTRY-1

(30 Periods)

Unit-I Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new

what is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ 2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

(14 Lectures)

Unit-II

Chemical Bonding and Molecular Structure

lonic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and/heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches.

(16 Lectures)

Section B: Organic Chemistry-1 Unit- III

(30 Periods)

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive

Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry

(8 Lectures)

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Three and erythro; D and L; cis - trans nomenclature; CIP Rules: R/S (for upto 2 chiral carbon atoms) and E/Z Nomenclature (for upto two C=C systems).

(10 Lectures)

Unit- N Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition). Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC₂ and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO₄, ozonolysis and oxidation with hot alk. KMnO₄.

(12 Lectures)

Reference Books:

. J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.

· F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.

- Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.

• T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.

- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.• L. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.

R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.

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SEMESTER III

CHEMISTRY - C V: INORGANIC CHEMISTRY II (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Unit -1

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, van Arkel-de Boer process and Mond's process, Zone refining.

(6 Lectures)

Unit -II

Chemistry of s Block Elements:

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- General characteristics: melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of each group.
- (ii) Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.
- (iii) Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.
- (iv) Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium.
- (v) Solutions of alkali metals in liquid ammonia and their properties.

Unit - [1] (22 Lectures)

Chemistry of p Block Elements:

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group.

(6 lectures)

Structure, bonding and properties: acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat of the following:

- Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH₃ where E = N, P, As, Sb, Bi), Group 16 and Group 17.
- · Oxides: oxides of phosphorus, sulphur and chlorine
- · Oxoacids: oxoacids of phosphorus and chlorine; peroxoacids of sulphur
- Halides: halides of silicon and phosphorus

Preparation, properties, structure and uses of the following compounds:

- Borazine
- Silicates, silicones,
- Phosphonitrilic halides {(PNCl₂)_n where n = 3 and 4}
- Interhalogen and pseudohalogen compounds
- Clathrate compounds of noble gases, xenon fluorides (MO treatment of XeF₂).

(26 Lectures)

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth- Heinemann.
 1997.
- Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 3rd Ed. (adapted), Pearson, 2009
- Shriver, D.F., Atkins P.W and Langford, C.H., Inorganic Chemistry 2nd Ed., Oxford University Press, 1994

Practical C - V Lab: 60 Lectures

(A) Iodo / Iodimetric Titrations

- Estimation of Cu(II) and K₂Cr₂O₂ using sodium thiosulphate solution (Iodometrically).
- (ii) Estimation of antimony in tartar-emetic iodimetrically
- (B) Complexometric titrations using disodium salt of EDTA

- (i) Estimation of Mg²⁺, Zn²⁺
 (ii) Estimation of Ca²⁺ by substitution method
- (C) Inorganic preparations
- (i) Cuprous Chloride, Cu2Cl2
- (ii) Manganese(III) phosphate, MnPO4.H2O
- (iii) Aluminium potassium sulphate KAl(SO₄)₂.12H₂O (Potash alum) or Chrome alum.

Reference Books:

- Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS, 1978
- Marr, G. and Rockett, R.W. Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972.

CHEMISTRY - C VI: ORGANIC CHEMISTRY II (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions - SN1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; SNAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg (Grignard reagent) - Use in synthesis of organic compounds.

(16 Lectures)

Alcohols, Phenols, Ethers and Epoxides:

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Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-BlancReduction; Oxidation of diols by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism:

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and LiAlH4

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(16 Lectures)

Carbonyl Compounds:

Structure, reactivity, preparation and properties;

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4, NaBH4, MPV, PDC)

U \sim V Addition reactions of α, β- unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

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(16 Lectures)

Carboxylic Acids and their Derivatives:

General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids.

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilicsustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

(12 Lectures)

Reference Books:

- •Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- •Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pyt. Ltd. (Pearson Education).
- •Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

Practical C - VI Lab: 60 Lectures

- 1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
- 2. Organic preparations:

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- i. Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
 - Using conventional method. a.
 - Using green approach b.
- Benzolyation of one of the following amines (aniline, o-, m-, p- toluidines and o-, ii. , p-anisidine) and one of the following phenols (β-naphthol, resorcinol, p- cresol) by Schotten-Baumann reaction.
- Oxidation of ethanol/ isopropanol (Iodoform reaction). iii.
- Selective reduction of meta dinitrobenzene to m-nitroaniline. iv.
- Hydrolysis of amides and esters. V.
- Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, vi. cyclohexanone, benzaldehyde.
- S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids vii. (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
- Aldol condensation using either conventional or green method. viii.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point. -

Reference Books:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- •Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
- ·Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- ·Ahluwalia, V.K. &Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CHEMISTRY - C VII: PHYSICAL CHEMISTRY III (Credits: Theory-04, Practicals-02)

unit - I & D Theory: 60 Lectures

Phase Equilibria: Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H2O and S), with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Three component systems: triangular plots, water-chloroform-acetic acid system. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible

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liquids (ideal and non ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications. (27 Lectures)

UNT -111 818 Electrochemical Cells: Rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation). (27 Lectures)

Unit-N Surface chemistry: Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). nature of adsorbed state. Qualitative discussion of BET. (6 Lectures)

Reference Books:

- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
- Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
- · McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004). • Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
 Ball, D. W. Physical Chemistry Cengage India (2012).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
- Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

Practical C - VII Lab: 60 Lectures

Phase Equibria:

- I. Determination of critical solution temperature and composition at CST of the phenolwater system and to study the effect of impurities of sodium chloride and succinic acid
- II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems.
- III. Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane.
- IV. Study the equilibrium of at least one of the following reactions by the distribution method:
 - (i)
 - $I_2 (aq) + I^- (aq) \rightarrow I_3^- (aq)$ $Cu^{2+} (aq) + nNH_3 \rightarrow Cu(NH3)_n^{2+}$ (ii)

Potentiometry:

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V. Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base iv. Potassium dichromate vs. Mohr's salt

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand
 & Co.: New Delhi (2011), 25
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H.
 Freeman & Co.: New York (2003).

SEMESTER IV

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CHEMISTRY - C VIII: INORGANIC CHEMISTRY III (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

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Coordination Chemistry:

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δ o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δ o, Δ t). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

(26 Lectures)

Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams) Different between the first, second and third transition series.

Chemistry of Cr, Mn, Fe and Co in various oxidation states with special reference to the following compounds: peroxo compounds of chromium, potassium dichromate, potassium

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permanganate, potassium ferrocyanide, potassium ferricyanide, sodium nitroprusside and sodium cobaltinitrite.

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(14 Lectures)

Lanthanoids and Actinoids:

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

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(6 Lectures)

Inorganic Reaction Mechanism

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect. Thermodynamic and Kinetic stability.

(14 Lectures)

Reference Books:

Purcell, K.F & Kotz, J.C., Inorganic Chemistry W.B. Saunders Co, 1977.

· Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.

- Cotton, F.A. & Wilkinson, G., Advanced Inorganic Chemistry Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann, 1997.
- Miessler, G. L. &. Tarr, Donald A. Inorganic Chemistry 3rd Ed. (adapted), Pearson, 2009

Practical C - VIII Lab:

60 Lectures

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).

ii. Estimation of copper as CuSCN

- iii. Estimation of iron as Fe₂O₃ by precipitating iron as Fe(OH)₃.
- Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)₃
 (aluminium oxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, [Cu(NH₃)₄]SO₄.H₂O

ii. Acetylacetonate complexes of Cu2+/Fe3+

- iii. Tetraamminecarbonatocobalt (III) nitrate
- iv. Potassium tri(oxalato)ferrate(III)

Properties of Complexes

i. Measurement of 10 Dq by spectrophotometric method

ii. Verification of spectrochemical series.

iii. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Reference Book:

- Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.
- G. Marr and B.W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972

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CHEMISTRY - C IX: ORGANIC CHEMISTRY III

(Credits: Theory-04, Practicals-02) More-60+15(ht) +25

Theory: 60 Lectures

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Nitrogen Containing Functional Groups

Preparation and important reactions of nitro compounds, nitriles and isonitriles.

Amines: Preparation and properties: Effect of substituent and solvent on basicity; Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

Unit-11

(18 Lectures)

Polynuclear Hydrocarbons

Aromaticity of polynuclear hydrocarbons, structure elucidation of naphthalene; Preparation and properties of naphthalene, phenanthrene and anthracene.

(8 Lectures)

Heterocyclic Compounds

Und-III

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Indole(Fischer indole synthesis and Madelung synthesis), Ouinoline and isoquinoline, (Skraup synthesis, Friedlander's synthesis, Knorr quinoline Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictetsynthesis, Spengler reaction, Pomeranz-Fritsch reaction)

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(22 Lectures)

Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action, Hoffmann's exhaustive methylation, Emde's modification; Structure elucidation and synthesis of Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, Imst-E. and Reserpine. (6 Lectures)

Terpenes

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral.

(6 Lectures)

Reference Books:

•Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

- •Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- •Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly& Sons (1976).
- •Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- *Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- *Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, PrajatiParakashan (2010).

Practical C - IX Lab: 60 Lectures

- 1. Functional group test for nitro, amine and amide groups.
- 2.Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, carbonyl compounds and esters)

Reference Books:

- •Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- •Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V.K. &Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

CHEMISTRY - C X: PHYSICAL CHEMISTRY IV

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures Unft - I & II

Conductance: Quantitative aspects of Faraday's laws of electrolysis Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at 29 infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, 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, and (v) hydrolysis constants of salts.

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Chemical Kinetics: Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates. (22 Lectures)

Catalysis: Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Photochemistry: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical 34 reactions in biochemical processes, photostationary states, chemiluminescence.

(12 Lectures)

Reference Books:

- Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- · Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Rogers, D. W. Concise Physical Chemistry Wiley (2010).
- Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).

Practical C - X Lab: 60 Lectures Conductometry:

- I. Determination of cell constant
- Determination of conductivity, molar conductivity, degree of dissociation and dissociation constant of a weak acid.
- III. Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Mixture of strong acid and weak acid vs. strong base iv. Strong acid vs. weak base

Chemical Kinetics:



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IV. Study the kinetics of the following reactions.

- 1. Iodide-persulphate reaction (i) Initial rate method; (ii)Integrated rate method
- 2. Acid hydrolysis of methyl acetate with hydrochloric acid.
- 3. Saponification of ethyl acetate.
- Comparison of the strengths of HCl and H₂SO₄ by studying kinetics of hydrolysis of methyl acetate.

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.;
 McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

SEMIESTER V

CHEMISTRY - C XI: ORGANIC CHEMISTRY IV (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

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Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides;

Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides (DNA and RNA).

(9 Lectures)

Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification.

α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis;

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Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups, Solid-phase synthesis; primary, secondary and tertiary structures of proteins, Denaturation

(18 Lectures)

Enzymes

Unit - II

Introduction, classification and characteristics of enzymes. Salient features of active site of

Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors, specificity of enzyme action (including stereospecificity), enzyme

inhibitors and their importance.

Unit-W (6 Lectures)

Lipids

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

(8 Lectures) Unit-IV

Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism).

ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD+, FAD.

Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle.

Caloric value of food, standard caloric content of food types.

(7 Lectures)

Pharmaceutical Compounds: Structure and Importance

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

(12 Lectures)

Reference Books:

*Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.

•Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.

·Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition.Lange Medical Books/ McGraw-Hill.

Practical C - XI Lab: 60 Lectures



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1. Estimation of glycine by Sorenson's formalin method.

2.Study of the titration curve of glycine.

3. Estimation of proteins by Lowry's method.

4. Study of the action of salivary amylase on starch at optimum conditions.

Effect of temperature on the action of salivary amylase.

6.Saponification value of an oil or a fat.

7. Determination of Iodine number of an oil/ fat.

8. Isolation and characterization of DNA from onion/ cauliflower/peas.

Reference Books:

·Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.

Arthur, I. V. Quantitative Organic Analysis, Pearson.

CHEMISTRY - C XII: PHYSICAL CHEMISTRY V (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Unit-I

Quantum Chemistry: Postulates of quantum mechanics, quantum mechanical operators and commutation rules, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation in Cartesian and spherical polar (Derivation not required). Separation of variables. Spherical harmonics. Discussion of solution (Qualitative).

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H₂ ⁺. Bonding and antibonding orbitals. Qualitative extension to H₂. Comparison of LCAO-MO and VB treatments of H₂ (only wave functions, detailed solution not

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required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).

(30 Lectures)

UNITI

Molecular Spectroscopy: Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation.

Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.

Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales (δ and T), spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

(30 Lectures)

Reference Books:

- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
 House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).

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Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

Practical C - XII Lab: 60 Lectures
Colorimetry:

- Verify Lambert-Beer's law and determine the concentration of CuSO₄/KMnO₄/K₂Cr₂O₇ in a solution of unknown concentration
- Determine the concentrations of KMnO₄ and K₂Cr₂O₇ in a mixture.
- III. Study the kinetics of iodination of propanone in acidic medium.
- IV. Determine the amount of iron present in a sample using 1, 10-phenathroline.
- V. Determine the dissociation constant of an indicator (phenolphthalein).
- VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
- VII. Analysis of the given vibration-rotation spectrum of HCl(g)

Adsorption

VIII. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

UV/Visible spectroscopy:

- Study the 200-500 nm absorbance spectra of KMnO₄ and K₂Cr₂O₇ (in 0.1 M H₂SO₄) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule⁻¹, kJ mol⁻¹, cm⁻¹, eV).
- Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of K₂Cr₂O₇.
- III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.;
 McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

SEMESTER VI

CHEMISTRY - C XIII: INORGANIC CHEMISTRY IV
(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Unit-I

Theoretical Principles in Qualitative Analysis (H,S Scheme)

Basic principles involved in analysis of cations and anions. Solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

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(12 Lectures)

Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

(26 Lectures)

UN7-TZ

Bioinorganic Chemistry:

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine, Cisplatin as an anti-cancer drug.

Iron and its application in bio-systems, Haemoglobin, Myoglobin; Storage and transfer of iron.

(14 Lectures)

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Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

- 1. Alkene hydrogenation (Wilkinson's Catalyst)
- 2. Synthetic gasoline (Fischer Tropsch reaction)
- 3. Polymerisation of ethene using Ziegler-Natta catalyst

(8 Lectures)

Reference Books:

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- Vogel, A.I. Qualitative Inorganic Analysis, Longman, 1972
- Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall, 1996-03-07.
- Lippard, S.J. & Berg, J.M., Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
- Cotton, F.A., Wilkinson, G., & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.;
 Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
- Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
- Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements 2nd Ed, Elsevier, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
- · Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
- Shriver, D.D., Atkins, P. and Langford, C.H., Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
- Purcell, K.F. & Kotz, J.C., Inorganic Chemistry, W.B. Saunders Co. 1977
- Miessler, G. L. & Tarr, Donald A., Inorganic Chemistry 4th Ed., Pearson, 2010.
- Collman, James P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
- Crabtree, Robert H. The Organometallic Chemistry of the Transition Metals.
 John Wiley New York, NY, 2000.
- Spessard, Gary O., & Miessler, Gary L., Organometallic Chemistry. Upper Saddle River, NJ: Prentice-Hall, 1996.

Practical C - XIII Lab: 60 Lectures

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO₃²⁻, NO₂⁻, S²⁻, SO₃²⁻, S₂O₃²⁻, CH₃COO⁻, F',Cl⁻, Br⁻, Γ, NO₃⁻, BO₃³⁻, C₂O₄²⁻, PO₄³⁻, NH₄⁺, K⁺, Pb²⁺, Cu²⁺, Cd²⁺, Bi³⁺, Sn²⁺, Sb³⁺, Fe³⁺, Al³⁺, Cr³⁺, Zn²⁺, Mn²⁺, Co²⁺, Ni²⁺, Ba²⁺, Sr²⁺, Ca²⁺,

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Mg2+ Mixtures should preferably contain one interfering anion, or insoluble component (BaSO₄, SrSO₄, PbSO₄, CaF₂ or Al₂O₃) or combination of anions e.g. CO₃² and SO₃², NO₂ and NO₃, Cl and Br, Cl and I, Br and I, NO3 and Br, NO3 and I. Spot tests should be done whenever possible.

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

Ni (II) and Co (II) i.

Cu(II) and Cd(II)

Reference Books:

Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla.

Vogel, A.I. A Textbook of Quantitative Analysis, ELBS. 1986

CHEMISTRY - C XIV: ORGANIC CHEMISTRY V (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Unit-2 Organic Spectroscopy

General principles Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in Und-I functional group analysis.

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin - Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpetation of NMR spectra of simple compounds.

Applications of IR, UV and NMR for identification of simple organic molecules.



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(24 Lectures)

unit - 1

Carbohydrates

Occurrence, classification and their biological importance.

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani- Fischer synthesis and Ruff degradation;

Disaccharides - Structure elucidation of maltose, lactose and sucrose.

Polysaccharides - Elementary treatment of starch, cellulose and glycogen.

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Nut - 15

(16 Lectures)

Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing;

Synthesis and applications of: Azo dyes - Methyl orange; Triphenyl methane dyes - Malachite green and Rosaniline; Phthalein Dyes - Phenolphthalein; Natural dyes - structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.

ONGL-D

(8 Lectures)

Polymers

Introduction and classification including di-block, tri-block and amphiphilic polymers;

Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics — thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene);

Fabrics - natural and synthetic (acrylic, polyamido, polyester); Rubbers - natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to; Biodegradable and conducting polymers with examples.

(12 Lectures)

Reference Books:

*Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.

 Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

·Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.

*Gowariker, V. R.; Viswanathan, N. V. &Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.

•Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

·Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

- ·Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- ·Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, PrajatiPrakashan (2010).
- ·Kemp, W. Organic Spectroscopy, Palgrave

Practical C - XIV Lab: 60 Lectures

1. Extraction of caffeine from tea leaves.

2. Preparation of urea formaldehyde resin.

3. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, e.g. salicylic acid, cinnamic acid, nitrophenols etc.

4.Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).

5. Preparation of methyl orange.

Reference Books:

•Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).

•Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

•Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

•Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

 Ahluwalia, V.K. &Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

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CHEMISTRY-DSE: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE Reper-1, 5th Semesies. (Credits: Theory-04, Practicals-02)

Theory: 60 Lectures (Compulsory elective)

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Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Brief introduction to types of ceramics. Superconducting and semiconducting oxides, fullerenes, carbon nanotubes and carbon fibre.

Cements: Manufacture of cement and the setting process, quick setting cements.

NA-17 (16 Lectures)

Fertilizers:

Different types of fertilizers (N, P and K). Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime.

UWI-III (8 Lectures)

Surface Coatings:

Brief introduction to and classification of surface coatings. Paints and pigments - formulation, composition and related properties. Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Umit - W (4 Lectures)

Batteries:

Working of the following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

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(10 Lectures)

Catalysis:

General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts.

Application of zeolites as catalysts.

(6 Lectures)

Chemical explosives:

Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

(6 Lectures)

Reference Books:

Stocchi, E., Industrial Chemistry, Vol I, Ellis Horwood Ltd. UK, 1990

Felder, R. M. and Rousseau, R.W., Elementary Principles of Chemical Processes, Wiley

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Publishers, New Delhi, 2005.

- Kingery, W. D., Bowen H. K. and Uhlmann, D. R. Introduction to Ceramics, Wiley Publishers, New Delhi, 1976.
- Kent, J. A. (ed) Riegel's Handbook of Industrial Chemistry, 9th Ed., CBS Publishers, New Delhi, 1997
- Jain, P. C. and Jain, M. Engineering Chemistry, Dhanpat Rai & Sons, Delhi 2005
- Gopalan, R., Venkappayya, D. and Nagarajan, S. Engineering Chemistry, Vikas Publications, New Delhi, 2004.
- Sharma, B. K. Engineering Chemistry, Goel Publishing House, Meerut, 2006

PRACTICALS-DSE LAB: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE 60 Lectures

- 1. Determination of free acidity in ammonium sulphate fertilizer.
- 2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
- 3. Estimation of phosphoric acid in superphosphate fertilizer.
- 4. Electroless metallic coatings on ceramic and plastic material.
- 5. Determination of composition of dolomite (by complexometric titration).
 - 6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
 - 7. Analysis of Cement.
 - 8. Preparation of pigment (zinc oxide).

Reference Books:

- Stocchi, E., Industrial Chemistry, Vol I, Ellis Horwood Ltd. UK, 1990
- Felder, R. M. and Rousseau, R.W., Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi, 2005.
- Kingery, W. D., Bowen H. K. and Uhlmann, D. R. Introduction to Ceramics, Wiley Publishers, New Delhi, 1976.
- Kent, J. A. (ed) Riegel's Handbook of Industrial Chemistry, 9th Ed., CBS Publishers, New Delhi, 1997
- Jain, P. C. and Jain, M. Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
- Gopalan, R., Venkappayya, D. and Nagarajan, S. Engineering Chemistry, Vikas Publications, New Delhi, 2004.
- Sharma, B. K. Engineering Chemistry, Goel Publishing House, Meerut, 2006

------ Springer - Anamaya Publishers,

CHEMISTRY-DSE: POLYMER CHEMISTRY
(Credits: Theory-06, Practicals-02)

OSE-11, 51 Semaster

(Credits: Theory-06, Practicals-02)

Theory: 60 Lectures

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Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

(4 Lectures)

Functionality and its importance:

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Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

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(8 Lectures)

Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

(8 lectures)

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

(4 Lectures)

Nature and structure of polymers-Structure Property relationships.

(2 Lectures)

Determination of molecular weight of polymers (Mn, Mw, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

(8 Lectures)

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). Unit-TV (8 Lectures)

Polymer Solution - Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures. (8 Lectures)

V-HWV

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes,

Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

(10 Lectures)

Reference Books:

Seymour's Polymer Chemistry, Marcel Dekker, Inc.

G. Odian: Principles of Polymerization, John Wiley.

- F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
- P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.

R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

CHEMISTRY PRACTICAL - DSE LAB: POLYMER CHEMISTRY

60 Lectures

Polymer synthesis



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 Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).

a. Purification of monomer

b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)

2. Preparation of nylon 66/6

- 1. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
- a. Preparation of IPC
- b. Purification of IPC
- Interfacial polymerization
- 3. Redox polymerization of acrylamide
- 4. Precipitation polymerization of acrylonitrile
- 5. Preparation of urea-formaldehyde resin
- Preparations of novalac resin/resold resin.
- Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

- 1. Determination of molecular weight by viscometry:
- (a) Polyacrylamide-aq.NaNO2 solution
- (b) (Poly vinyl proplylidine (PVP) in water

2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.

3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).

4. Testing of mechanical properties of polymers.

5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

- 1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
- 2. Instrumental Techniques
- 3. IR studies of polymers
- 4. DSC analysis of polymers
- 5. Preparation of polyacrylamide and its electrophoresis
- *at least 7 experiments to be carried out.

Reference Books:

- Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
- Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
- Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
- Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
- Petr Munk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
- L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
- Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
- Seymour/ Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide

Alternative Green solvents

- 6. Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice.
- 7. Mechanochemical solvent free synthesis of azomethines

Alternative sources of energy

- 8. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).
- 9. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

- Anastas, P.T and Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press, 1998
- · Kirchoff, M. and Ryan M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC, 2002
- Ryan, M.A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical
- Society, Washington DC, 2002
 Sharma, R.K.; Sidhwani, I.T. and Chaudhari, M.K. Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi, Bangalore ISBN 978-93-81141-55-7, 2013
- Cann, M.C. and Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society, 2008
- Cann, M. G. and Thomas, P. Real world cases in Green Chemistry, American Chemical Society, 2008
- Lancaster, Mike Green Chemistry: An introductory text: 2nd Ed. RSC publishing, ISBN 978-1-84755-873-2
- Pavia, D.L., Kriz, G.S., Lampman, G.M. and Engels, R.G. Introduction to Organic Laboratory Techniques - a Microscale Approach 4th Ed., Brooks-Cole Laboratory Series for Organic Chemistry, 2006

CHEMISTRY-DSE: INDUSTRIAL CHEMICALS AND

ENVIRONMENT

(Credits: Theory-04, Practicals-02)

DSE-TI, both Semester (AM)

Theory: 60 Lectures

Industrial Gases and Inorganic Chemicals



Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

(10 Lectures)

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

II-ful Environment and its segments

(4 Lectures)

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases. Methods of estimation of CO, NOx, SOx and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates. -

Unit-111 Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer,

Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water. UND TIV

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis

VM-E

(10 Lectures)

(30 Lectures)

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

(6 Lectures)

Reference Books:

E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.

 R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.

J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.

S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New

Delhi.

- K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, Environmental Chemistry, CRC Press (2005).
- G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
- A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).

CHEMISTRY PRACTICAL - DSE LAB: INDUSTRIAL CHEMICALS & ENVIRONMENT

60 Lectures

- Determination of dissolved oxygen in water.
- 2. Determination of Chemical Oxygen Demand (COD)
- 3. Determination of Biological Oxygen Demand (BOD)
- Percentage of available chlorine in bleaching powder.
- 5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO₃ and potassium chromate).
- 6. Estimation of total alkalinity of water samples (CO₃ ²⁻, HCO₃) using double titration method.
- Measurement of dissolved CO2.
- Study of some of the common bio-indicators of pollution.
- Estimation of SPM in air samples.
- Preparation of borax/ boric acid.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New
- K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.

CHEMISTRY-DSE: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS
(Credits: Theory-04, Practicals-02)

Theory: 60 Dectures

UND-1-7

Introduction to spectroscopic methods of analysis:

Recap of the spectroscopic methods covered in detail in the core chemistry syllabus: Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation.

PROJECTON CHEMISTO



(4 Lectures)

(16 Lectures)

Molecular spectroscopy:

Infrared spectroscopy:

Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection. UV-Visible/Nea IR - emission, absorption, fluorescence and photoaccoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, didde arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoaccoustic, fluoresdent tags).

Separation techniques

Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to -IR and MS), Electrophoresis (plates and capillary) and use-with DNA analysis.

Immunoassays and DNA techniques

Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, - Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

Elemental analysis:

Mass spectrometry (electrical discharges).

Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength resolution (dependence on technique), (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, Detection of radiation matrix effects, other interferences).

NMR spectroscopy: Principle, Instrumentation, Factors affecting chemical shift, Spincoupling,

Electroanalytical Methods: Potentiometry & Voltammetry

(4 Lectures)

(16 Lectures)

Radiochemical Methods

(4 Lectures)

X-ray analysis and electron spectroscopy (surface analysis)

(4 Lectures)

Reference books:

(4 Lectures)

PHARMACEUTICAL CHEMISTRY (Credits: 02) 4th Semester

(Hands on Exercises: 60 Lectures)

Skill Enhance Course-II

Drugs & Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).

Fermentation

Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.

Practicals

1.Preparation of Aspirin and its analysis.

. Proparation of magnesium bisineate (Antao

Reference Books:

G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK.

Hakishan, V.K. Kapoor: Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi.

•William O. Foye, Thomas L., Lemke, David A. William: Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd. New Delhi.

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CORE COURSES B.Sc. (Honours)-Mathematics

Semester-I Core-I, Calculus-I

(Total Marks: 100)

Part-I (Marks: 75)

(Theory: 60 Marks+Mid-Sem: 15 Marks)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

12 marks

Hyperbolic functions, Higher order derivatives, Leibniz rule and its applications to problems of the type $e^{ax} \sin(bx+c)$; $e^{ax} \cos(bx+c)$; $e^{m \sin^{-1} x}$; $(\tan^{-1} x)^2 etc$ L'Hospital's rule.

Unit-II

12 marks

Asymptotes, Curvature. Curve tracing in Standard curves as Astroid, Epicycloids, Cardioids, Limacon, Cycloid, Descrates Folium etc (simple curves)

Unit-III

12 marks

Reduction formulae, derivations and illustrations of reduction formula of the type $\int sin^n x \, dx$, $\int \cos^n x \, dx$, $\int \tan^n x \, dx$, $\int \cot^n x \, dx$, $\int \sec^n x \, dx$, $\int \csc^n x \, dx$, $\int \sin^n x \cos^n x \, dx$. Arc length and area (Cartesian form, Polar form and Parametric form), Volume and Surface of revolution.

Unit-IV

Gradient, Divergence and curl and formulae, tangent plane and normal plane.

Unit-V

12 marks

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

Part-II(Practical, Marks:25)

(viva - 5 marks, Record - 5 marks, Experiment - 15 marks)

List of Practical's (Using any software) Practical/Lab work to be performed on a Computer

- Tracing of conics in Cartesian co-ordinates (ex- Astroid, Cissoids, Cartenary.).
- 2. Tracing of conics in Polar co- ordinates (Lemniscates of Bernoulli, $r = a \sin 2\theta, r^2 =$ $a^2 cos 2\theta$)
- 3. Sketching parametric curves (cycloid, x = a(t + sint), y = a(1 + cost))

4. Plotting of e^x , 2^x , $\frac{1}{2x+1}$

Matrix operation (addition, multiplication, inverse, transpose).

- Books Recommended 1. Topics in Calculus By R.K. Panda & P.K.Satpathy. S.G.Publications, Puri Ch-1, Ch- 2.1 to 2.17, 2.2, Ch-5, Ch-6.1 to 6.9.
- 2. Integral Calculus by Gorakh Prasad & Chandrika Prasad:- Chap- 4

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- 3. Differential Calculus by Gorakh Prasad & Chandrika Prasad:- Chap-5
- 4. Differential Calculus by B.C. Das & Mukherjee:- L'Hospital's rule & Leibniz rule

Books for Reference:

- M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd.(Pearson Education), Delhi, 2007: Chapters:4(4.3,4.4,4.5 & 4.7), 9(9.4), 10(10.1-10.4)
- 2. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002: Chapters: 6, (6.2-6.5), 7(7.8), 8(8.2-8.3, Pages: 532-538), 11(11.1), 13(13.5)
- 3. Analytical Geometry of Quadratic Surfaces, B.P. Acharya and D.C. Sahu, Kalyani Publishers, New Delhi, Ludhiana.
- 4. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005:
- 5. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989
- 6. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.

Semester-I

Core-II, Algebra-I

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d)

having equal marks.)

Unit-I

16 Marks

Polar representation of complex numbers, n-th roots of unity, De Moivers theorem for rational indices and its applications.

Unit-II

16 Marks

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit-III

16 Marks

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax = b; solution sets of linear systems, applications of linear systems, linear independence. 16 Marks

Unit-IV

Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of Rn,

Unit-V

16 Marks

Dimension of subspaces of Rn and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Books Recommended:

- Higher Engineering Mathematics by B.S. Grewal:- Chap-19.1,19.5,19.6.
- 2. Topics in algebra by S. Padhy, Lokanath Sahu. Kalyani Publishers Ch 1.6-1.11, Ch 2.1-2.1.2, 2.1.5, 2.1.6, Lemma 2.1.1.
- Basic Structures in Algebra by J. N. Patnaik (Linear Algebra):- Chapter 3.2 to 3.8.1, 3.8.8 to 3.9.5, 3.9.8 to 3.10, 3.10.3.
- 4. An introduction to Linear Algebra By V. Krishnamurthy, V.P.Mainra, J.L.Arora Affiliated East-west press Pvt Ltd, New Delhi:- Ch 4.1.1, 4.1.2, 4.1.4 to 4.1.5, 4.2.2, 4.3.1, 4.4.3, 5.7, 6.8.

Books for Reference:

- L.V. Ahlfors, Complex Analysis, McGraw-Hill (International Student Edn.)
- 2. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006:
- 3. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005: Chapters:2(2.4), 3,4(4.1-
- 4.1.6,4.2-4.2.11, 4.4(4.1-4.4.8),4.3-4.3.9, 5(5.1-5.1.4).

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Semester-II Core-III, Real Analysis (Analysis-I)

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

16 Marks

Review of Algebraic and Order Properties of R; Neighborhood of a point in R; Idea of countable sets, uncountable sets and uncountability of R: Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.(Except Dedekind)

Unit-II

16 Marks

The Completeness Property of R; The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrasstheorem for sets.

Unit-III

16 Marks

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchys Convergence Criterion.

Unit-IV

16 Marks

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Raabe's Test.

Unit-V

16 Marks

Cauchys n-th root test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Book Recommended:

 S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications ch-1(excluding 4.3, 4.4), ch-3 (excluding art 3, art7), ch-4 (excluding art 7,8,9,10.3-10.4,11).

Books for References:

 R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons(Asia) Pvt. Ltd., Singapore, 2002

 G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Pub-lishing Co., Chapters: 2(2.1 to 2.4, 2.5 to 2.7), 3(3.1-3.5), 4(4.1 to 4.7, 4.10, 4.11,4.12, 4.13).

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SEMESTER-II

CORE-IV, Differential Equations

(Total Marks: 100)

Part-I (Marks:75)

Theory: 60 Marks+Mid-Sem:15 Marks 04 Lectures (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d)

having equal marks.)

Unit-I

12 marks

Differential equations and mathematical models. First order and 1st degree ODE (variables separable, homogeneous, exact, and linear). Equations of 1st order but of higher degree. Applications of 1st order differential equations (Growth, Decay and Chemical Reactions, Heat ow, Oxygen debt, Economics).

Unit-II

12 marks

Second order linear equations (homogeneous and non-homogeneous) with constant coefficients, 12 marks

Unit-III

Second order equations with variable coefficients, variation of parameters, (Wronskion)method of undetermined coefficients, equations reducible to linear equations with constant coefficients, Euler's equation. Applications of second order differential equations, Legendre equation.

Unit-IV

12 marks

Power series solutions of second order differential equations. Legendre, Bessel's series solutions. (excluding polynomial)

Unit-V

12 marks

Laplace transforms and its applications to solutions of differential equations.

Part-II(Practical: Marks:25)

(viva - 5 marks, Record - 5 marks, Experiment - 15 marks) List of Practical's (Using any Software) Practical/Lab work to be performed on a Computer.

- Growth model (exponential case only). Doubling time period.
- Decay model (exponential case only). Half life time
- Oxygen debt model.
- Economic model.
- Vibration problems.(Undamped SHM)
- 6. Malthusian law of population Growth.

Book Recommended:

1. J. Sinha Roy and S. Padhy, A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi. Chapters: 1, 2(2.1 to 2.7), 3(excluding 3.6, 3.8), 4(4.1 to 4.7), 5, 7(7.1-7.4), 9(9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.12, 9.13). Books for References:

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1. Martin Braun, Differential Equations and their Applications, Springer International.

2. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.

3. G. Dennis Zill-A First Course in Differential Equations with Modelling Applications

Semester-III CORE -V: Theory of Real Functions (Analysis-II)

Total Marks: 100

Theory: 80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having

equal marks.)

Unit-I

Limits of functions ($\epsilon - \delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity.

Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, nonuniform continuity criteria, uniform continuity theorem.

Unit-III

Relative extrema, interior extremum theorem. Rolles theorem, Mean value theorem, Cauchy's mean value theorem, intermediate value property of derivatives. Applications of mean value theorem to inequalities.

Unit-IV

Approximation of polynomials, Taylor's theorem to inequalities. Maclaurins theorem and problems, Taylor's theorem with Lagrange's form of remainder, Taylors theorem with Cauchys form of remainder.

Unit-V

Application of Taylors theorem to convex functions, relative extrema. Taylors series and Maclaurins series expansions of exponential and trigonometric functions, ln(1 + x); 1/(ax + b)and $(1 + x)^n$:

Book Recommended:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications ch-5, ch-6 (excluding art 4), ch-7 (excluding art 2)

Books for References:

- 1. . G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Pub-lishing Co., Chapters:6(6.1-6.8), 7(7.1-7.7),
- 2. R. Bartle and D.R. Sherbet, Introduction to Real Analysis, John Wiley and Sons, 2003.
- 3. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
- 4. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
- 5. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.

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SEMESTER-III

CORE-VI: Group Theory (Algebra-II)

Total Marks: 100

Theory: 80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having

equal marks.)

Unit-I

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups. Subgroups and examples of subgroups.

Centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.

Unit-III

Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagranges theorem and consequences including Fermats Little theorem.

Unit-IV

External direct product of a finite number of groups, normal subgroups, factor groups, Cauchys theorem for finite abelian groups.

Unit-V

Group homeomorphisms, properties of homomorphism's, Cayleys theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Book Recommended:

1. Topics in Algebra by S.Padhi, L. Sahoo By Kalyani Publishers ch-3 (excluding 3.8.3 to 3.9, 3.11)

Books for References:

- 1. Joseph A. Gallian, Contemporary Abstract Algebra(4th Edn.), Narosa Publishing House, New
- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- 2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- 3. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
- I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

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SEMESTER-III

CORE-VII:

Partial Differential Equations and Systems of Ordinary Differential Equations (Total Marks: 100)

Part-I (Marks: 75)

Theory: 60 Marks+Mid-Sem: 15 Marks 04 Lectures (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

> Unit-I 12Marks

Homogeneous linear systems with constant coefficients (Two Equations in two unknown functions). Simultaneous linear 1st order equations in three variables, methods of solution, Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables.

> Unit-II 12Marks

Formation of 1st order partial differential equations, Linear and non-linear partial differential equations of 1st order, special types of 1st-order equations, Solutions of partial differential equations of 1st order satisfying given conditions.

Unit-III

Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients.

Unit-IV

Partial differential equations with variable coefficients, Separation of variables, Nonlinear equation of the second order. Laplace equation.

Unit-V

Solution of Laplace equation by separation of variables, Monge's method Rr+Ss+Tt=V One dimensional wave equation, Solution of the wave equation(method of separation of variables), Diffusion equation, Solution of one-dimensional diffusion equation, method of separation of variables.

Part-II(Practical: Marks:25)

List of Practical's (Using any Software)

Practical/Lab work to be performed on a Computer.

1. To find the general solution of the non-homogeneous system of the form: $\frac{dx}{dt} = a_1x + b_1y + f_1(t), \qquad \frac{dy}{dt} = a_2x + b_2y + f_2(t)$

$$\frac{dx}{dt} = a_1 x + b_1 y + f_1(t), \qquad \frac{dy}{dt} = a_2 x + b_2 y + f_2(t)$$

with given conditions.

- 2. Solutions of wave equations $\frac{\partial^2 u}{\partial t^2} c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions: a. $u(x,0) = \phi(x), u_t(x,0) = \psi(x), x \in R, t > 0$.

 - b. $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u_x(0,t) = 0, x \in (0,\infty), t > 0.$
 - c. $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u(0,t) = 0, x \in (0,\infty), t > 0.$

d. $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u(0,t) = 0, u(1,t) = 0, 0 < x < l, t > 0.$

3. Solutions of wave equation $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

a. $u(x,0) = \phi(x), u(0,t) = a, u(l,t) = b, 0 < x < l, t > 0.$

b. $u(x,0) = \phi(x), x \in R, 0 < t < T.$

c. $u(x,0) = \phi(x), u(0,t) = a, x \in (0,\infty), t \ge 0.$

Book Recommended:

1. J.Sinha Roy and S. Padhy, A Course on Ordinary and Partial Defferential Equations, KalyaniPublishers, New Delhi, Ludhiana, 2012:-Chapters:11 (excluding method iv, 11.3 Natani's method)

2. Mathematics for degree students by Dr. P.K.Mittal, S.chand & co.Ltd, New delhi Ch-9, ch-10 (excluding 10.4), ch-11 (excluding 11.8 to 11.10), ch-12 (excluding 12.3)

Books for References:

1. Tyn Myint-U and Lokenath Debnath, Linear Partial Di_erential Equations for Scientists and En-gineers, 4th edition, Springer, Indian reprint, 2006.

2. S.L. Ross, Di_erential equations, 3rd Ed., John Wiley and Sons, India, 2004.

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Semester-IV Core-VIII

Numerical Methods

(Total Marks: 100)

Part-I(Marks:75)

Theory:60 Marks+Mid-Sem:15 Marks

04 Lectures (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d)

having equal marks.)

Unit-1

12 Marks

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's Raphson method,

Unit-II

12 Marks

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method.

Unit-III

12 Marks

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

Unit-IV

12 Marks

Numerical Integration: Trapezoidal rule, Simpsons 1/3rd rule, Simpsons 3/8th rule.

Unit-V

12 Marks

Ordinary Differential Equations: Euler method, Picard's method, Runge-Kutta methods of orders two and four.

Part-II(Practical: Marks:25)

List of Practicals (Using any Software) Practical/Lab work to be performed on a Computer

- 1. Enter 100 integers into an array and sort them in an ascending order and desending
- 2. Bisection Method.
- 3. Newton Raphson Method...
- Gauss-Siedel Method.
- Lagrange Interpolation or Newton Interpolation.
- Simpsons rule.
- Roots of Quadratic Equation.

Note: For any of the CAS (Computer aided software) Data types-simple data types, oating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and

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logical expressions, control state-ments and loop statements, Arrays should be introduced to the students.

Book Recommended:

1. Introductory Numerical Analysis by dr. N Datta & R.N.Jena, Sreedhar Prakashan, Kolkotta - Ch -I(except theorems), Ch-II (upto 2.15), Ch-III (3.7 to 3.14), Ch-IV (4.3 to 4.6), Ch-V (upto 5.3, 5.7), Ch-VI (6.1 to 6.3)

Books for reference:

1. B.P. Acharya and R.N. Das, A Course on Numerical Analysis, Kalyani Publishers, New Delhi, Ludhiana. Chapters: I, 2(2.1 to 2.4, 2.6, 2.8, 2.9), 3(3.1 to 3.4, 3.6 to 3.8, 3.10), 4(4.1, 4.2), 5(5.1, 5.2, 5.3), 6(6.1, 6.2, 6.3, 6.10, 6.11), 7(7.1, 7.2, 7.3, 7.4 &7.7).

2. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

Semester-IV

Riemann Integration and Series of Functions (Analysis-III)

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

16 marks

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemannsum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions.Intermediate Value theorem for Integrals; Fundamental theorems of

Unit-II

16 marks

Improper integrals; Convergence of Beta and Gamma functions.

Unit-III

16 marks

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability andintegrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniformconvergence and Weierstrass M-Test.

Unit-IV

16 marks

Limit superior and Limit inferior. Power series, radius of convergence; Abels Theorem; Weierstrass Approximation Theorem.

Unit-V

16 Marks

Fourier Series

Book Recommended:

- 1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Ltd., New Delhi. ch-9 (upto 10.2), ch-11(upto 4.4 and Problems of poisson's integral and Dirichlet's integral), Ch-12 (upto 3.2, upto theorem 4).
- 2. B.S.Grewell Higher engineering mathematics, 38th Edition:- Ch-10 (upto 10.7)

Engineering Mathematics by Erwin Kreyszig :- Ch-14(14.1, 14.2).

Books for References:

1. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

Semester-IV Core-X

Ring Theory and Linear Algebra-I(Analysis-III)

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-l

16 Marks

Definition and examples of rings, some special classes of rings, Defⁿ of Field, properties of rings, sub rings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals.

Unit-II

16 marks

Ring homomorphism's, properties of ring homomorphism's, Isomorphism theorem.

Unit-III

Matrix associated with a linear map. Rank and Nullity of a Matrix, transpose of a matrix, Elementary Row operations, matrix inversion.

Unit-IV

16 Marks

Determinant Minors and rank of a matrix, Product of determinants, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Unit-V

16 Marks

Euclidean Spaces and Inner Products, subspaces.

Book Recommended:

- Mathematics for degree students(1st year) by Dr. P.K.Mittal by S.Chand & Co. Ltd-Chap-14, Chap-15
- 2. Basic Structures in Algebra by J.N. Patnaik, Kalyani Publishers:- Ch-4 (Excluding
- 3. 1. V. Krishnamurthy, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 5(5.1, 5.2, 5.5, 5.6, 5.7, 5.9), 6(6.1, 6.2, 6.5, 6.6, 6.8).

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Books for Reference:

1. Joseph A. Gallian, Contemporary Abstract Algebra(4th Edn.), Narosa Publishing House, New Delhi. Chapters:12, 13, 14, 15.

Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004. Chapters: 1 (1.2-1.6), 2(2.1-2.5).

3. I.N. Herstein-Topics in Algebra, Wiley Eastern Pvt. Ltd.

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- R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia)Pvt. Ltd., Singapore, 2002.
- G. Das and S. Pattanayak-Fundamentals of Mathematics Analysis, TMH Publishing Co., Chapters:8, 9.10

Semester-V CORE-XI

Multivariate Calculus (Calculus-II)

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.) 16 Marks Unit-l

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, Derivative of composite functions, change of variables. Chain rule for one and two independent parameters. Taylor's theorem, Maclaurin's theorem for two variables.

Unit-II

16 marks

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

Unit-III

16 marks

Definition of vector field, divergence and curl.

Unit-IV

16 marks

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates,line integral, Change of variables in double integrals. Change of order of integration, Green's theorem (without proof)

Unit-V

16 marks

Length of curve, Mass and Work. surface integrals, integrals over parametrically defined surfaces. Stokes theorem, Gauss Divergence theorem.(without proof of theorems). Volume by triple integral.

Books Recommended:

- 1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Ltd., New Delhi. Ch-15 (upto 3.1, 5, 5.1, 7.2, 8, 9, 10 to 10.2), ch-16 (2, 3, 3.2), Ch-17 (upto 1.4, 2.8, 3.4, 4,5) Ch-18 (1.3, 2.2, 3.1, 5, 7.7)
- 2. Advanced Integral Calculus by J.K.Gayal, K. P. Gupta, Pragati Prakasan, Meerut.
- 3. Topics in calculus by R.K.Panda &P.K.Satapathy :- Chap-6 (6.15 to 6.17) Books for Reference:
 - 1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), Delhi, 2007. Chapters: 11(11.1(Pages: 541-543), 11.2-11.6, 11.7(Pages:598-605), 11.8(Pages:610-614)), 12 (12.1, -12.3, 12.4(Pages:652-660), 12.5, 12.6), 13 (13.2, 13.3,13.4(Pages:712-716), 13.5(Pages:723-726; 729-730), 13.6 (Pages:733-737), 13.7(Pages:742-745))

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Semester-V CORE-XII

Mathematical Modelling

Total Marks: 100

Theory: 80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d)

having equal marks.)

Unit-I

16 Marks

Mathematical Modelling through differential equations1st order, linear growth and decay models, non-linear growth and decay models, compartment models, Growth of scientists, Mathematical Modelling (Effect of Immigration and Emigration on population size), Newton's law of Cooling, Fick's Law of Diffusion, Change of Price Commodity, Spread of Technological Innovations and infections Diseases, Orthogonal Trajectories, SHM.

Unit-II

16 Marks

Mathematical Modelling in Dynamics through ordinary Differential equation of 1st order, Motion under gravity in a resisting medium, Motion of a rocket, Mathematical Modelling in population dynamics, competition model, Diffusion of Glucose or medicine in the Blood stream.

Unit-III

16 Marks

Mathematical Modelling of Epidemics through system of ordinary differential equation of 1st order (A simple Epidemic model, SIS model, SIS with constant number of carriers), Richardson's model for arms races, Lanchester's combat model.

Mathematical Modelling in Economics based on systems of ordinary differential Unit-IV equations of first order (Domar macro model, Domar first debt model, second debt model, Allen's speculative model) Motion of projectiles, Mathematical Modelling of Rectilinear motion,

Unit -V

Mathematical Modelling of Planetary motions, Components of velocity and Acceleration Vectors along Radial and Transverse Directions, Motion Under a central forces, Motion under the inverse square law, Kepler's Laws of planetary motion, Circular Motion & satellites, Circular motion of satellites, Catenary, A curve of pursuit.

Books Recommended:

1. J.N. Kapur-Mathematical Modelling, Ch-2(Exculding 2.4.3), ch- 3(excluding 3.1.3, 3.1.4, 3.2.5, 3.2.6, 3.3, 3.4.5- 3.4.8), Ch-4 (Excluding 4.2.4, 4.3.3)

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Semester-VI

CORE-XIII

Metric Spaces and Complex Analysis (Analysis-IV)

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

16 Marks

Metric spaces: definition and examples. Spheres, diameter of a non empty set, bounded metric space, open sets, closed sets, open and closed spheres, derived set and theorems...

Unit-II

16 Marks

Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Analytical function, examples of analytical functions.

Unit-III

16 Marks

Complex integration, cauchy's theorem. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem, Cauchy integral formula.

Unit-IV

16 Marks

Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.

Unit-V

16 Marks

Calculus of Residues (unit circle method and upper half of large semicircle method).

Books Recommended:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Ltd., New Delhi:- Ch- 19(upto 2.5 closed sets upto theorem 4.(excluding Euclidean metric space, Hilbert space, subspaces etc.)

2. Engineering mathematics by B.S.Grewell :- Ch 20 (excluding 20.7-20.11, 20.15 (1), (2), (3), (4)), integration around a small semi-circle, rectangular contours, indenting contours having pole on real line).

Books for Reference:

1. P.K. Jain and K. Ahmad, Metric Spaces, Narosa Publishing House, New Delhi. Chapters: 2(1-

9),3(1-4), 4(1-4), 6(1-2), 7(1 only). 2. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGrawHill International Edition, 2009. Chapters: 1(11 only), 2(12,13), 2(15-22, 24, 25), 3(29, 30, 34)4(37-41, 43-46, 50-53), 5(55-60, 62,63,66).

Books for References:

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Semester-VI CORE-XIV

Linear Programming

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks 5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

16 Marks

Basic of Operations research, Scope, Phase, Models of Operation Research. Classification of models, Linear Programming, Formulation of LP problems, Sensitivity Analysis, Graphical Method.

Unit-II

16 marks

Simplex Method Introduction, Definition, Simplex Algorithm.

Artificial Variables Technique, Charne's Big M Method, Duality in Linear Programming.

Transportation Problem Introduction Mathematical Formulation, Optimal solution, North West Corner Rule, Least Cost Or Matrix Minima Method.

16 Marks

Transhipment and Assignment Problems, Game theory.

Recommended Book.

1. Operations Research with C Programming by S.KalaVathy, Vikas Publishing House Pvt Ltd. Noida, New Delhi: Ch-1, Ch-2 (upto 2.3 Excluding 2.3.1, 2.3.2), Ch-3, Ch-4, Ch-5 (upto 5.2), Ch-6, Ch-8 (upto 8.4.2), Ch-9 (upto 9.6), Ch-19 (upto 19.4)

Books for Reference:

- 1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows,2nd Ed., John Wiley and Sons, India, 2004. Chapters:3(3.2-3.3, 3.5-3.8), 4(4.1-4.4),
- 2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009. Chapter: 14
- 3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., PrenticeHall India, 2006.

DISCIPLINE SPECIFIC ELECTIVE(DSE)

SEMESTER-V DSE-I

Analytical Geometry

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

Co-ordinates of a point in space, distance between two points, division of the join of two points, angle between two lines, projection on a straight line, general equation of plane, intercept form, normal form, passing through one point, three points, two sides of a plane, length of the perpendicular from a point to a plane, bisectors of angles between two planes.

Unit-II

16 Mark

Right line- representation of a line, equation of line through on point drawn in a direction, equation of line through two points, transformation from unsymmetric form to symmetric form, condition for a line to lie in a plane, co-planer lines, shortest distance between two lines, length of the perpendicular from a point to a line.

Unit-III

16 Marks

Equation of a sphere, sphere through four given points, plane sections of a sphere, intersection of two spheres, sphere with a given diameter, equation of circle, sphere through a given circle, intersection of a sphere and a line, equation of a tangent plane.

16 Marks

Unit-IV Equation of a cone, enveloping cone of a sphere, quadric cones with vertex at origin, condition for tangency, the right circular cone.

16 Marks

Equation of a cylinder, enveloping cylinder, the right circular cylinder, intersection of a Unit-V line with a conicoid, tangent lines and tangent plane at a point, condition of tangency, director sphere.

Books Recommended

1. Analytical Solid Geometry, Shanti Narayan:-Ch- 1(excluding 1.4, 1.8.1 to1.8.3), Ch-2(upto 2.71), Ch-3 (excluding 3.5, 3.8) Ch-6.11-6.6, Ch-7.1-7.14, 7.42,7.43,7.6 to 7.82, Ch-8.1,8.3 to 8.33,

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SEMESTER-V DSE-II

Probability & Statistics

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student)

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having Unit-I

16 Marks

Sample Space, Probability axioms, real random variables (discrete & continuous), Probability measure, Conditioning and independence, Basic properties, Baye's theorem,

Random variables, Probability function, Distribution function, density function, Unit-II Mathematical expectation, moments, Probability Generating Function, Mean and Variance.

Discrete Distribution, Uniform, Binomial, Poisson, Continuous distribution, uniform, Unit-III normal Distribution.

Chebyshev's inequality, Weak Law of large numbers, Bernoulli's theorem, Expectation of Unit-IV function of two variables, Expectation & Variance.

Unit-V

16 Marks

Correlation Coefficient, lines of regression for two variables.

Books Recommended:

1. Elements of Probability Theory by D. Pratihari, S.P.Mohanty:-Ch-3, Ch-4 (upto 4.3.5, 4.10 upto Example 20), Ch-5 (upto 5.4.1, 5.4.3, 5.5, 5.6), Ch-6 (upto 6.2.1, 6.3), Ch-8 (upto 8.5), Ch-9 (upto 9.2.3, 9.2.5, 9.2.6), Ch-10 (10.4.1). 2. Engineering Mathematics by B.S.Grewel :- Ch-23 (23.9 to 23.11)

SEMESTER-VI

DSE-III

Theory of Equations

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student.

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

16 Marks

General Properties of Polynomials and equations, Relations between roots and Coefficient of equations.

Unit-II

16 Marks

Symmetric functions of roots, Application of Symmetric function of the roots, Transformation of equations, Newton's theorem on sums of powers of roots.

Unit-III

16 Marks

Limits of the roots of equations, Sturms theorem, Newton's method to find Superior limits of positive and negative roots.

Unit-IV

16 Marks

Algebraic solutions of cubic equation by Cardon's method, solution of Biquadratic equation by Descarte's, Ferrari's method.

Unit-V

16 Marks

Descarte's rule of sign for positive roots & negative roots, repeated roots solution of reciprocal equations.

Books Recommended:

- 1. A Text Book of Algebra by Ravinder kumar and siri krishanwasan, pitamber publishing co.(pvt) ltd :- Ch-3
- 2. Higher Algebra by A. Kurosh, Moscow Mir Publications:- Art 39, 40.

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SEMESTER-VI

DSE-IV

Differential Geometry

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student.

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

16 marks

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae, Helices, Spherical indicatrices

Osculating spheres, Evolutes and involutes of curves, Tangent Plane, Envelope.

Fundamental Magnitudes of 1st order, Fundamental Magnitudes of 2nd order.

Unit-IV

16 marks

Principal and Gaussian curvatures. Lines of curvature, Minimal Surfaces, Developable Surfaces.

Unit-V

16 marks

Euler's Theorem, Dupin's theorem, Asymptotic Lines.

Book Recommended:

- 1. Elements of Mechanics and Differential Geometry by Maheswar Mishra, P.K.Satpathy, S.G.Publications, Cuttack:- Ch-1 (upto 1.14), Ch-2 (upto 2.10), Ch-3 (upto 3.6). Books for References
 - 1. C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.:- Chapters:1(1-4, 7,8,10), 2(13, 14, 16, 17), 3, 4(29-31, 35, 37, 38).
 - 2. B.P. Acharya and R.N. Das-Fundamentals of Di_erential Geometry, Kalyani Publishers,

SEMESTER -IV

Skill Enhancement Courses (SEC-II) (Credit: 2, Total Marks: 50)

Logic and Sets

Total Marks:50

Theory:40 Marks+Mid-Sem:10 Marks

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-1

8 Marks

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators.

Unit-II 8 marks Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers.

Unit-III

8 Marks

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, generalized union and intersections.

Unit-IV

8 Marks

Relation: Product of set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, n-ary relations.

Unit-V

8 Marks

Mathematical Induction Method.

Books Recommended:

Topics in Algebra, Cardinality set by Padhy & Sahu, Kalyani Pub. :- Ch-1

2. Fundamental Concepts of Analysis BY Alton H Smith, Walter A. Atbrechtjr Prentice Hall India Pvt.Ltd: Ch-3 (upto 3.8.7).

3. Discrete Mathematics BY Dr. J P Tripathy, B. K. Publications Pvt.Ltd Bhubaneswar: Ch-1, Ch-2 (2.2), Ch-4 (upto 4.2)

Books for Reference:

- 1. R.P. Grimaldi-Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998
- 2. P.R. Halmos-Naive Set Theory, Springer, 1974.
- 3. E. Kamke-Theory of Sets, Dover Publishers, 1950.

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CORE COURSE (HONOURS IN PHYSICS)

Semester I

PHYSICS-C I: MATHEMATICAL PHYSICS-I

(Credits: Theory-04, Practicals-02)

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

UNIT-I

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

Dirac Delta function and its properties:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

UNIT-II

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Comparison of velocity and acceleration in cylindrical and spherical coordinate system.

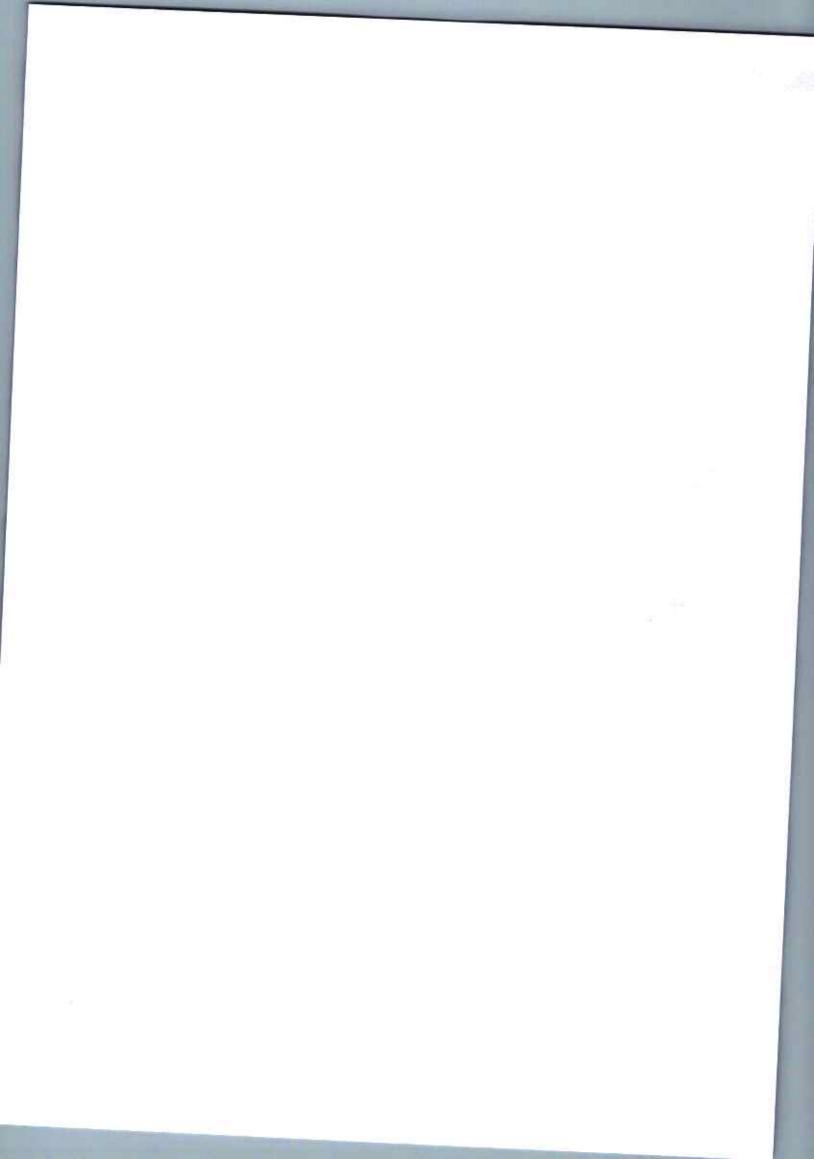
UNIT-III

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7th Edn., Reference Books: Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning



Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
Mathematical Physics and Special Relativity M. Das, P.K. Jena and B.K. Dash
Citation Prekashan) 2nd Edition 2009
Mathematical PhysicsH. K. Dass, Dr. Rama Verma (S. Chand Higher Academics)
6th Edition 2011.
Mathematical Physics -C. Harper, (Prentice Hall India) 2006.
Methamatical Physics-Goswami (Cengage Learning) 2014
Mathematical Method for Physical Sciences M. L. Boas (Wiley India) 2006

PHYSICS LAB- C I LAB:

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems
- The course will consist of lectures (both theory and practical) in the Lab
- ☐ Evaluation done not on the programming but on the basis of formulating the problem
- Aim at teaching students to construct the computational problem to be solved
- ☐ Students can use any one operating system Linux or Microsoft Windows

Topics	Description with Applications				
Introduction and Overview	Computer architecture and organization, memory and				
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow emphasize the importance of making equations in terms dimensionless variables, Iterative methods. Truncation and round off errors, Absolute and relative errors. Floating point computations.				
Errors and error Analysis					
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (Ifstatement. Ifelse Statement. Nested if Structure. Elseif Statement. Ternary Operator Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.				
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search				

Random number generation	Area of circle, area of square, volume of sphere, value of π .				
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving Type equation here. $A=\tan \alpha; I=I_0 \left(\frac{\sin \alpha}{\alpha}\right)^2 \text{ in optics}$				
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. $sin \theta$, $cos \theta$, $tan \theta$, etc .				
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop				
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta RK) second and fourth order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $dx/dt=y+x-x^3/3$; $dy/dx=-x$ for four initial conditions $x(0)=0, y(0)=-1, -2, -3, -4.$ Plot x vs y for each of the four initial conditions on the same screen for $0 \le t \le 15$ The differential equation describing the motion of a pendulum is $\frac{\partial^2 v}{\partial t^2} = -\sin v$ The pendulum is released from rest at an angular displacement α , i. e. $v(0) = \alpha \& v' = 0$. Solve the equation for $\alpha = 0.1, 0.5$ and 1.0 and plot \square as a function of time in the range $0 \le t \le 8\pi$. Also plot the analytic solution valid for small $v, \sin v = v$				

Referred Books:

... Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw---Hill Pub.

Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. 2007, Cambridge University Press.

A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.

Elementary Numerical Analysis, K.E. Atkinson, 3 rd Edn., 2007, Wiley India Edition.

Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub. An Introduction to computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press.

PHYSICS-C II: MECHANICS (Credits: Theory-04, Practicals-02)

UNIT-I

Rotational Dynamics: Centre of Mass and Laboratory frames. Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

UNIT-II

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

UNIT-III

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.

UNIT-IV

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

UNIT-V

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

Reference Books:			22 2	
An introduction to mechanics,	D.	Kleppner,	R.J	. Kolenkow.

1973, McGraw-Hill.

Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.

Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education

Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley

Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning
Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
Mechanics - J. C. Slater and N. H. Frank (McGraw-Hill)

PHYSICS LAB-C II LAB

- To study the random error in observations.
- 2. To determine the height of a building using a Sextant.
- 3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
- 4. To determine the Moment of Inertia of a Flywheel.
- 5. To determine g and velocity for a freely falling body using Digital Timing Technique
- 6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
- 7. To determine the Young's Modulus of a Wire by Optical Lever Method.
- 8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
- 9. To determine the elastic Constants of a wire by Searle's method.
- 10. To determine the value of g using Bar Pendulum.
- 11. To determine the value of g using Kater's Pendulum

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, AsiaPublishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal

Semester II

PHYSICS-C III: ELECTRICITY AND MAGNETISM (Credits: Theory-04, Practicals-02)

UNIT-I

Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor.

Capacitance: Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics.

UNIT-III

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

UNIT-IV

Magnetic Properties of Matter: Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field.

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to de circuits.

Reference	Books:
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Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

☐ Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
☐ Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
☐ Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
☐ Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
☐ Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

PHYSICS LAB-C III LAB

- Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d)
 Capacitances, and (e) Checking electrical fuses.
- 2. To study the characteristics of a series RC Circuit.
- 3. To determine an unknown Low Resistance using Potentiometer.
- 4. To determine an unknown Low Resistance using Carey Foster's Bridge.
- 5. To compare capacitances using De'Sauty's bridge.
- Measurement of field strength B and its variation in a solenoid (determine dB/dx)
- 7. To verify the Thevenin and Norton theorems.
- 8. To verify the Superposition, and Maximum power transfer theorems.
- 9. To determine self inductance of a coil by Anderson's bridge.
- 10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency,
- (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
- 11. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor Q.
- 12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
- 13. Determine a high resistance by leakage method using Ballistic Galvanometer.
- 14. To determine self-inductance of a coil by Rayleigh's method.
- 15. To determine the mutual inductance of two coils by Absolute method.

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
 Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,
 reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

PHYSICS-C IV: WAVES AND OPTICS (Credits: Theory-04, Practicals-02)

UNIT-I

Geometrical optics: Fermat's principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics. Idea of dispersion. Application to thick lense, Ramsden and

Huygens eyepiece.

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

UNIT-II

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens

Principle.Reflection and refraction from Hygen's principle.

Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism.

UNIT-III

Interference: Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

UNIT-IV

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

UNIT-V

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

☐ Geometrical and Physical Optics – R.S. Longhurst, Orient Blackswan, 01-Jan-1986

☐ Vibrations and Waves -- A. P. French, (CBS) Indian print 2003

Optics, E. Hecht (PearsonIndia)

PHYSICS LAB- C IV LAB

- 1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ_2 –T law.
- To investigate the motion of coupled oscillators.
- 3. To study Lissajous Figures.
- 4. Familiarization with: Schuster's focusing; determination of angle of prism.
- 5. To determine refractive index of the Material of a prism using sodium source.
- To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
- 7. To determine the wavelength of sodium source using Michelson's interferometer.
- 8. To determine wavelength of sodium light using Fresnel Biprism.
- 9. To determine wavelength of sodium light using Newton's Rings.
- 10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
- 11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
- 12. To determine dispersive power and resolving power of a plane diffraction grating.

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani

Semester III

PHYSICS-C V: MATHEMATICAL PHYSICS-II

(Credits: Theory-04, Practicals-02)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

UNIT-II

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

UNIT-III

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations: Legendre & Hermite Differential Equations. Properties of Legendre & Hermite Polynomials:

UNIT-IV Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Associated Legendre polynomials and spherical harmonics.

UNIT-V

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Conducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of a stretched string.

Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.	
Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.	
Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.	
Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.	
Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Bo	Pub. oks
Mathematical Physics and Special Relativity M. Das, P.K. Jena and B.K. Dash	
(Sailtrichne Prakashan) 2nd Edition 2009	
Mathematical PhysicsH. K. Dass, Dr. Rama Verma (S. Chand Higher Academics	,
6th Edition 2011. Mathematical Physics -C. Harper, (Prentice Hall India) 2006.	
Mathematical Physics-Goswami (CENGAGE Learning) 2014	
Mathematical Method for Physical Sciences M. L. Boas (Wiley India) 2006	

- Mathematics for Physicists, P. Dennery and A. Krzywicki Dover)
- Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.

PHYSICS LAB-C V LAB

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Topics	Description with Applications
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation. Fixed difference method	First order differential equation Radioactive decay Current in RC, LC circuits with DC source Newton's law of cooling Classical equations of motion Second order Differential Equation Harmonic oscillator (no friction) Damped Harmonic oscillator Over damped

	Critical damped	
	Oscillatory	
	Forced Harmonic oscillator	
	Transient and	
	Steady state solution	
	Apply above to LCR circuits also	
	• Solve $x^2 \frac{d^2 y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^3$	
	With boundary condition at x=1, y= $\frac{1}{2}$ e ² , $\frac{dy}{dx} = -\frac{3}{2}e^2 - \frac{1}{2}$	
	In the range 1 \le x \le 3. Plot y and $\frac{dy}{dx}$ against x in the given range	
	on the graph.	
Partial differential equations	Partial differential equations:	
1955-125	Wave equation	
	Heat equation	
	Poisson equation	
	Laplace equation	
Using Scicos / xcos	Generating square wave, sine wave, saw tooth wave	
C10 344/FH)	Solution to harmonic oscillator	
	Study of beat phenomenon	
	Phase space plots	

- ☐ Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.20 Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- ☐ Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

PHYSICS-C VI: THERMAL PHYSICS

(Credits: Theory-04, Practicals-02)

(Include related problems for each topic)

UNIT-I

Introduction to Thermodynamics

Recapitulation of Zeroth and First law of thermodynamics:

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. UNIT-II

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations

UNIT-III

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) Tds Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. Magnetic Work, Cooling due to adiabatic demagnetization, UNIT-IV

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

UNIT-V

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams..

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger.
1988, Narosa.
Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford
University Press
☐ Heat and Thermal Physics-Brijlal & Subramaiam (S.Chand Publication) 2014
☐ Thermal Physics C. Kittel and H. Kroemer (McMillan Education India) 2010

PHYSICS LAB- C VI LAB

- To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
- 2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
- 3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
- To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
- To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
- To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
- 7. To calibrate a thermocouple to measure temperature in a specified Range using
- (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
- 8. To determine J by Caloriemeter.

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

PHYSICS-C VII: DIGITAL SYSTEMS AND APPLICATIONS (Credits: Theory-04, Practicals-02)

UNIT-I

Integrated Circuits (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs.

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

UNIT-II

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

UNIT-III

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. UNIT-IV

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. (3 Lectures)

UNIT-V

Introduction to Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).

Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. Reference Books:

Reference Dooks:	
Digital Principles and Applications, A	A.P. Malvino, D.P.Leach and Saha, 7th Ed.,
2011, Tata McGraw	, and and a series of the seri
Fundamentals of Digital Circuits, An	and Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
 Digital Circuits and systems, Venugo 	pal, 2011, Tata McGraw Hill.
Digital Systems: Principles & Application	ations, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
Logic circuit design, Shimon P. Vings	ron, 2012, Springer.
 Digital Electronics, Subrata Ghoshal, 	
Microprocessor Architecture Program	iming & applications with 8085, 2002, R.S.
Goankar, Prentice Hall,	
Concept of Electronics: D.C.Tayal (H	imalay Publication) 2011
Electronics-V. K. Meheta (S. Chand F	

The Art of Electronics, P. Horowitz and W. Hill, CUP

PHYSICS PRACTICAL-C VII LAB

- 1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
- 2. To test a Diode and Transistor using a Multimeter.
- 3. To design a switch (NOT gate) using a transistor.
- To verify and design AND, OR, NOT and XOR gates using NAND gates.
- 5. To design a combinational logic system for a specified Truth Table.
- 6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
- 7. To minimize a given logic circuit.
- 8. Half Adder, Full Adder and 4-bit binary Adder.
- 9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
- 10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
- 11. To build JK Master-slave flip-flop using Flip-Flop ICs
- 12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
- 13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
- 14. To design an astable multivibrator of given specifications using 555 Timer.
- 15. To design a monostable multivibrator of given specifications using 555 Timer.

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

Semester IV

PHYSICS-VIII: MATHEMATICAL PHYSICS-III

(Credits: Theory-04, Practicals-02)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions.

UNIT-II

Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

UNIT-III

Integrals Transforms:

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples.

UNIT-IV

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT.

UNIT-V

Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- · Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.
- · Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Complex Variables, A. S. Fokas & M. J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003,
 Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
- Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition 2011.
- Mathematical Physics –C. Harper, (Prentice Hall India) 2006.

Mathematical Physics-Goswami (Cengage Learning) 2014

•Mathematical Method for Physical Sciences -- M. L. Boas (Wiley India) 2006

Introduction to the theory of functions of a complex variable- E.T.Copson (Oxford) Univ.
 Press, 1970

PHYSICS PRACTICAL-C VIII LAB

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:

$$dy/dx = e^{-x}$$
 with $y = 0$ for $x = 0$

$$dy/dx + e^{-x}y = x^2$$

$$d^2y/dt^2 + 2 dy/dt = -y$$

$$d^2y/dt^2 + e^{-t}dy/dt = -y$$

2. Dirac Delta Function:

Evaluate
$$\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{\frac{-(x-2)^2}{2\sigma^2}} (x+3) dx$$
 for $\sigma = 1, 0, 1, 0, 0.01$ and show it tends to 5

3. Fourier Series:

Program to sum $\sum_{n=1}^{\infty} (0.2)^n$

Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:

$$\int_{-1}^{1} p_n(\mu) p_m(\mu) d\mu = \delta n, m$$

Plot $P_n(x)$, $J_v(x)$

Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of

least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. $\sin \theta$, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.

8. Integral transform: FFT of e-x2

Reference Books:

 Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press

Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications

 Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444

· Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company

Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing



PHYSICS-C IX: ELEMENTS OF MODERN PHYSICS

(Credits: Theory-04, Practicals-02)

UNIT-I

Atomic Spectra and Models

Inadequacy of classical physics, Brief Review of Black body Radiation, Photoelectric effect, Compton effect, Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle. Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations, Bohr's model of H atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Expt. Sommerfeld's Modification of Bohr's Theory. (13 Lectures)

UNIT-II

Wave Particle Duality

Dual nature of radiation, wave nature of particles. de Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity. Superposition of two waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time.

UNIT-III

Time development of a wave Packet; Heisenberg Uncertainty Principle, Illustration of the Principle through thought Experiments of Gamma ray microscope and electron diffraction through a slit. Estimation of ground state energy of harmonic oscillator and hydrogen atom, non existence of electron in the nucleus. Uncertainty and Complementarities.

UNIT-IV

Nuclear Physics

Size and structure of atomic nucleus and its relation with atomic weight; Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

UNIT-V

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Gamow's theory of Alpha decay; Beta decay(qualitative idea only)- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- · Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
- Modern Physics Bernstein, Fishbane and Gasiorowicz (Pearson India) 2010
- Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles -- R. Eisberg (Wiley India)
 2012

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.

- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K. Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill
- Modern Physics-Serway (CENGAGE Learnings) 2014
- •Modern Physics --- Murugesan and Sivaprasad -(S. Chand Higher Academics)
- Physics of Atoms and Molecules Bransden (Pearson India) 2003

PHYSICS PRACTICAL-C IX LAB

- 1. Measurement of Planck's constant using black body radiation and photo-detector
- Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
- 3. To determine work function of material of filament of directly heated vacuumdiode.
- 4. To determine the Planck's constant using LEDs of at least 4 different colours.
- 5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
- 6. To determine the ionization potential of mercury.
- 7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
- 8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
- 9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
- 10. To show the tunneling effect in tunnel diode using I-V characteristics.
- 11. To determine the wavelength of laser source using diffraction of single slit.
- 12. To determine the wavelength of laser source using diffraction of double slits.
- 13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal

PHYSICS-C X: ANALOG SYSTEMS AND APPLICATIONS (Credits: Theory-04, Practicals-02)

UNIT-I

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

UNIT-II

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β . Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

UNIT-III

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers.

Coupled Amplifier: RC-coupled amplifier and its frequency response.

UNIT-IV

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

UNIT-V

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

- · Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- · Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- · Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn., 2009, PHI Learning
- · Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- · OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- · Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk, 2008, Springer
- · Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
- Concept of Electronics: D.C. Tayal (Himalay Publication) 2011
- Electronic devices: Circuits and Applications: W.D. Stanley Prentice Hall
- Electronics- V. K. Meheta (S. Chand Publication)2013
- Electronic Circuits: L.Schilling and Velove: 3rd Ed Mc Graw Hill

- · Electronics-Raskhit & Chattopadhyay (New age International Publication)2011
- Electricity and Electronic-D.C. Tayal (Himalaya Pub.)2011
- •Electronic devices and circuits -R.L. Boylstad (Pearson India) 2009

PHYSICS PRACTICAL-C X LAB

- 1. To study V-I characteristics of PN junction diode, and Light emitting diode.
- 2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
- 3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
- 4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
- 5. To study the various biasing configurations of BJT for normal class A operation.
- 6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
- 7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
- 8. To design a Wien bridge oscillator for given frequency using an op-amp.
- 9. To design a phase shift oscillator of given specifications using BJT.
- 10. To study the Colpitt's oscillator.
- 11. To design a digital to analog converter (DAC) of given specifications.
- 12. To study the analog to digital convertor (ADC) IC.
- 13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
- 14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
- 15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
- 16. To study the zero-crossing detector and comparator
- 17. To add two dc voltages using Op-amp in inverting and non-inverting mode
- 18. To design a precision Differential amplifier of given I/O specification using Op-amp.
- 19. To investigate the use of an op-amp as an Integrator.
- 20. To investigate the use of an op-amp as a Differentiator.
- 21. To design a circuit to simulate the solution of a 1st/2nd order differential equation.

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
- Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

Semester V

PHYSICS-C XI: QUANTUM MECHANICS AND APPLICATIONS (Credits: Theory-04, Practicals-02)

UNIT-I

Schrodinger equation & the operators: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Hermitian operator, Eigen values and Eigen functions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.

UNIT-II

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigen values; expansion of an arbitrary wave function as a linear combination of energy eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.

UNIT-III

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions ground state, zero point energy & uncertainty principle.

UNIT-IV

One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

UNIT-V

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

- A Text book of Quantum Mechanics, P. M.Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- · Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- · Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University
- Quantum Physics---S. Gasiorowicz (Wiley India) 2013
- Quantum Mechanics -J.L. Powell and B. Craseman (Narosa) 1988

- · Introduction to Quantum Mechanics- M.Das, P.K.Jena, (SriKrishna Prakashan)
- · Basic Quantum Mechanics -A.Ghatak (Mc Millan India) 2012
- . Introduction to Quantum Mechanics R. Dicke and J. Wittke
- Quantum Mechanics- Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- · Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
- · Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer
- Quantum Mechanics F. Mandl (CBS) 2013
- •Cohen-Tannoudji, B Diu and F Laloë, Quantum Mechanics (2 vols) Wiley-VCH 1977

PHYSICS PRACTICAL-C XI LAB

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E]$$
 where $V(r) = -\frac{e^2}{r}$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is \approx -13.6 eV. Take e = 3.795 (eVÅ) $^{1/2}$, hc = 1973 (eVÅ) and m = $0.511x10^6$ eV/c².

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^{2}y}{dr^{2}} = A(r)u(r), A(r) = \frac{2m}{h^{2}} [V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r}e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 (eVÅ)^{1/2}, $m = 0.511 \times 10^6$ eV/c2, and a = 3 Å, 5 Å, 7 Å. In these units hc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^{2}y}{dr^{2}} = A(r)u(r), A(r) = \frac{2m}{h^{2}} [V(r) - E]$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2} kr^2 + \frac{1}{3} br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $m=940~\text{MeV/c}^2$, $k=100~\text{MeV fm}^{-2}$, b=0, 10, 30 MeV fm-3In these units, ch=197.3~MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2} [V(r) - E]$$

Where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r^{i}} - e^{\alpha r^{i}}), r^{i} = \frac{r - r_{0}}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: $m = 940 \times 10^6 \text{ eV/C}^2$, D = 0.755501 eV, $\alpha = 1.44$, $r_0 = 0.131349 \text{ Å}$

Laboratory based experiments:

- 5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
- 6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
- 7. To show the tunneling effect in tunnel diode using I-V characteristics.
- 8. Quantum efficiency of CCDs

- Schaum's outline of Programming with C++. J.Hubbard, 2000, McGraw-- Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
- An introduction to computational Physics, T.Pang, 2nd Edn., 2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
- Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

PHYSICS-C XII: SOLID STATE PHYSICS (Credits: Theory-04, Practicals-02)

UNIT-I

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Types of Lattices, Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

UNIT-II

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law

UNIT-III

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia-and Paramagnetic Domains. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

UNIT-IV

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability.

Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

UNIT-V

Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient.

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- · Solid State Physics, M.A. Wahab, 2011, Narosa Publications
- Solid State Physics S. O. Pillai (New Age Publication)
- Solid State Physics- R.K.Puri &V.K. Babbar (S.Chand Publication)2013
- Lasers and Non linear Optics –B.B.Laud-Wiley Eastern.
- •LASERS: Fundamentals and Applications Thyagarajan and Ghatak (McMillanIndia) 2012

PHYSICS PRACTICAL-C XII LAB

- 1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
- 2. To measure the Magnetic susceptibility of Solids.
- 3. To determine the Coupling Coefficient of a Piezoelectric crystal.
- 4. To measure the Dielectric Constant of a dielectric Materials with frequency
- 5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
- 6. To determine the refractive index of a dielectric layer using SPR
- 7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
- 8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
- 9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap.
- 10. To determine the Hall coefficient of a semiconductor sample.

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Semester VI

PHYSICS-C XIII: ELECTROMAGNETIC THEORY (Credits: Theory-04, Practicals-02)

UNIT-I

Maxwell Equations: Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density.

UNIT-II

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance.

Propagation through conducting media, relaxation time, skin depth. Electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere **UNIT-III**.

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)

UNIT-IV

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light.

UNIT-V

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter.

Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
- Electricity and Magnetism --- D C Tayal (Himalaya Publication)2014
- Introduction to Electrodynamics-A.Z.Capri & P.V.Panat (Alpha Science) 2002
- · Optics E.Hecht, (Pearson India)

Additional Books for Reference

- · Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press
- Electromagnetic Theory-A. Murthy (S. Chand Publication)2014
- · Classical Electrodynamics, J. D. Jackson (Wiley India)

PHYSICS PRACTICAL-C XIII LAB

- 1. To verify the law of Malus for plane polarized light.
- 2. To determine the specific rotation of sugar solution using Polarimeter.
- 3. To analyze elliptically polarized Light by using a Babinet's compensator.
- 4. To study dependence of radiation on angle for a simple Dipole antenna.
- 5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil,

Xylene, etc.) by studying the diffraction through ultrasonic grating.

- 6. To study the reflection, refraction of microwaves
- 7. To study Polarization and double slit interference in microwaves.
- To determine the refractive index of liquid by total internal reflection using Wollaston's airfilm.
- 9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
- 10. To study the polarization of light by reflection and determine the polarizing angle for airglass interface.
- 11. To verify the Stefan's law of radiation and to determine Stefan's constant.
- 12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- · Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

PHYSICS-C XIV: STATISTICAL MECHANICS (Credits: Theory-04, Practicals-02)

UNIT-I

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Microcanonical, Canonical and grand canonical ensemble. Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function,

UNIT-II

Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

UNIT-III

Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula.

UNIT-IV

Rayleigh-Jean's Law. Ultraviolet Catastrophe. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

UNIT-V

Quantum Statistics: Identical particles, macrostates and micro states. Fermions and Bosons, Bose Einstein distribution function and Fermi-Dirac Distribution function. Bose-Einstein Condensation, Bose deviation from Planck's law, Effect of temperature on F-D distribution function, degenarate Fermigas, Density of States, Fermi energy.

- Statistical Mechanics-R.K.Pathria & Paul D. Beale (Academic Press) 3rd Edition (2011)
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.
- An introduction to Equilibrium Statistical Mechanics: Palash Das (I.K.International Publication) 2012
- •Statistical Physics -- F. Mandl (CBS) 2012
- Statistical Physics of Particles-M. Kardar (CUP 2007)

PHYSICS PRACTICAL-C XIV LAB

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

- Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
- a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations

b) Study of transient behavior of the system (approach to equilibrium)

c) Relationship of large N and the arrow of time

- d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
- e) Computation and study of mean molecular speed and its dependence on particle mass
- f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed
- 2. Computation of the partition function Z(β) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
- a) Study of how $Z(\beta)$, average energy <E>, energy fluctuation ΔE , specific heat at constant volume C_v , depend upon the temperature, total number of particles N and the spectrum of single particle states.
- b) Ratios of occupation numbers of various states for the systems considered above
- c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.
- Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
- 4. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases
- 5. Plot Maxwell-Boltzmann distribution function versus temperature.
- 6. Plot Fermi-Dirac distribution function versus temperature.
- 7. Plot Bose-Einstein distribution function versus temperature.

- · Elementary Numerical Analysis, K.E.Atkinson, 3 rd Edn. 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

PHYSICS-DSE (Discipline Specific Elective): (4 papers) DSE-1 to DSE-4 (6 Credits each) CLASSICAL DYNAMICS DSE-1

(Credits: Theory-05, Tutorial-01)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Classical Mechanics of Point Particles: Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations.

UNIT-II

Applications to simple systems such as coupled oscillators. Canonical momenta & Hamiltonian. Hamilton's equations of motion.

UNIT-III

Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Motion of charged particles in external electric and magnetic fields.

UNIT-IV

Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction & twin paradox.

UNIT-V

Four-vectors: space-like, time-like & light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press
- Classical Mechanics-J. C.Upadhyay (Himalaya Publication) 2014
- •Classical Dynamics of Particles and Systems S. T. Thornton (Cengage Learning) 2012
- •Introduction to Classical Mechanics-R. K. Takwale, S.Puranik-(Tata Mc Graw Hill)
- Classical Mechanics-M. Das, P.K.Jena, M. Bhuyan, R.N.Mishra (Srikrishna Prakashan)

PHYSICS-DSE: 2

Nuclear and Particle Physics (Credits: Theory-05, Tutorials-01)

UNIT-I

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

UNIT-II

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model,

UNIT-III

Radioactivity decay:(a) Alpha decay: basics of α -decay processes, theory of α - emission, Gamow factor, Geiger Nuttall law. (b) β -decay: energy kinematics for β -decay, positron emission, electron capture, neutrino hypothesis. (c) Elementary idea of Gamma decay.

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value,

UNIT-IV

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Particle Accelerators: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

UNIT-V

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm. Elementary ideas of quarks and gluons.

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- · Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- · Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Basic ideas and concepts in Nuclear Physics An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub.Inc., 1991)
- Atomic and Nuclear Physics -A. B. Gupta, Dipak Ghosh. (Books and Allied Publishers)
- Physics of Atoms and Molecules Bransden (Pearson India) 2003
- Subatomic Physics Henley and Gracia (World Scientific) 2012
- •Introduction to Nuclear and Particle Physics-A.Das and T.Ferbel (World Scientific)
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

PHYSICS-DSE: 3 BIO-PHYSICS (CREDITS: THEORY-05, TUTORIALS-01)

UNIT-I

Building Blocks & Structure of Living State: Atoms and ions, molecules essential forblife, what is life. Living state interactions: Forces and molecular bonds, electric &bthermal interactions, electric dipoles, casimir interactions, domains of physics in biology.

UNIT-II

Heat Transfer in biomaterials: Heat Transfer Mechanism, The Heat equation, Joule heating of tissue. Living State Thermodynamics: Thermodynamic equilibrium, first law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics, Physics of many particle systems, Two state systems, continuous energy distribution, Composite systems, Casimir contribution of free energy, Protein folding and unfolding.

UNIT-III

Open systems and chemical thermodynamics: Enthalpy, Gibbs Free Energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis & synthesis, Entropy of mixing, The grand canonical ensemble, Hemoglobin.

UNIT-IV

Diffusion and transport Maxwell-Boltzmann statistics, Fick's law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric field, Lateral diffusion in membranes, Navier stokes equation, low Reynold's Number Transport, Active and passive membrane transport.

UNIT-V

Fluids: Laminar and turbulent fluid flow, Bernoulli's equation, equation of continuity, venture effect, Fluid dynamics of circulatory systems, capillary action.

Bioenergetics and Molecular motors: Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in Chloroplasts, Light absorption in biomolecules, vibrational spectra of bio-biomolecules.

- Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartelett Publishers
- · Aspects of Biophysics, Hughe S W, John Willy and Sons.
- · Essentials of Biophysics by P Narayanan, New Age International
- Molecular Biophysics- P.K.Banarjee (S. Chand Publication) 2014.
- . Essentials of Biophysics : P. Narayanan, (New Age International, New Delhi) 2005 .
- . Biophysics: An introduction: Rodney Cotterill, John Wiley and Sons Ltd, 2002.
- . Biophysics- Dr.G.R. Chatwal (Himalaya Pub.) 2011

PHYSICS-DSE: 4 PHYSICS OF EARTH (CREDITS: THEORY-05, TUTORIALS-01)

UNIT-I

(a) Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences.

(b) General characteristics and origin of the Universe. The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.

(c) Energy and particle fluxes incident on the Earth.

(d) The Cosmic Microwave Background.

UNIT-II- Structure:

(a) The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy. How do we learn about Earth's interior?

(b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems.

(c) The Atmosphere: variation of temperature, density and composition with altitude, clouds.

(d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers.

(e) The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms.

UNIT-III-Dynamical Processes:

(a) The Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations. Concept of plate tectonics; sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes: types products and distribution.

(b) The Hydrosphere: Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend – air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.

(c) The Atmosphere: Atmospheric circulation. Weather and climatic changes.Earth's heat budget. Cyclones.

Climate:

Earth's temperature and greenhouse effect.

ii. Paleoclimate and recent climate changes.

iii. The Indian monsoon system.

(d) Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle. The role of cycles in maintaining a steady state.

UNIT-IV - Evolution:

Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods in their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and neptunism. Law of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent.

1. Time line of major geological and biological events.

2. Origin of life on Earth.

3. Role of the biosphere in shaping the environment.

4. Future of evolution of the Earth and solar system: Death of the Earth.

UNIT-V- Disturbing the Earth - Contemporary dilemmas

- (a) Human population growth.
- (b) Atmosphere: Green house gas emissions, climate change, air pollution.
- (c) Hydrosphere: Fresh water depletion.
- (d) Geosphere: Chemical effluents, nuclear waste.
- (e) Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystems.

- Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
- Consider a Spherical Cow: A course in environmental problem solving, John Harte.
 University Science Books
- Holme's Principles of Physical Geology. 1992. Chapman & Hall.
- Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

SKILL ENHANCEMENT COURSE (CREDIT: 02)- SEC-2

RENEWABLE ENERGY AND ENERGY HARVESTING

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

UNIT-I

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

UNIT-II

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

UNIT-III

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydropower sources.

- Non-conventional energy sources G.D Rai Khanna Publishers, New Delhi
- · Solar energy M P Agarwal S Chand and Co. Ltd.
- · Solar energy Suhas P Sukhative Tata McGraw Hill Publishing Company Ltd.
- Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
- · J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable energy

GENERIC ELECTIVE COURSES

Semester-I

Generic Elective (GE -1): Biodiversity (Microbes, Algae, Fungi and Archegoniate) - 100 marks

(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-I	Microbes: Viruses - Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria - Discovery, General characteristics and cell structure; Reproduction - vegetative, asexual and recombination(conjugation, transformation and transduction); Economic importance.
Unit-II	Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and lifecycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia. Economic importance of algae.
	Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota) Penicillium, Alternaria (Ascomycota), Puccinia, Agaricus (Basidiomycota); Symbiotic Associations-Lichens:
Unit-III	Introduction to Archegoniate: Unifying features of archegoniates, Transition to land habit, Alternation of generations.
	Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of Sphagnum.
Unit-IV	Pteridophytes: General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Selaginella, Equisetum and Pteris. (Developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.
Unit-V	Gymnosperms: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of <i>Cycas</i> and <i>Pinus</i> . (Developmental details not to be included). Ecological and economical importance.

Practical

- I. EMs/Models of viruses T-Phage and TMV, Line drawing/Photograph of
- 2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule. 3. Gram staining
- 4. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus* and Polysiphonia through temporary preparations and permanent slides. (* Fucus -Specimen and permanent slides)
- 5. Rhizopus and Penicillium: Asexual stage from temporary mounts and sexual structuresthrough permanent slides.
- 6. Alternaria: Specimens/photographs and tease mounts.
- 7. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
- 8. Agaricus: Specimens of button stage and full grown mushroom; Sectioning
- 9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
- 10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
- 11. Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus throughgemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
- 12. Funaria- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores(temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
- 13. Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m.microsporophyll and megasporophyll (temporary slides), l.s. strobilus(permanent slide).
- 14. Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore,w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
- 15. Pteris- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores(temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
- 16. Cycas- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet,v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root(permanent slide).
- 17. Pinus- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m.dwarf shoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. &r.l.s. stem (permanent slide).

Suggested Readings

- 1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd
- 2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin
- 3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt.
- 4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and 5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi,
- 6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
- 7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd
- 8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot,

Semesteŗ-IV

Generic Elective (GE -2): Plant Anatomy and Embryology - 100 marks

(Credits-6: Theory-4, Practical-2)
THEORY (Each class 1 hour): PRACTICAL (Each class 2 hours)
[75 marks (Mid Sem 15 + End Sem 60)]
Lectures: 60 [40 Theory + 20 Practical classes]

Unit-1	Introduction:
	Meristematic and permanent tissues: Root and shoot apical meristems; Simple and complex tissues
	Organs: Structure of dicot and monacot root stem and leaf.
Unit-H	Secondary Growth: Vascular cambium - structure and
	function, seasonal activity. Secondary growth in root and stem. Wood (heartwood and sapwood)
	Adaptive and protective systems: Epidermis, cuticle, stomata, General account of adaptations in xerophytes and hydrophytes
Unit-III	Structural organization of flower: Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.
	Pollination and fertilization: Pollination mechanisms and adaptations; Double fertilization, Seed-structure appendages and dispersal mechanisms.
Unit-IV	Embryo and endosperm: Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship
Unit-V	Apomixis and polyembryony : Definition, types and Practical applications

HOD, BARRY

Practical

- 1. Study of meristems through permanent slides and photographs.
- 2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
- 3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only
- 4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only
- 5. Leaf: Dicot and Monocot leaf (only Permanent slides).
- 6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem).
- 7. Structure of anther (young and mature), tapetum (amoeboid and secretory)
- 8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/
- 9. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development(Permanent slides/photographs).
- 10. Ultrastructure of mature egg apparatus cells through electron micrographs.
- 11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
- 12. Dissection of embryo/endosperm from developing seeds.
- 13. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings

- 1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House
- 2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

ANIMAL DIVERSITY

THEORY (CREDITS 4)

F.M=Mid Sem-15+Sem-60=75

-50m-40-75

Unit 1. Protista

12 marks

General characters of Protozoa; Life cycle of Plasmodium

Porifera

General characters and canal system in Porifera

Radiata

General characters of Cnidarians and polymorphism

Unit 2. Aceolomates

12 marks

General characters of Helminthes; Life cycle of Taenia solium

Pseudocoelomates

General characters of Nemethehelminthes; Parasitic adaptations

Coelomate Protostomes

General characters of Annelida; Metamerism.

Unit 3. Arthropoda

12 marks

General characters. Social life in insects.

Mollusca

General characters of mollusca; Pearl Formation

Coelomate Deuterostomes

General characters of Echinodermata, Water Vascular system in Starfish.

Unit 4. Protochordata

12 marks

Salient features

Pisces

Osmoregulation, Migration of Fishes

Amphibia

General characters, Adaptations for terrestrial life, parental care in Amphibia.

Unit .5

12 marks

Amniotes; Origin of reptiles. Terrestrial adaptations in reptiles.

Aves:

The origin of birds; Flight adaptations

Mammalia

Early evolution of mammals; Primates; Dentition in mammals. CBCS Undergraduate Program in Zoology 2015

ENVIRONMENT AND PUBLIC HEALTH THEORY (Credits 4)

UNIT I: Introduction

Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

UNIT II Climate Change

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

Unit III Pollution

Air, water, noise pollution sources and effects, Pollution control

Unit IV Waste Management Technologies

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.

Unit 5 Diseases

Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid CBCS Undergraduate Program in Zoology 2015

> of texte and persistent Prairie

no disaster. Seveso disesio alla

at disease, typhoid CBCS

ENVIRONMENT AND PUBLIC HEALTH

PRACTICAL (Credits 2)

1. To determine pH, Cl, SO₄, NO₃ in soil and water samples from different locations.

SUGGESTED BOOKS	Su Gorge
☐ Cutter, S.L., Environmental Risk and Hazards, Pren	tice-Hall of India Pyt. Ltd. New Delhi 1000
T Kallum Pas Pas U.S.	J.a., I.e. Denn, 1999.
□ Kolluru Rao, Bartell Steven, Pitblado R and Stricoff Handbook □, McGraw Hill Inc., New York, 1996.	-Risk Assessment and Management
□ Kofi Acenta Dush Dist	
☐ Kofi Asante Duah —Risk Assessment in Environme Singapore, 1998.	ntal management □, John Wiley and sons,
☐ Kasperson, J.X. and Kasperson, R.E. and Kasperson, V.N.University Press, New York, 2003.	R.E., Global Environmental Risks,
☐ Joseph F Louvar and B Diane Louver Health and Engapplications, Prentice Hall, New Jersey 1997	vironmental Risk Analysis fundamentals with
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	A STATE OF THE PARTY OF THE PAR
	d., New Delhi. 1999.
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Electives Generic /Interdisciplinary

SEMESTER-1

GE-I: Calculus and Ordinary Differential Equations (For Physics Hons)

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d)

having equal marks.)

Unit-I

16 marks

Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quardrature, Volume and Surface area of solids of revolution.

Unit-II

Sphere, Cones and Cylinders, Conicoid.

16 marks

Unit-III

16 marks

Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurins theorem for functions of two variables. Maxima and Minima of functions of two and three variables, Implicit functions, Lagranges multipliers. Multiple integrals.

Unit-IV

16 marks

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogenous, exact and linear). Equations of 1st order but higher degree.

Unit-V

16 marks

Second order linear equations with constant coeffcients, homogeneous forms, Second order equations with variable coeffcients, Variation of parameters. Laplace transforms and its applications to solutions of differential equations.

Books Recommended:

- Topics in Calculus by R.K.Panda & P.K.Satpathy, S.G.Publications: Chap 1, Ch-2 up to, 2.17, 2.20 to 2.22.
- Analytical Solid Geometry by Shanti Narayan: 6.11 to 6.6, 7.1 to 7.14, 7.42, 7.6 to 7.82, 8.1, 8.3, 10.1 to 10.2.
- Mathematical Analysis by S.C.Mallick: Chap 15(1.1 to 3, 5, 5.1, 6, 7, 8, 9, 10 to 10.2, 11) Chap16 (2, 3, 3.2)
- J. Sinharoy and S. Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Publishers. Chapters: 2(2.1 to 2.7 (i)), 3(up to 3.5, 3.7), 4(4.2, 4.4, 4.5 to 4.7), 9(9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.12, 9.13).

Books for References:

- 1. Shantinarayan-Text Book of Calculus, Part-II, S. Chand and Co., Chapter-8 (Art. 24, 25,
- 2. Shantinarayan-Text Book of Calculus, Part-III, S. Chand and Co., Chapter-1 (Art 1,2), 3, 4(Art.10 to 12 omitting Simpsons Rule), 5(Art-13) and 6(Art-15).
- 3. B.P. Acharya and D.C. Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
- 4. Santosh K. Sengar-Advanced Calculus, Chapters: 2, 4, 5, 6, 7, 11, 12, 13.
- 5. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
- David V. Weider-Advanced Calculus, Dover Publications.
- 7. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer
- 8. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New
- 9. G. Dennis Zill-A First Course in Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.

SEMESTER-II

GE-II: Calculus and Ordinary Differential Equations (For Chemistry Hons)

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d) having equal marks.)

Unit-I

16 marks

Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quardrature, Volume and Surface area of

Unit-II

Sphere, Cones and Cylinders, Conicoid.

16 marks

Unit-III

16 marks

Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurins theorem for functions of two variables. Maxima and Minima of functions of two and three variables, Implicit functions, Lagranges multipliers. Multiple integrals.

Unit-IV

16 marks

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogenous, exact and linear). Equations of 1st order but higher degree.

Unit-V

16 marks

Second order linear equations with constant coeffcients, homogeneous forms, Second order equations with variable coeffcients, Variation of parameters. Laplace transforms and its applications to solutions of differential equations.

Books Recommended:

- 5. Topics in Calculus by R.K.Panda & P.K.Satpathy, S.G.Publications:- Chap 1, Ch-2 up to, 2.17, 2.20 to 2.22.
- 6. Analytical Solid Geometry by Shanti Narayan:- 6.11 to 6.6, 7.1 to 7.14, 7.42, 7.6 to 7.82, 8.1, 8.3, 10.1 to 10.2.
- 7. Mathematical Analysis by S.C.Mallick:- Chap 15(1.1 to 3, 5, 5.1, 6, 7, 8, 9, 10 to 10.2, 11) Chap16 (2, 3, 3.2)
- 8. J. Sinharoy and S. Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Publishers. Chapters: 2(2.1 to 2.7 (i)), 3(up to 3.5, 3.7), 4(4.2, 4.4, 4.5 to 4.7), 9(9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.12, 9.13).

Books for References:

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SEMESTER-III GE-III: Linear Algebra and Advanced Algebra (For Chemistry Hons)

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d)

having equal marks.)

Unit-I

16 marks

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity, Inverse of a linear map, Rank-Nullity theorem.

Unit-II

16 marks

Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices. Elementary row operations, System of linear equations, Matrix inversion using row operations, Determinant and Rank of matrices, Eigen values, Eigen vectors, Quadratic forms.

Unit-III

16 marks

Group Theory: Definition and examples, Subgroups, Normal subgroups, Cyclic groups, Cosets, Quotient groups, Permutation groups, Homomorphism.

Unit-IV

16 marks

Lagranges Interpolation, Newtons Gregory Forword Interpolation, Simpson's 1/3 rule, Trapezoidal Rule.

Unit-V

Scalar & vector point function, Velocity, Acceleration, tangent plane, normal, Divergence, Gradient, Curl.

Books Recommended:

1. Topics in Algebra by S.Padhy, L. Sahoo by Kalyani Pub.:- Ch-3

2. Basic Structures in Algebra By J.N Patniak ByKalyani Pub.:- Ch-3 (upto 3.8.5, 3.8.8 to 3.8.14, 3.9.2 to 3.9.5, 3.9.8 to 3.10.3)

3. Introductory Numerical Analysis By Dutta and Jena, Sreedhar Prakashan:- Ch-2 (upto 2.14, Ch-3 (3.10 to 3.14)

4. Topics in Calculus by Panda & Satapathy, S.G. Pub. :- Ch-6

Books for References:

1. V. Krishnamurthy, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 3, 4(4.1 to 4.7), 5(except 5.3), 6(6.1, 6.2, 6.5, 6.6, 6.8),7(7.4 only).

2. I.H. Seth-Abstract Algebra, Prentice Hall of India Pvt. Ltd., New Delhi.

3. I.N. Herstein-Topics in Algebra, Wiley Eastern Pvt. Ltd.

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- Shantinarayan-Text Book of Calculus, Part-II, S. Chand and Co., Chapter-8 (Art. 24, 25, 26)
- Shantinarayan-Text Book of Calculus, Part-III, S. Chand and Co., Chapter-1 (Art 1,2), 3, 4(Art.10 to 12 omitting Simpsons Rule), 5(Art-13) and 6(Art-15).
- B.P. Acharya and D.C. Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
- 13. Santosh K. Sengar-Advanced Calculus, Chapters: 2, 4, 5, 6, 7, 11, 12, 13.
- Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
- 15. David V. Weider-Advanced Calculus, Dover Publications.
- Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
- M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.27
- G. Dennis Zill-A First Course in Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.

SEMESTER-IV(for Physic's Hons students)

GE-IV: Linear Algebra and Advanced Algebra

Total Marks: 100

Theory:80 Marks+Mid-Sem:20 Marks

5 Lectures, 1 Tutorial (per week per student

(From 5 Units; Each unit having one question consisting of two parts (a), (b) or (c), (d)

having equal marks.)

Unit-I

16 marks

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity.

Unit-II

16 marks

Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices. Elementary row operations, Matrix inversion using row operations, Determinant and Rank of matrices, Eigen values, Eigen vectors.

Unit-III

16 marks

Group Theory: Definition and examples, Subgroups, permutation groups, cyclic groups, lagranges theorem. A counting principle.

Unit-IV

16 marks

Lagranges Interpolation, Newtons Gregory Forword Interpolation, Simpson's 1/3 rule, Trapezoidal Rule. 16 marks Unit-V

Scalar & vector point function, Velocity, Acceleration, tangent plane, normal, Divergence, Gradient, Curl.

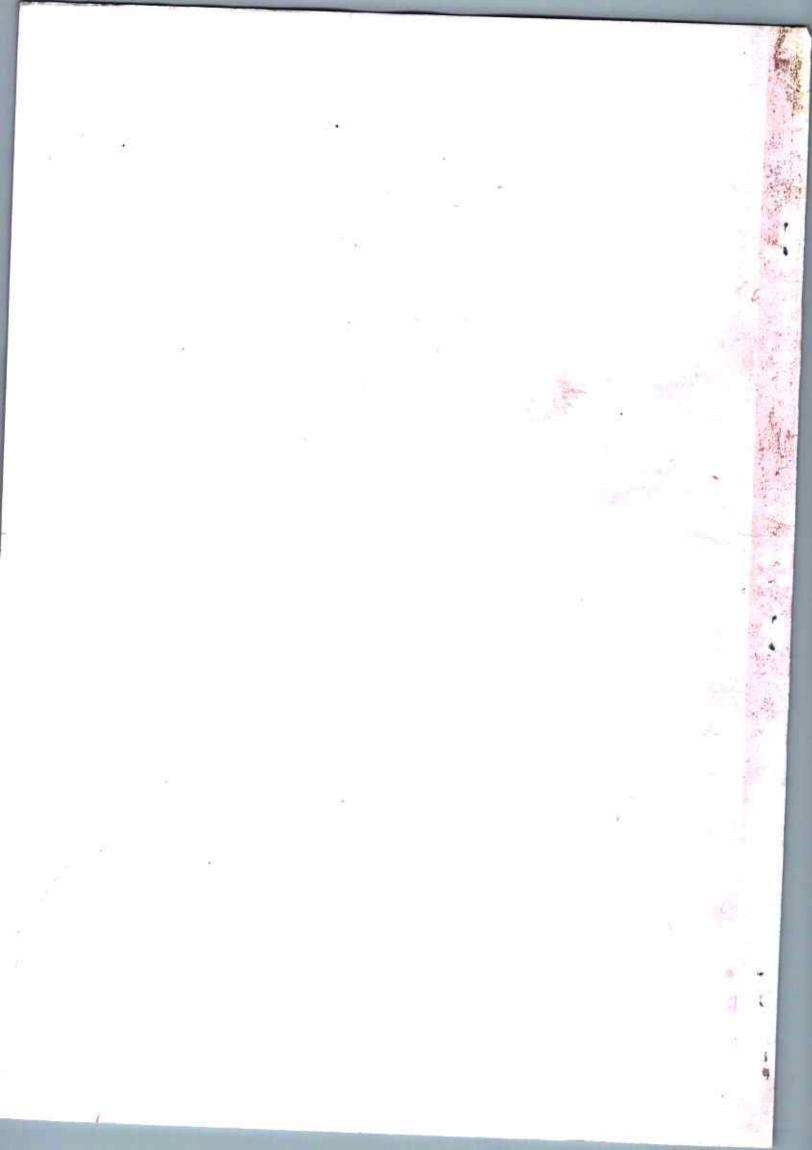
Books Recommended:

- 1. Topics in Algebra by S.Padhy, L. Sahoo by Kalyani Pub.:- Ch-3 (upto 3.6), ch-5, Ch-6
- 2. . V. Krishnamurthy, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 5(5.1,5.5,5.6,5.7,5.9), 6(6.1, 6.2, 6.5,
- 3. Introductory Numerical Analysis By Dutta and Jena , Sreedhar Prakashan:- Ch-2 (upto 2.14, Ch-3 (3.10 to 3.14)
- 4. Topics in Calculus by Panda & Satapathy, S.G. Pub. :- Ch-6 (excluding 6.13, 6.14)

Books for Reference

- I.H. Seth-Abstract Algebra, Prentice Hall of India Pvt. Ltd., New Delhi.
- 2. I.N. Herstein-Topics in Algebra, Wiley Eastern Pvt. Ltd.

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Generic Elective

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL

ORGANIC CHEMISTRY I GE, POPER - 17 3rd Semester

(Credits: Theory-4, Practicals-2)

THEORY: Lectures: 60

Section A: Physical Chemistry-1 (30 Lectures)

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature - Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

(10 Lectures)

Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between G and Go, Le Chatelier's principle. Relationships between Kp, Ke and Kx for reactions involving ideal gases.

(8 Lectures)

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts applications of solubility product principle.

(12 Lectures)



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Section B: Organic Chemistry-2 (30 Lectures)

Functional group approach for the following reactions (preparations physical properties and Chemical reactions) to be studied in context to their structure with mechanism.

Aromatic hydrocarbons

Preparation (benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (benzene): Electrophilic substitution reactions: nitration, halogenation sulphonation. Friedel-Craft's reaction (alkylation and acylation) Side chain oxidation of alkyl benzenes.

(8 Lectures)

Alkyl and Aryl Halides

Alkyl Halides .

Preparation: from alkenes and alcohols.

Reactions: Types of Nucleophilic Substitution (Sn1, Sn2 and Sni) reactions, hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic electrophilic and nucleophilic substitution (replacement by - OHgroup) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).

Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards Nucleophilic substitution reactions.

(8 Lectures)

Alcohols, Phenols and Ethers)

Alcohols: Preparation: Preparation of 10, 20 and 30 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3), factors affecting acidity, Oppeneauer oxidation

Diols: oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-



Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten - Baumann Reaction, acidity and factors affecting

Ethers (aliphatic and aromatic).

Preparation: Williamson ether synthesis. Reactions: Cleavage of ethers with HI

Aldehydes and ketones (aliphatic and aromatic):

Preparation: from acid chlorides and from nitriles.

Reactions - Nucleophilic addition, Nucleophilic addition - elimination reaction including Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

(14 Lectures)

Reference Books:

•T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.

•Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.

•I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.

•R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.

· Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.

•G. M. Barrow: Physical Chemistry Tata McGraw Hill (2007).

•G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).

J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).

B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).

•R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

CHEMISTRY LAB: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

60 Lectures

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.

2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide,

3. Determination of enthalpy of ionization of acetic acid.

Determination of integral enthalpy of solution of salts (KNO3, NH4Cl).

5. Determination of enthalpy of hydration of copper sulphate.

6. Study of the solubility of benzoic acid in water and determination of H.

Ionic equilibriapH measurements

a)Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter. b)Preparation of buffer solutions:

(i)Sodium acetate-acetic acid

(ii)Ammonium chloride-ammonium hydroxide Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

1. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, Section B: Organic Chemistry determination of melting point and calculation of quantitative yields to be done.

(a)Bromination of Phenol/Aniline

(b)Benzoylation of amines/phenols

(c)Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

2. Systematic Qualititive organic analyses of organic compounds possessing monofunctional groups (Alcohals, Phenols, Carbonyl,- COOH) and preparation of one suitable derivative.

Reference Books:

A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.

•F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).

•B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

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GENERIC ELECTIVE PAPERS (GE) -(ANY TWO) FOR OTHERDEPARTMENTS/DISCIPLINES: (CREDIT: 06 EACH)

GE: 1 MECHANICS

(Credits: Theory-04, Practicals-02)

UNIT-I

Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients

Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

UNIT-II

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. Physiological effects on astronauts.

UNIT-III

Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants -Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and σ by Searles method.

UNIT-V

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

Note: Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate.

Reference Books:

- University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley
- Mechanics Berkeley Physics, Vol..1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
- Physics Resnick, Halliday & Walker 9/e, 2010, Wiley
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Properties of Matter D.S. Mathur (S.Chand publication) 2013
- Mechanics- D.C. Tayal (Himalaya Publication) 2013
- Classical Dynamics of Particles and Systems –S. T. Thornton (Cengage Learning) 2012
- Analytical Mechanics-Fowles (Cengage Learnings) 2014
- •Classical Mechanics-M.Das, P.K.Jena, M.Bhuyan and R.N.Mishra (Srikrishna Publication)

PHYSICS LAB: GE LAB: MECHANICS

- Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
- 2. To determine the Height of a Building using a Sextant.
- 3. To determine the Moment of Inertia of a Flywheel.
- 4. To determine the Young's Modulus of a Wire by Optical Lever Method.
- 5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
- 6. To determine the Elastic Constants of a Wire by Searle's method.
- 7. To determine g by Bar Pendulum.
- 8. To determine g by Kater's Pendulum.
- 9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

GE: 2 ELECTRICITY, MAGNETISM AND EMT (Credits: Theory-04, Practicals-02)

UNIT-I

Vector Analysis: Scalar and Vector product, gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

UNIT-II

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.

UNIT-III

Capacitance: Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

UNIT-IV

Magnetism: Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferromagnetic materials.

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

Maxwell's equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

Reference Books:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
- Electricity & Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J.Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
- Electricity and Magnetism- K.K Tewari (S. Chand Higher Academics)2013

GE LAB: ELECTRICITY, MAGNETISM AND EMT

- 1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
- 2. Ballistic Galvanometer:
- (i) Measurement of charge and current sensitivity
- (ii) Measurement of CDR
- (iii) Determine a high resistance by Leakage Method
- (iv) To determine Self Inductance of a Coil by Rayleigh's Method.
- 3. To compare capacitances using De'Sauty's bridge.
- 4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)
- 5. To study the Characteristics of a Series RC Circuit.
- 6. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor
- 7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and
- (b) Quality factor Q
- 8. To determine a Low Resistance by Carey Foster's Bridge.
- 9. To verify the Thevenin and Norton theorems
- 10. To verify the Superposition, and Maximum Power Transfer Theorems Reference Books
- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted
 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal

2015-16 First Semester-2015.

RAYAGADA AUTONOMOUS COLLEGE RAYAGADA NATIONAL CADET#CORPS

B.A / B.Com / B.Sc- Program Generic Elective -1 Internal assessment: 20 Marks Semester Examination: 80Marks

Unit 01: INTRODUCTION TO NCC:

16 Marks

Introduction, Aims of NCC, Motto of NCC, NCC Song, NCC Flag, NCC Training, NCC Camps, Youth Exchange Programme, Incentives for NCC Cadets, Adventure activities.

Unit 02: LEADERSHIP:

16 Marks

Meaning & Leadership Traits, Types of Leadership, Discipline, Duties & Rights of an Indian Citizen, Man Management, Customs of Services.

Unit 03: NATIONAL INTEGRATION:

16 Marks

Meaning, Aim & Importance, Hindrance to National Integration, Unity in Diversity & Vice-Versa, India & Its neighbours.

Unit 04: DRILL, WEAPON TRAINING, & FIELD CRAFT:

16 Marks

Foot Drill, Word of Command, Rank & File, Arms Drill, Guard of Honours, Weapon Training, Principles of Shooting, Field Craft, Camouflage & Concealment, Judging Distance, Methods of Measuring Degree.

Unit 05: FIELD TACTICES:

16 Marks

Field signals, Section Formation, platoon formation, Fire control order, Petrol & Ambush.