

# **National Education Policy - 2020**

**(Common Minimum Syllabus for  
all UP State Universities and Colleges)**

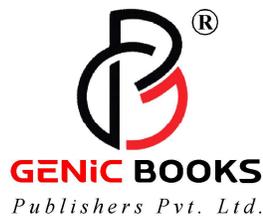
**B.Sc. Third Year, Semester – V & VI**

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**B. Sc Third Year**

**Semester: Fifth**

**Course Title: Diversity of Non-Chordates, Parasitology and Economic Zoology**

**Subject: Zoology**

**Unit Topics**

**I Protozoa to Coelenterate**

- Protozoa – Paramecium (Morphology and Reproduction)
- Porifera – Sycon (Canal System)
- Coelenterata – Obelia (Morphology and Reproduction)

**II Ctenophora to Nemathelminthes**

- Ctenophora – Salient features
- Platyhelminthes-Taenia (Tape worm) (Morphology and Reproduction)
- Nemathelminthes – Ascaris lumbricoides (Morphology and Reproduction)

**III Annelida**

- Annelida – Hirudinaria (Leech) (Morphology and Reproduction)

**IV Arthropoda**

- Arthropoda – Palaemon (Prawn) (Morphology, Appendages, Nervous System and Reproduction)

**V Mollusca to Hemichordata**

- Mollusca – Pila (Morphology, Shell, Respiration, Nervous System and Reproduction)
- Echinodermata – Pentaceros (Morphology and Water Vascular System)

**VI Vectors and pests**

- Life cycle and their control of following pests: Gundhi bug, Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control

**VII Economic Zoology-1**

- Animal breeding and culture: Pisciculture

**VIII Economic Zoology- 2**

- Sericulture, Apiculture, Lac-culture, Vermiculture

**B. Sc Third Year****Semester: Fifth****Course Title: Diversity of Chordates and Comparative Anatomy****Subject: Zoology****Unit Topic****I Origin of Chordates & Hemichordata - Salient Features and Outline Classification included**

- Origin of Chordates. Classification of Phylum Chordata upto the class.
- Hemichordata: General characteristics, classification and detailed study of Balanoglossus (Habit and Habitat, Morphology, Anatomy, Physiology and Development).

**II Cephalochordata and Urochordata - Salient Features and Outline Classification included**

- Urochordata: General characteristics, classification and detailed study of Herdmania (Habit and Habitat, Morphology,
- Cephalochordata: General characteristics, classification and detailed study of Branchiostoma (Amphioxus) (Habit and Habitat, Morphology, Anatomy, Physiology).
- Anatomy, Physiology and Post Embryonic Development).

**III Classification and General Characteristics of Vertebrates**

- General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) up to the order with examples.
- Poisonous and Non Poisonous Snakes and biting mechanism.
- Neoteny and Paedogenesis
- Migration in birds
- Dentition in Mammals

**GENIC BOOKS**

**IV Comparative Anatomy and Physiology of Vertebrates Integumentary System**

Structure, functions and derivatives of integument

**Skeletal System**

Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches

**V Digestive System**

Alimentary canal and associated glands, dentition

**VI Respiratory System**

Skin, gills, lungs and air sacs; Accessory respiratory organs

**VII Circulatory System**

General plan of circulation, evolution of heart and aortic arches

**Urinogenital System**

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

**VIII Nervous System**

Comparative account of brain

Autonomic nervous system, Spinal cord, Cranial nerves in mammals

**Sense Organs**

Classification of receptors

Brief account of visual and auditory receptors in man

**B. Sc Third Year**

**Semester: Fifth**

**Course Title: Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology**

**Subject: Zoology**

**PRACTICAL**

### Unit Topics

#### **I Study of animal specimens of various animal phyla.**

1. To prepare permanent stained slide of septal nephridia of earthworm.
2. To take out the nerve ring of earthworm.
3. To take out hastate plate from Palaemon.

#### **II 1. Study of animal specimens of various animal phyla**

2. Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig).
3. To prepare stained/unstained slide of placoid scales.
  - (i) Comparative study of bones of different vertebrates.
  - (ii) Comparative study of histological slides of different tissues of vertebrates.

#### **III 1. Permanent Preparation of Euglena, Paramecium**

2. Study of prepared slides/specimens of Entamoeba, Giardia, Leishmania, Trypanosoma, Plasmodium, Fasciola, Taenia, Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma
3. Permanent Preparation of Cimex (bed bug)/ Pediculus (Louse), Haematopinus (cattle louse), fresh water annelids, arthropods; and soil arthropods, as per availability. Manual Microtomy has been proposed Subject to Consideration of Member (Demo System Allowed)
4. Larval stages of helminths and arthropods.
5. Permanent mounts of wings, mouth parts and developmental stages of mosquito and house fly. Permanent preparation of ticks/ mites, abdominal gills of aquatic insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly.
6. Identification of pests.
7. Life history of silkworm, honeybee and lac insect.
8. Different types of important edible fishes of India.
9. Slides of plant nematodes.
10. Study of an aquatic ecosystem, its biotic components and food chain.

## **GENIC BOOKS**

11. Project Report/ model chart making.
12. Dissections : through multimedia / models
13. Cockroach : Central nervous system
14. Wallago: Afferent and efferent branchial vessels, Cranial nerves, Weberian ossicles.

**B. Sc Third Year**

**Semester: Fifth, Paper - I**

**Course Title: Plant Physiology, Metabolism & Biochemistry**

**Subject: Botany**

### **Unit Topics**

#### **I Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem**

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops,

Transport of ions across cell membrane, active and passive transport, Composition of phloem sap, girdling experiment; Pressure flow model.

#### **II Carbon Oxidation**

Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Krebs cycle, mitochondrial electron transport, oxidative phosphorylation, ATP- Synthetase, Chemiosmotic mechanism, P/O ratio, cyanide-resistant respiration, factors affecting respiration.

#### **III Nitrogen Metabolism**

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination, amino acid synthesis.

#### **IV Lipid Metabolism & Photosynthesis**

Lipid Metabolism: Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation.;

Photosynthesis: Pigments, Action spectra and Enhancement effect, Electron transport system and Photophosphorylation, C<sub>3</sub> & C<sub>4</sub> photosynthesis, CAM- Reaction and Significance

## **V Plant Development, Movements, Dormancy & Responses**

Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene.) autonomic & paratonic movements, Control and Coordination in plants, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red-light responses on photomorphogenesis, Seed physiology & Dormancy, Vernalization & Senescence

## **VI Biomolecules**

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, inulin).

Lipids: Storage lipids: Fatty acids structure and functions, Structural lipids: Phosphoglycerides; Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers

**VII Proteins:** Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, Ramchandran plot, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins

**Nucleic acids:** Structure of nitrogenous bases; Structure and function of nucleic acids, Nucleic acid denaturation & Re-naturation, MiRNA

**VIII Enzymes:** Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes & Abzymes.

Phytonutrients, Nutraceuticals, dietary supplements and antioxidants.

**B. Sc Third Year****Semester: Fifth, Paper - II****Course Title: Molecular Biology & Bioinformatics****Subject: Botany****Unit Topics****I Genetic material**

Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): semi-conservative. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming,  $\theta$  (theta) mode of replication, replication of linear, dsDNA, replicating the 5' end of linear chromosome including replication enzymes.

**II Transcription & Regulation of gene expression**

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase-various types; Translation, (Prokaryotes and eukaryotes), genetic code. Regulation of gene expression in Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes

**III Principles & Techniques of genetic engineering**

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Antibody Engineering.

**IV Applications of Genetic engineering**

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); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products, Biosafety concerns..

**V Bioinformatics & its applications**

Computer fundamentals – programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics – Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny,

computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.

#### **VI Biological databases :**

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss- Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem)

#### **VII Data Generation and Data Retrieval**

Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss – Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

#### **VIII Phylogenetic analysis**

Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA);

Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.

**B. Sc Third Year**

**Semester: Fifth, Paper - III**

**Course Title: Experiments in Physiology, Biochemistry & Molecular Biology**

**Subject: Botany**

#### **Unit Topics**

##### **I Plant water relation, Mineral Nutrition and translocation in phloem**

1. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of *Rhoeo* / *Tradescantia*.
2. Osmosis – by potato osmoscope experiment
3. Effect of temperature on absorption of water by storage tissue and determination of Q<sub>10</sub>.
4. Experiment to demonstrate the transpiration phenomenon with the bell jar method

## **GENIC BOOKS**

5. Experiment for demonstration of Transpiration by Four-Leaf Experiment:
6. Structure of stomata (dicot & monocot)
7. Determination of rate of transpiration using cobalt chloride method.
8. Experiment to measure the rate of transpiration by using Farmer's Potometer
9. Experiment to measure the rate of transpiration by using Ganong's potometer
10. Effect of Temperature on membrane permeability by colorimetric method.
11. Study of mineral deficiency symptoms using plant material/photographs.

### **II Nitrogen Metabolism, Photo Synthesis & Respiration**

1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography.
2. Separation of plastidial pigments by solvent and paper chromatography.
3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method.
4. Effect of  $\text{HCO}_3$  concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting).
5. Measurement of oxygen uptake by respiring tissue (per g/hr.)
6. Determination of the RQ of germinating seeds.
7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmott' bubble

### **III Plant Development, Movements, Dormancy & Responses**

1. Geotropism and phototropism — Klinostat
2. Hydrotropism
  - a. Measurement of growth — Arc and Liver Auxonometer
3. To study the phenomenon of seed germination (effect of light).
4. To study the induction of amylase activity in germinating grains.
5. Test of seed viability by TTC method.
6. To study the effect of different concentrations of IAA on Avena

**IV Techniques for biochemical analysis**

1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc.
2. Separation of amino acids by paper chromatography.
3. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples.,
4. Qualitative Analysis of carbohydrates,
5. Estimation of reducing sugar by anthrone method,
6. Qualitative Analysis of Lipids
7. Qualitative analysis of Amino acids and Proteins
8. Quantitative Analysis of Nucleic Acids,
9. Analysis of dietary supplements, nutraceuticals & antioxidants
10. Testing of adulterants in food items.

**V Genetic material**

1. Instruments and equipments used in molecular biology.
2. Preparation of LB medium and cultivating E.coli on it.
3. Isolation of Genomic DNA
4. Isolation of DNA from plants
5. Examination of the purity of DNA by agarose gel electrophoresis.
6. Quantification of DNA by UV-spectrophotometer
7. Estimation of DNA by diphenylamine method.

**VI Preparation of models/ charts:**

1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)through photographs
2. Numericals based on DNA re-association kinetics (melting profiles and Cot curves)
3. Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous ; Semiconservative model of

## **GENIC BOOKS**

replication (Messelson and Stahl's experiment); Telomerase assisted end-replication of linear DNA

4. Study of structures of : tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs
5. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozymes and Alternative splicing
6. Understanding the regulation of lactose (lac) operon (positive & negative regulation) and tryptophan (trp) operon (Repression and De-repression & Attenuation) through photographs.
7. Understanding the mechanism of RNAi by photographs

### **VII Genetic Engineering**

1. Isolation of protoplasts.
2. Construction of restriction map of circular and linear DNA from the data provided.
3. Isolation of plasmid DNA.
4. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph).
5. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.
6. Agarose gel analysis of plasmid DNA
7. Restriction digestion of plasmid DNA -Demonstration of PCR

### **VIII Applications of Genetic engineering**

1. ELISA Test,
2. Viability tests of cells
3. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
4. Study of steps of genetic engineering for production of Bt cotton, Golden rice,
5. FlavrSavr tomato through photographs.

**B. Sc Third Year****Semester: Fifth, Paper - IV****Course Title: Project in Botany for Pre-graduation****Subject: Botany****Suggestive List of Projects**

1. Rural Areas: Flora of a city/ village, Biodiversity of Village, Soil & seed testing service provision to farmers,
2. Industrial waste management
3. water pollution status of rural water & promotion of WASH in villages
4. Plant Disease identification in farms, nurseries and orchards.
5. Digital portal for plants: Campus, city or particular area
6. Rare and endangered plants & their conservation & domestication
7. Air pollution tolerance index (APTI) : Screening of sensitive/tolerant plant species at various locations in particular area
8. Science Communication by Creating science documentaries of innovators , Internet Science ( Social media, Websites, Blogs, Youtube, Podcast etc.)
9. Science Outreach Talks and Public Sensitization for plant biodiversity conservation sensitization of public.
10. Phytochemistry of medicinal plants & their antimicrobial, nutraceutical and antioxidant properties
11. Study of pollen grains in different flowers.
12. Study of stomata in different plants
13. Study of various types of secretory and special tissues in plants.

**B. Sc Third Year****Semester: Fifth, Paper - 1****Course Title: Organic Synthesis - A****Subject: Chemistry****Unit Topics****I Chemistry of Alkanes and Cycloalkanes**

- A) Alkanes** :Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenations -relative reactivity and selectivity
- B) Cycloalkanes:** Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat forms of cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.

## **II Chemistry of Alkenes**

Methods of formation of alkenes, Addition to  $C=C$ : mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereo selectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, syn and anti-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across  $C=C$ ; use of NBS; interconversion of E- and Z- alkenes.

## **III Chemistry of Alkynes**

Methods of formation of alkynes, Addition to  $C\equiv C$ , mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; inter conversion of terminal and non-terminal alkynes.

## **IV Aromaticity and Chemistry of Arenes**

Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/ carbanions. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl, naphthalene and anthracene.

## **V Chemistry of Alcohols**

Classification and nomenclature, Monohydric alcohols– nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and

Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [ $\text{Pb}(\text{OAc})_4$  and  $\text{HIO}_4$ ] and pinacol pinacolone rearrangement. Trihydric alcohols- nomenclature, methods of formation, chemical reactions of glycerol.

**VI Chemistry of Phenols :** Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols–electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben Hoesch reaction, Lederer – Manasse reaction and Reimer – Tiemann reaction

**VII Chemistry of Ethers and Epoxides:** Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions– cleavage and autoxidation, Ziesel’s method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

### **VIII Chemistry of Organic Halides**

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides,  $\text{SN}^2$  and  $\text{SN}^1$  reactions with energy profile diagrams; Polyhalogen compounds : Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition – elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC.

**B. Sc Third Year**

**Semester: Fifth, Paper - 2**

**Course Title: Rearrangements and Chemistry of Group Elements**

**Subject: Chemistry**

#### **Unit Topics**

##### **I Rearrangements**

A detailed study of the following rearrangements: Pinacol-pinacolone, Demjanov, BenzilBensilic acid, Favorskii, Hofman, Curtius, Schmidt, Baeyer-Villiger and Fries rearrangement

## II 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. Phase transfer catalysts, application of zeolites as catalysts. Enzyme catalysis; Michaelis-Menten equation, turn-over number.

## III Chemistry of Main Group Elements

**s-Block Elements:** Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls.

**p-Block Elements:** Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides.

**Chemistry of Noble Gasses:** Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

## IV Chemistry of Transition Elements

**Chemistry of Elements of First Transition Series** -Characteristic properties of d-block elements. Binary compounds (hydrides, carbides and oxides) of the elements of the first transition series and complexes with respect to relative stability of their oxidation states, coordination number and geometry.

**Chemistry of Elements of Second and Third Transition Series-** General characteristics, comparative treatment of Zr/Hf, Nb/Ta, Mo/W in respect of ionic radii, oxidation states, magnetic behavior, spectral properties and stereochemistry.

## V Chemistry of Lanthanides

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, ceric ammonium sulphate and its analytical uses.

## VI Chemistry of Actinides

Electronic configuration, oxidation states and magnetic properties, chemistry of separation of Np, Pu and Am from U.

**VII Metal Carbonyls**

Metal carbonyls: 18-electron rule, preparation, structure and nature of bonding in the mononuclear and dinuclear carbonyls.

**VIII Bioinorganic Chemistry**

Essential and trace elements in biological processes, metalloporphyrins with special reference to hemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to  $\text{Ca}^{2+}$ . Nitrogen fixation.

**B. Sc Third Year****Semester: Fifth****Course Title: Qualitative Analysis****Subject: Chemistry****PRACTICAL****Unit Topics****I Inorganic Qualitative Analysis**

Semi micro Analysis– cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals- 2 +4 or 4+ or 3+3

**II Elemental analysis and identification of functional groups**

Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.

**III Separation of Organic Mixture**

Analysis of an organic mixture containing two solid components using water,  $\text{NaHCO}_3$ ,  $\text{NaOH}$  for separation and preparation of suitable derivatives

**IV Identification of organic compounds**

Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

**B. Sc Third Year****Semester: Fifth****Course Title: Classical & Statistical Mechanics****Subject: Physics**

**Unit Topics****PART A : Introduction to Classical Mechanics****I Constrained Motion**

Constraints–Definition, Classification and Examples. Degrees of Freedom and Configuration space. Constrained system, Forces of constraint and Constrained motion. Generalised coordinates, Transformation equations and Generalised notations & relations. Principle of Virtual work and D'Alembert's principle.

**II Lagrangian Formalism**

Lagrangian for conservative & non-conservative systems, Lagrange's equation of motion (no derivation), Comparison of Newtonian & Lagrangian formulations, Cyclic coordinates, and Conservation laws (with proofs and properties of kinetic energy function included). Simple examples based on Lagrangian formulation.

**III Hamiltonian Formalism**

Phase space, Hamiltonian for conservative & non-conservative systems, Physical significance of Hamiltonian, Hamilton's equation of motion (no derivation), Comparison of Lagrangian & Hamiltonian formulations, Cyclic coordinates, and Construction of Hamiltonian from Lagrangian. Simple examples based on Hamiltonian formulation.

**IV Central Force**

Definition and properties (with prove) of central force. Equation of motion and differential equation of orbit. Bound & unbound orbits, stable & non-stable orbits, closed & open orbits and Bertrand's theorem. Motion under inverse square law of force and derivation of Kepler's laws. Laplace-Runge Lenz vector (Runge-Lenz vector) and its applications.

**PART B : Introduction to Statistical Mechanics****V Macrostate & Microstate**

Macrostate, Microstate, Number of accessible microstates and Postulate of equal a priori. Phase space, Phase trajectory, Volume element in phase space, Quantisation of phase space and number of accessible microstates for free particle in 1D, free particle in 3D & harmonic oscillator in 1D.

**VI Concept of Ensemble**

Problem with time average, concept of ensemble, postulate of ensemble

average and Liouville's theorem (proof included). Micro Canonical, Canonical & Grand Canonical ensembles.

Thermodynamic Probability, Postulate of Equilibrium and Boltzmann Entropy relation.

### **VII Distribution Laws**

Statistical Distribution Laws: Expressions for number of accessible microstates, probability & number of particles in  $i$ th state at equilibrium for Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac statistics. Comparison of statistical distribution laws and their physical significance.

Canonical Distribution Law: Boltzmann's Canonical Distribution Law, Boltzmann's Partition Function, Proof of Equipartition Theorem (Law of Equipartition of energy) and relation between Partition function and Thermodynamic potentials.

### **VIII Applications of Statistical Distribution Laws**

Application of Bose-Einstein Distribution Law: Photons in a black body cavity and derivation of Planck's Distribution Law.

Application of Fermi-Dirac Distribution Law: Free electrons in a metal, Definition of Fermi energy, Determination of Fermi energy at absolute zero, Kinetic energy of Fermi gas at absolute zero and concept of Density of States (Density of Orbitals).

**B. Sc Third Year**

**Semester: Fifth**

**Course Title: Quantum Mechanics & Spectroscopy**

**Subject: Physics**

### **Unit Topics**

#### **PART A : Introduction to Quantum Mechanics**

#### **I Operator Formalism**

Operators: Review of matrix algebra, definition of an operator, special operators, operator algebra and operators corresponding to various physical-dynamical variables.

Commutators: Definition, commutator algebra and commutation relations among position, linear momentum & angular momentum and energy & time. Simple problems based on commutation relations.

## **II Eigen & Expectation Values**

Eigen & Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate & Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation.

Hermitian Operators: Definition, properties and applications. Prove of the hermitian nature of various physical-dynamical operators.

## **III Uncertainty Principle & Schrodinger Equation**

Uncertainty Principle: Commutativity & simultaneity (theorems with proofs). Non commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical- dynamical parameters and its applications.

Schrodinger Equation: Derivation of time independent & time dependent forms, Schrodinger equation as an eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation.

## **IV Applications of Schrodinger Equation**

Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator.

Application to 3D Problems: Infinite Square well potential (Particle in a 3D box) and the Hydrogen atom (radial distribution function and radial probability included).

(Direct solutions of Hermite, Associated Legendre and Associated Laguerre differential equations to be substituted).

## **PART – B : Introduction to Spectroscopy**

### **V Vector Atomic Model**

Inadequacies of Bohr and Bohr-Sommerfeld atomic models w.r.t. spectrum of Hydrogen atom (fine structure of H-alpha line). Modification due to finite mass of

nucleus and Deuteron spectrum. Vector atomic model (Stern-Gerlach experiment included) and physical & geometrical interpretations of various quantum numbers for single & many valence electron systems. LS & jj couplings, spectroscopic notation for energy states, selection rules for transition of electrons and intensity rules for spectral lines. Fine structure of H-alpha line on the basis of vector atomic model.

### **VI Spectra of Alkali & Alkaline Elements**

Spectra of alkali elements: Screening constants for s, p, d & f orbitals; sharp, principle, diffuse & fundamental series; doublet structure of spectra and fine structure of Sodium D line.

Spectra of alkaline elements: Singlet and triplet structure of spectra.

### **VII X – Rays & X – Ray Spectra**

Nature & production, Continuous X– ray spectrum & Duane – Hunt’s law, Characteristic X–ray spectrum & Mosley’s law, Fine structure of Characteristic X– ray spectrum, and X– ray absorption spectrum.

### **VIII Molecular Spectra**

Discrete set of energies of a molecule, electronic, vibrational and rotational energies. Quantisation of vibrational energies, transition rules and pure vibrational spectra. Quantisation of rotational energies, transition rules, pure rotational spectra and determination of inter nuclear distance. Rotational-Vibrational spectra; transition rules; fundamental band & hot band; O, P, Q, R, S branches.

**B. Sc Third Year**

**Semester: Fifth**

**Course Title: Demonstrative Aspects of Optics & Lasers**

**Subject: Physics**

#### **Unit Topics**

##### **Lab Experiment List**

1. Fresnel Biprism: Wavelength of sodium light
2. Fresnel Biprism: Thickness of mica sheet)
3. Newton’s Rings: Wavelength of sodium light
4. Newton’s Rings: Refractive index of liquid
5. Plane Diffraction Grating: Resolving power

**GENIC BOOKS**

6. Plane Diffraction Grating: Spectrum of mercury light
7. Spectrometer: Refractive index of the material of a prism using sodium light
8. Spectrometer: Dispersive power of the material of a prism using mercury light
9. Polarimeter: Specific rotation of sugar solution
10. Wavelength of Laser light using diffraction by single slit

**B. Sc Third Year****Semester: Fifth****Course Title: Group and Ring Theory & Linear Algebra****Subject: Mathematics****PART-A : Group and Ring Theory****Unit Topics**

- I Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups,
- II Characteristic Subgroups, Commutator subgroup and its properties; Applications of factor groups to automorphism groups, Polynomial rings over commutative rings.
- III Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein Criterion of Irreducibility of polynomials over rational field.
- IV Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.

**PART-B : Linear Algebra**

- V Vector spaces and their elementary properties Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Direct sum, Quotient space.
- VI Linear transformations, The Algebra of linear transformations, Range and Null space of a linear Transformation

VII Rank and nullity theorem, their representation as Linear Transformations and matrices, Change of Basis.

VIII Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finitedimensional spaces, Gram-Schmidt orthogonalization process.

**B. Sc Third Year**

**Semester: Fifth**

**Course Title: Multivariate Analysis and Non-parametric Methods**

**Subject: Statistics**

**Unit Topics**

I Elementary operations on Matrices, Rank of Matrix, Row and Column Rank, Inverse of a matrix. Eigen values and Eigen vectors.

II Introduction to multivariate analysis, Uses and applications of multivariate analysis, Bivariate normal distribution: definition and Simple properties.

III Multivariate Normal Distribution, Marginal and Conditional Distributions, Characteristics functions.

IV Maximum Likelihood Estimation of mean vector and Dispersion matrix and their Independence sufficient statistics of these estimates.

V Concepts and definitions of Multiple and Partial correlations and Multiple Regressions for three variables only (with their practical applications)

VI Non- parametric tests, Tests for location and symmetry, One sample tests: Sign test, Wilcoxon Signed rank tests.

VII Tests for randomness : Run test, Test for goodness of fit.

VIII Two sample tests: Median Test, Kilmogrov – Simronv'stest and Mann – Whitney U test.

**B. Sc Third Year**

**Semester: Fifth**

**Course Title: Analysis of Variance and Design of experiment**

**Subject: Statistics**

**Unit Topics**

- I Definition of Analysis of variance, assumptions and Limitations of ANOVA, One way classification.
- II Two way classification with one observation per cell. Multiple comparison tests using critical difference criteria.
- III Principles of Design of Experiment: Randomization, Replication and Local Control, Choice of size and type of a plot using uniformity trials.
- IV Completely Randomized Design (CRD), Concept and definition, statistical analysis of CRD, Merits and demerits.
- V Randomized Block Design (RBD), Concept and definition of efficiency of design, Comparison of efficiency between CRD and RBD.
- VI Latin Square Design (LSD), Lay-out, ANOVA table, Comparison of efficiencies between LSD and RBD; LSD and CRD.
- VII Missing plot technique: Estimation of missing plots by minimizing error sum of squares in RBD and LSD with one missing observation.
- VIII Factorial Experiments: General description of factorial experiments,  $2^2$ ,  $2^3$  and  $2^n$  factorial experiments arranged in RBD and LSD, Definition of Main effects and interactions in  $2^2$  and  $2^3$  factorial experiments.

**B. Sc Third Year****Semester: Fifth****Course Title: Non-parametric Methods and DOE Lab****Subject: Statistics****Unit Topics**

- 1. Problems based on Non-parametric tests for one sample.
- 2. Problems based on Non-parametric tests for two sample.
- 3. Problems based on Rank and Inverse of a matrix.
- 4. Problems based on Mean vector and Dispersion matrix of a multivariate normal distribution.

5. Problems based on Analysis of variance in one-way and two-way classification.
6. Problems based on Analysis of a Latin square design.
7. Problems based on Analysis of variance in RBD and LSD with one missing observation.

**B. Sc Third Year****Semester: Sixth****Course Title: Evolutionary and Developmental Biology****Subject: Zoology****Unit Topic****I Theories of Evolution**

- Origin of Life
- Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artificial selection)
- Modern synthetic theory of evolution
- Patterns of evolution (Divergence, Convergence, Parallel, Coevolution)

**II Population Genetics**

- Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy- Weinberg equilibrium and conditions for its maintenance
- Forces of evolution: mutation, selection, genetic drift

**III Direct Evidences of Evolution**

- Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

**IV Species Concept and Extinction**

- Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)
- Mass extinction (Causes, Names of five major extinctions)

## **GENIC BOOKS**

### **V Gamete Fertilization and Early Development**

- Gametogenesis, Fertilization
- Cleavage pattern
- Gastrulation, fate maps
- Developmental mechanics of cell specification
- Morphogenesis and cell adhesion

### **VI Developmental Genes**

- Genes and development
- Molecular basis of development
- Differential gene expression

### **VII Early Vertebrate Development**

- Early development of vertebrates (fish, birds & mammals)
- Metamorphosis, regeneration and stem cells
- Environmental regulation of development

### **VIII Late Developmental Processes**

- The dynamics of organ development
- Development of eye, kidney, limb
- Metamorphosis: the hormonal reactivation of development in amphibians, insects
- Regeneration: salamander limbs, mammalian liver, Hydras
- Aging: the biology of senescence

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Ecology, Ethology, Environmental Science and Wildlife**

**Subject: Zoology**

**Unit Topic**

**I Introduction to Ecology**

- History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors

**II Organization of Ecosystem**

- Levels of organization, Laws of limiting factors, Study of physical factors,
- Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion. Exponential and logistic growth,
- Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, , Food web, Energy flow through the ecosystem,
- Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Carbon cycle

**III Community Ecology**

Community characteristics: species richness, dominance, diversity, abundance, Ecological succession with one example

**IV Environmental Hazards**

- Sources of Environmental hazards
- Climate changes
- Greenhouse gases and global warming
- Acid rain, Ozone layer destruction

**V Effects of Climate Change**

- Effect of climate change on public health
- 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.

## **GENIC BOOKS**

### **VI Behavioural Ecology and Chronobiology**

- Origin and history of Ethology,
- Instinct vs. Learnt Behaviour
- Associative learning, classical and operant conditioning, Habituation, Imprinting,
- Circadian rhythms; Tidal rhythms and Lunar rhythms
- Chronomedicine

### **VII Introduction to Wild Life**

- Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.

### **VIII Protected areas**

- National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Lab on Ecology, Environmental Science, Behavioral Ecology & wildlife**

**Subject: Zoology**

### **PRACTICAL**

#### **Unit Topics**

- I** 1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
  2. Study of population dynamics through numerical problems.
  3. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
- II** Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

- III** 1. Demonstration of basic equipment's needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
2. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
3. Demonstration of different field techniques for flora and fauna

**B. Sc Third Year**

**Semester: Sixth, Paper - I**

**Course Title: Cytogenetic, Plant Breeding & Nanotechnology**

**Subject: Botany**

### **Unit Topics**

#### **I Cell biology**

Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus.

Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes- Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram. Cell cycle: G<sub>0</sub>, G<sub>1</sub>, S and G<sub>2</sub> phases- mitosis: open and closed mitosis- amitosis- meiosis. Variation in Chromosome number (Numerical aberrations)- aneuploidy and Euploidy- haploidy, polyploidy- significance (Structural aberrations)- deletion, duplication, inversion and translocation.

#### **II Genetics**

Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Linkage, crossing over, Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants

#### **III Plant breeding**

## **GENIC BOOKS**

Plant introduction. Agencies of plant introduction in India, Procedure of introduction – Acclimatization – Achievements, Selection – mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, Molecular Breeding (use of DNA markers in plant breeding), achievements in India, Breeding for pest, pathogenic diseases and stress resistance.

### **VI Biostatistics:**

Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling, Frequency distribution- definition only, Central tendency– Arithmetic Mean, Mode and Median; Measurement of dispersion–Coefficient of variation, Standard Deviation, Standard error of Mean; Test of significance: chi-square test for goodness of fit. Computer application in biostatistics – MS Excel and SPSS

### **V Plant tissue culture**

Principles, components and techniques of in vitro plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.

### **VI Nanotechnology**

Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Nanoparticles synthesis, Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.

### **VII Artificial Intelligence in Plant Sciences**

Big Data Analytics, Blockchain Technology, 3-D Printing, Machine learning, Algorithms of Machine Learning, Expert systems and Fuzzy logic ,

Artificial Neural Networks and Genetic algorithms, Predictive Analytics, Agents and Robotics, IoT Sensors, Object Image capture & analysis ; Applications of Artificial Neural Networks in Plant Science.

### **VIII Introduction to use of Digital technologies – AI, IoT & ICT in Botany**

Educational software- INFLIBNET, NICNET, BRNET, internet as a knowledge repository- google scholar, science direct. resource management, weather forecasting. IoT Database management, IoT platforms, IoT Graphical user interface  
• IoT application development for Android Mobile phones, ICT Applications for different crops and horticulture

**B. Sc Third Year**

**Semester: Sixth, Paper - II**

**Course Title: Ecology & Environment**

**Subject: Botany**

#### **Unit Topics**

**I Natural resources & Sustainable utilization:** Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water, Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy, Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.

#### **II Ecology & Ecosystem**

Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic com-Energy flow in an ecosystem

Ecological Succession-Definition & types. Processes and types (autogenic allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere.

Food chains and food webs, Ecological pyramids, production and productivity; And components.

Types of ecosystems: Forest Ecosystem, Grassland, Crop land, aquatic Ecosystems Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.

### **III Soil Formation, Properties & Conservation**

Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Crop rotation. Mechanical–Basin Listing, Construction of dams, Watershed Management, Soil reclamation

### **IV Biodiversity and its conservation:**

Definition -genetic, species, and ecosystem diversity. Value of biodiversity: social, ethical, aesthetic and option values; hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators. Conservation of Biodiversity:

Ex-situ and in-situ conservation, Red data book, botanical gardens, National park, Sanctuaries, hot & hottest spots and Bioreserves. Role of Seed Bank and Gene Bank

Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI.

### **V Phytogeography:**

Biogeographic regions of India & world, Agroecological & Floristic zones of India. Natural vegetation of India, static and dynamic plant geography, basic principles governing geographical distribution of plants, Phytogeographical regions of India, Vegetational types in Uttar Pradesh.

### **VI Environmental audit & Sustainability**

Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice.

### **VII Pollution, Waste management & Circular Economy**

Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge

management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG ;Waste- Types , collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) - classification, collection and segregation , Incineration, Pyrolysis and gasification , Sanitary landfilling ; composting, Biogas production ,Circular Economy & sustainability.

### **VIII Environmental ethics, Carbon Credits & Role of GIS**

Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways.

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Wasteland reclamation. Consumerism and waste products. Clean development mechanism.

Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.

**B. Sc Third Year**

**Semester: Sixth, Paper - III**

**Course Title: Lab on Cytogenetics, Conservation & Environment management**

**Subject: Botany**

#### **Unit Topics**

##### **I Cell biology**

1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
2. Measurement of cell size by the technique of micrometry.
3. Counting cells per unit volume with the help of haemocytometer (Yeast/ pollen grains)
4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa.

## **GENIC BOOKS**

### **II Genetics**

1. Monohybrid cross (Dominance and incomplete dominance)
2. Dihybrid cross (Dominance and incomplete dominance)
3. Gene interactions (All types of gene interactions mentioned in the syllabus)
  - a. Recessive epistasis 9: 3: 1.
  - b. Dominant epistasis 12: 3: 1
  - c. Complementary genes 9: 7
  - d. Duplicate genes with cumulative effect 9: 6: 1
  - e. Inhibitory genes 13: 3
4. Observe the genetic variations among inter and intra specific plants.
5. Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment.

### **III Biostatistics:**

1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size).
2. Calculation of correlation coefficient values and finding out the probability.
3. Determination of goodness of fit in Mendellian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance.
4. Computer application in biostatistics - MS Excel and SPSS

### **IV Plant tissue culture**

1. Familiarization of instruments and special equipments used in the plant tissue culture experiments
2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media.
3. Surface sterilization of plant materials for inoculation (implantation in the medium)

4. Micropropagation of potato/tomato/ - Demonstration
5. Protoplast isolation and culturing – Demonstration

#### **V Ecology & Environment**

1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites
2. Study of morphological adaptations of hydrophytes and xerophytes (four each).
3. Study of biotic interactions of: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).
4. Observation and study of different ecosystems mentioned in the syllabus.
5. Field visit to familiarize students with ecology of different sites

#### **VI Soil Formation, Properties & Conservation**

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
  - a. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
3. Soil Profile study
4. Soil types of India-Map

#### **VII Biodiversity and Phytogeography:**

1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/field visit).
2. Marking of vegetation types of India, World & Uttar Pradesh on maps
3. Phytogeographical areas of India

#### **VIII Pollution & Waste management**

## **GENIC BOOKS**

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter
2. Estimation of chloride and dissolved oxygen content in water sample
3. Comparative anatomical studies of leaves from polluted and less polluted areas.
4. Measurement of dissolved O<sub>2</sub> by azide modification of Winkler's method.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water
7. Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung.

### **Climate Change, Carbon Credits & Role of GIS**

1. Conducting Waste Audit of your Institution –Demo
2. Green auditing of the College/University –Demo

## **B. Sc Third Year**

**Semester: Sixth, Paper - IV**

**Course Title: Project in Botany for Graduation**

**Subject: Botany**

### **Course outcomes:**

After completing this course a student will have:

- Project work will supplement field experimental learning and deviations from classroom and laboratory transactions.
- project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes
- It will promote creativity and the spirit of enquiry in learners.
- They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing

- It will enhance their abilities, enthusiasm, and interest.

**B. Sc Third Year****Semester: Sixth, Paper – I****Course Title: Organic Synthesis - B****Subject: Chemistry****Unit Topics****I Reagents in Organic Synthesis**

A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO<sub>2</sub>, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetraoxide. Reduction with NaBH<sub>4</sub>, LiAlH<sub>4</sub>, Meerwein – Ponndorf – Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H

**II Organometallic Compounds**– Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.

**III Chemistry of Aldehydes and ketones:** Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1, 3–dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH<sub>4</sub> and NaBH<sub>4</sub> reductions. Halogenation of enolizable ketones An introduction to  $\alpha, \beta$  unsaturated aldehydes and Ketones.

**IV Carboxylic acids and their Functional Derivatives**

Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric

acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.

### **V Organic Synthesis via Enolates**

Acidity of  $\alpha$ -hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines.

**VI Organic Compounds of Nitrogen-** Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrites), reductive amination of aldehydic and ketonic compounds, Gabriel- phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling

### **VII Heterocyclic Chemistry**

Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis, Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline

### **VIII Natural Products**

**Alkaloids & Terpenes:** Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification; Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.

**B. Sc Third Year****Semester: Sixth, Paper – II****Course Title: Chemical Energetics and Radio Chemistry****Subject: Chemistry****Unit Topics****I Thermodynamics – 1 :**

**First Law of Thermodynamics:** Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law– Joule– Thomson coefficient and inversion temperature. Calculation of  $w$ ,  $q$ ,  $dU$  &  $dH$  for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

**Thermochemistry:** Standard state, standard enthalpy of formation– Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation.

**II Thermodynamics II**

Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature.

Concept of Entropy, Entropy as a state function, entropy as a function of  $V$  &  $T$ , entropy as a function of  $P$  &  $T$ , entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions

Gibbs function ( $G$ ) and Helmholtz function ( $A$ ) as thermodynamic quantities.  $A$  &  $G$  as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of  $G$  and  $A$  with  $P$ ,  $V$  and  $T$ .

Third Law of Thermodynamics; Nernst heat theorem, statement and concept of residual entropy. Nernst distribution law– Thermodynamic derivation, applications.

**III Electrochemistry:** Electrical transport:- Conduction in metals and in electrolyte solutions, specific conductance molar and equivalent conductance, measurement of equivalent conductance, variation of molar,

equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes . Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method.

**IV Ionic Equilibrium:** Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, Electrolytic and Galvanic cells–Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Definition of pH and pKa, determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers– Mechanism of buffer action, Henderson-Hassel equation, application of buffer solution. Hydrolysis of salts

**V Photo Chemistry:** Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus-Draper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions– energy transfer processes (simple examples), kinetics of photochemical reaction.

**VI Colligative Properties-**Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes.

#### **VI - I Surface Chemistry**

**Adsorption:** Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation

required); Gibbs adsorption isotherm and surface excess; Heterogeneous catalysis (single reactant);

**Colloids:** Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids, Coagulation and Schulz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation

## **VI – II Radiochemistry**

Natural and induced radioactivity; radioactive decay- $\alpha$ -decay,  $\beta$ -decay,  $\gamma$ -decay; neutron emission, positron emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttall rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine- $^{99m}\text{Tc}$  radiopharmaceuticals

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Analytical Methods**

**Subject: Chemistry**

### **PRACTICAL**

#### **Unit Topics**

##### **I Gravimetric Analysis**

1. Analysis of Cu as  $\text{CuSCN}$ ,
2. Analysis of Ni as Ni (dimethylglyoxime)
3. Analysis of Ba as  $\text{BaSO}_4$ .

##### **II Paper Chromatography**

Ascending and Circular. Determination of  $R_f$  values and identification of organic compounds: Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent– ninhydrin. Separation of a mixture of D, L– alanine, glycine, and L-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent– ninhydrin. Separation of monosaccharides– a mixture of D- galactose and D– fructose using n- butanol: acetone: water (4:5:1). Spray reagent– aniline hydrogen phthalate

##### **III Thin Layer Chromatography**

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Determination of  $R_f$  values and identification of organic compounds:  
Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2, 4- dinitrophenyl hydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)

### **IV Thermochemistry**

1. To determine the solubility of benzoic acid at different temperatures and to determine  $\Delta H$  of the dissolution process
2. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base
3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Solid State & Nuclear Physics**

**Subject: Physics**

### **Unit Topics**

#### **PART – A : Introduction to Solid State Physics**

##### **I Crystal Structure**

Lattice, Basis & Crystal structure. Lattice translation vectors, Primitive & non-primitive cells. Symmetry operations, Point group & Space group. 2D & 3D Bravais lattice. Parameters of cubic lattices. Lattice planes and Miller indices. Simple crystal structures - HCP & FCC, Diamond, Cubic Zinc Sulphide, Sodium Chloride, Cesium Chloride and Glasses.

##### **II Crystal Diffraction**

X-ray diffraction and Bragg's law. Experimental diffraction methods - Laue, Rotating crystal and Powder methods. Derivation of scattered wave amplitude. Reciprocal lattice, Reciprocal lattice vectors and relation between Direct & Reciprocal lattice. Diffraction conditions, Ewald's method and Brillouin zones. Reciprocal lattice to SC, BCC & FCC lattices. Atomic Form factor and Crystal Structure factor.

### **III Crystal Bindings**

Classification of Crystals on the Basis of Bonding - Ionic, Covalent, Metallic, van der Waals (Molecular) and Hydrogen bonded. Crystals of inert gases, Attractive interaction (van der Waals- London) & Repulsive interaction, Equilibrium lattice constant, Cohesive energy and Compressibility & Bulk modulus. Ionic crystals, Cohesive energy, Madelung energy and evaluation of Madelung constant.

### **IV Lattice Vibrations**

Lattice Vibrations: Lattice vibrations for linear mono & di atomic chains, Dispersion relations and Acoustical & Optical branches (qualitative treatment). Qualitative description of Phonons in solids. Lattice heat capacity, Dulong-Petit's law and Einstein's theory of lattice heat capacity.

Free Electron Theory: Fermi energy, Density of states, Heat capacity of conduction electrons, Paramagnetic susceptibility of conduction electrons and Hall effect in metals.

Band Theory: Origin of band theory, Qualitative idea of Bloch theorem, Kronig-Penney model, Effective mass of an electron & Concept of Holes & Classification of solids on the basis of band theory.

## **PART – B : Introduction to Nuclear Physics**

### **V Nuclear Forces & Radioactive Decays**

General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor.

Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties. Radioactive Decays: Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay & electron capture, fundamental laws of radioactive disintegration and radioactive series.

### **VI Nuclear Models & Nuclear Reactions**

Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Single particle shell model (the level scheme in the context of reproduction of magic numbers included).

Nuclear Reactions: Bethe's notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative), Nuclear reactors and Nuclear fusion.

### **VII Accelerators & Detectors**

Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron.

Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.

### **VIII Elementary Particles**

Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum, angular momentum, electric charge, baryonic charge, leptonic charge, isospin & strangeness. Concept of Quark model.

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Analog & Digital Principles & Applications**

**Subject: Physics**

### **Unit Topics**

#### **PART – A : Analog Electronic Circuits**

##### **I Semiconductor Junction**

Expressions for Fermi energy, Electron density in conduction band, Hole density in valence band, Drift of charge carriers (mobility & conductivity), Diffusion of charge carries and Life time of charge carries in a semiconductor. Work function in metals and semiconductors.

Expressions for Barrier potential, Barrier width and Junction capacitance (diffusion & transition) for depletion layer in a PN junction. Expressions for Current (diode equation) and Dynamic resistance for PN junction.

##### **II Transistor Modeling**

Transistor as Two-Port Network. Notation for dc & ac components of voltage & current. Quantitative discussion of Z, Y & h parameters and their equivalent two-generator model circuits. h-parameters for CB, CE & CC configurations. Analysis of transistor amplifier using the hybrid equivalent model and estimation of Input Impedance, Output Impedance and Gain (current, voltage & power).

### **III Field Effect Transistors**

JFET: Construction (N channel & P channel); Configuration (CS, CD & CG); Operation in different regions (Ohmic or Linear, Saturated or Active or Pinch off & Break down); Important Terms (Shorted Gate Drain Current, Pinch Off Voltage & Gate Source Cut-Off Voltage); Expression for Drain Current (Shockley equation); Characteristics (Drain & Transfer); Parameters (Drain Resistance, Mutual Conductance or Transconductance & Amplification Factor); Biasing w.r.t. CS configuration (Self Bias & Voltage Divider Bias); Amplifiers (CS & CD or Source Follower); Comparison (N & P channels and BJTs & JFETs).

MOSFET: Construction and Working of DE-MOSFET (N channel & P channel) and E-MOSFET (N channel & P channel); Characteristics (Drain & Transfer) of DE-MOSFET and E-MOSFET; Comparison of JFET and MOSFET.

### **IV Other Devices**

SCR: Construction; Equivalent Circuits (Two Diodes, Two Transistors & One Diode-One Transistor); Working (Off state & On state); Characteristics; Applications (Static switch, Phase control system & Battery charger).

UJT: Construction; Equivalent Circuit; Working (Cutoff, Negative Resistance & Saturation regions); Characteristics (Peak & Valley points); Applications (Trigger circuits, Relaxation oscillators & Sawtooth generators).

## **PART – B : Digital Electronics**

### **V Number System**

Number Systems: Binary, Octal, Decimal & Hexadecimal number systems and their inter conversion.

Binary Codes: BCD, Excess-3 (XS3), Parity, Gray, ASCII & EBCDIC Codes and their advantages & disadvantages. Data representation.

### **VI Binary Arithmetic**

Binary Addition, Decimal Subtraction using 9's & 10's complement, Binary Subtraction using 1's & 2's compliment, Multiplication and Division.

### **VII Logic Gates**

Truth Table, Symbolic Representation and Properties of OR, AND, NOT, NOR, NAND, EX-OR & EX-NOR Gates. Implementation of OR, AND & NOT gates (realization using diodes & transistor). De Morgan's theorems. NOR & NAND

## **GENIC BOOKS**

gates as Universal Gates. Application of EX-OR & EX-NOR gates as parity checker. Boolean Algebra. Karnaugh Map.

### **VIII Combinational & Sequential Circuits**

Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Subtractor, Full Subtractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders.

Sequential Circuits: SR, JK & D Flip-Flops, Shift Register (transfer operation of Flip-Flops), and Asynchronous & Synchronous counters.

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Analog & Digital Circuits**

**Subject: Physics**

#### **Unit Topics**

##### **Lab Experiment List**

1. Energy band gap of semiconductor by reverse saturation current method
2. Energy band gap of semiconductor by four probe method
3. Hybrid parameters of transistor
4. Characteristics of FET, MOSFET, SCR, UJT
5. FET Conventional Amplifier
6. FET as VVR and VCA
7. Study and Verification of AND gate using TTL IC 7408
8. Study and Verification of OR gate using TTL IC 7432
9. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400
10. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402
11. Study and Verification of NOT gate using TTL IC 7404
12. Study and Verification of Ex-OR gate using TTL IC 7486

**B. Sc Third Year****Semester: Sixth****Course Title: Number Theory & Game Theory****Subject: Mathematics****Unit Topics****PART – A : Number Theory****I Theory of Numbers**

Divisibility; Euclidean algorithm; primes; congruences; Fermat's theorem, Euler's theorem and Wilson's theorem; Fermat's quotients and their elementary consequences; solutions of congruences; Chinese remainder theorem; Euler's phi-function.

**II Congruence**

Congruence modulo powers of prime; primitive roots and their existence; quadratic residues; Legendre symbol, Gauss' lemma about Legendre symbol; quadratic reciprocity law; proofs of various formulations; Jacobi symbol.

**III Diophantine Equations**

Solutions of  $ax + by = c$ ,  $x^2 + y^2 = z^2$ ; properties of Pythagorean triples; sums of two, four and five squares; assorted examples of Diophantine equations.

**IV Generating Functions and Recurrence Relations**

Generating Function Models, calculating coefficient of generating functions, Partitions, Exponential Generating Functions, A Summation Method. Recurrence Relations: Recurrence Relation Models, Divide and conquer Relations, Solution of Linear, Recurrence Relations, Solution of Inhomogeneous Recurrence Relations, Solutions with Generating Functions.

**PART – B : Game Theory**

**V** Introduction, overview, uses of game theory, some applications and examples, and formal definitions of: the normal form, payoffs, strategies, pure strategy Nash equilibrium.

**VI** Introduction, characteristic of game theory, Two- person zero-sum game, Pure and Mixed strategies, Saddle point and its existence.

## **GENIC BOOKS**

**VII** Fundamental Theorem of Rectangular games, Concept of Dominance, Dominance and Graphical method of solving rectangular games.

**VIII** Relationship between rectangular game and Linear Programming Problem, reduction of  $m \times n$  game and solution of  $2 \times 2$ ,  $2 \times s$ , and  $r \times 2$  cases by graphical method. Algebraic and linear programming solution of  $m \times n$  games.

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Statistical Computing and Introduction to Statistical Software**

**Subject: Statistics**

### **Unit Topics**

- I Introduction to Computer: Generation of Computer, Basic Structure of Computer, Digital computer and its peripherals, number systems (Binary, Octal, Hexadecimal Systems). Flow chart for simple statistical problems.
- II Solid Understanding of Basics Excel:- Getting Start with Excel, Working with Cell and Ranges, Data Entry & Editing Number formatting, delete, insert and adjust cells, columns and rows, Preview and print workbook.
- III Custom Fill, Autofill, Flash fill, Date & Time, Data Formatting. Sort & Filter, Grouping Sheets, Managing worksheets Changing Name, Colour, Add, Delete, Hide/Unhide, Worksheet Views- Comparing Sheet Side by Side, Splitting Sheet into Panes, freezing Panes.
- IV Using Excel: Basic Mathematical functions, Graphs, Descriptive Statistics, Analysis of Variance (One-way & Two way ANOVA), Karl Pearson correlation coefficient, Regression Analysis.
- V Introduction to R Programming and R Studio, Installing R, Ras a calculator. Creating a data set, Understanding a data set, Data structure: Vectors, Matrices, Arrays, Data Frames, Factors and Lists
- VI Data inputs: Entering data from the keyboard, Importing Data, creating new variables, recoding variable, renaming variables,
- VII Graphs using R, Inferential Statistics- Parametric test: Test for Normality, t-test for single mean, t-test for difference between means, paired t-test.

VIII Using R: Wilcoxon signed rank sum test, Mann Whitney U test, Kolmogorov-Smirnov Test for normality, Analysis of Variance (One-way & Two way ANOVA), Karl Pearson correlation coefficient, Regression Analysis.

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Operations Research**

**Subject: Statistics**

**Unit Topics**

- I History & background of OR, Applications and uses of OR in different fields, General linear programming problems and their formulations.
- II Solving LPP by Graphical Method Solving LPP by Simplex method.
- III Method Solving LPP by Big-M method and Two phase Method.
- IV Transportation problem: North-west corner rule, Least cost method, Vogel's approximation method. Optimum solution: Modi method.
- V Assignment Problem: Hungarian Method, Travelling Salesman Problem,
- VI Job sequencing: n jobs - 2 machines, n jobs - k machines, 2 jobs-n machines.
- VII Game theory: Introduction, Competitive Situations, Characteristics of Competitive Games. Rectangular game, Two-Person Zero-Sum game, minimax – maximin principle, Solution to rectangular game using graphical method
- VIII Dominance rule to reduce the game matrix and solution of Payoff matrix with mixed strategy.

**B. Sc Third Year**

**Semester: Sixth**

**Course Title: Operations Research and Research and Statistical computing Lab**

**Subject: Statistics**

**Unit Topics**

- 1. Problem based on Mathematical formulation of L.P.P

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2. Problem based on solving LPP using Graphical Method
3. Problem based on solving LPP using Simplex Method
4. Problem based on solving LPP using Big M method involving artificial variables.
5. Allocation Problem based on Transportation model.
6. Allocation Problem based on Assignment model.
7. Problems based on Game payoff matrix.
8. Problem based on solving Graphical solution to  $m \times n$  rectangular game.
9. Problem based on solving Mixed strategy game.
10. Problem based on application of R as Calculator.
11. Problem based on application of R in simple data analysis
12. Problem based on application of Excel in data analysis

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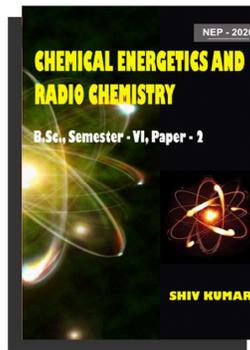
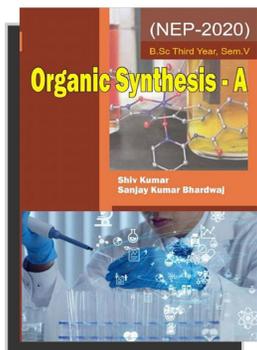
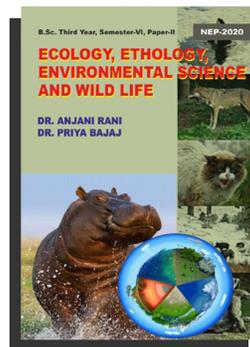
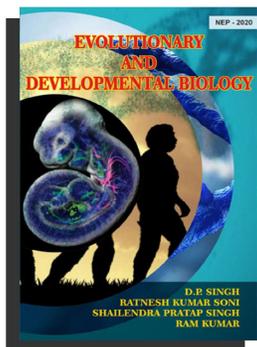
- Books
- Syllabus
- Unsolved Papers
- Question Bank
- Competitive Exam Books
- Research Project / Assignment / Thesis Work

**Co-curricular**

I SEM.	Food Nutrition and Hygiene	Z010101T
II SEM.	First AID and Health	Z020201
III SEM.	Human Values and Environment Studies	Z030301
IV SEM.	Physical Education and Yoga	Z040401
V SEM.	Analytic Ability and Digital Awareness	Z050501
VI SEM.	Communication Skills and Personality Development	Z060601

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