Syllabus for the post of Senior Laboratory Assistant
(Required Educational Qualification: Degree in Science)

Chemistry

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; Nucleophlicity 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.

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.

Unit III: Chemistry of Aliphatic Hydrocarbons

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

B. 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, hydroboration-oxidation, 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 benzylicbromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

C. 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. Unit IV: 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.

Physical chemistry

Unit I: Gaseous state:

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. 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 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.

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.

Unit III: 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. Defects in crystals. Glasses and liquid crystals.

Unit IV: 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; dissociation constants of mono-, di- and triprotic acids (exact treatment).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. 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.

Inorganic Chemistry

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.Normal and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions. 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.

Unit II: Periodicity of Elements: 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 & 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) Ionization 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-Jaffe's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.Sanderson's electron density ratio.

Unit III: Chemical Bonding:

(i) Ionic 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, 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.

(iii) Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

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

(v) 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.

(vi) Acids and Bases: Brönsted- Lowry concept of acid-base reaction, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

Unit IV : Inorganic Polymers:

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes.Borazines, silicates and phosphazenes, and polysulphates

Unit V: 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 &Bsworth diagrams).Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

Organic Chemistry –

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Unit IV: 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.

Unit V: Alchols, Phenols, Ethers and epoxide:

Alcohols: preparation, properties and relative reactivity of 10 , 20 , 30 alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation 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 $LiAlH_4$

Unit VI: Carbonyl Compounds: Structure, reactivity and preparation; 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 and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enoltautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Biology

UNIT 1:LIGHT AND LIFE

Nature of light, spectrum of light useful for various biological processes in the life of plants and animals, spectrum of light which is harmful to life, unit of light energy (Photon, quantum), Photo Biological reactions.Measurement of light (Lux, Foot Candle). Pigments associated with harvesting light energy: pigments/receptors of light, chlorophylls, caroteniods, phycobilinoproteins, bacteriochlorophylls, phytochromes, Rhodopsin etc. chemistry and functional roles.Photosynthesis: History, Photosynthetic equations, Light and dark reactions, mechanism of photolysis of water and oxygen evolution; C3, C4, CAM plants, spectrum of photoautotrophs, photoautotroph vsphotoheterotrophs; Photoautotroph vs. chemoautotroph, structure of chloroplast and quantasome, Anoxygenic and oxygenic photosynthesis, reaction centers.

UNIT 2: BIODIVERSITY & BIO-PROSPECTING

- Defining Biodiversity - Components of biodiversity. Biodiversity crisis and biodiversity loss. Importance of biodiversity in daily life. Biodiversity and climate change. Types of Ecosystems : India as mega biodiversity Nation. Hot spots and biodiversity in India. Biodiversity and Ecosystem functioning. Plant and Animal systematic. Species concept in biodiversity studies.
- Modern Tools in the study of Biodiversity : Endemism, endemic plants and animals; Assessment of mapping of biodiversity; GIS/Remote sensing; Biotechnology and Conservation, IUCN; Germplasm banks, National Parks, Botanical Gardens; Wildlife Sanctuaries, Bioresources
- Representative type (one each) studies from Cryptogams, Phanerogams, Non-chordates and Chordates: Sacred flora and fauna 20 Periods Bio-prospecting Micro organisms as a source of novel enzymes, antibiotics, antiviral agents; Immunosuppresive agents and other therapeutic agents. Botanicals for Biocontrol, Health and biodiversity.

Unit 3 :ECOLOGY : CONCEPTS & MANAGEMENT

- Ecology: History, definition, ecological factors (abiotic and biotic factor), ecological range (Eury , Steno) Stress and adaptation (Morphological, physiological, anatomical and biochemical), Biotic interaction, phenotypic and genotypic plasticity, canalization.
- Ecosystem: Concept, components, (e.g., aquatic, marine, forest, grassland, desert, fish tank, cuxenic cultures, complete and incomplete ecosystem), energy flow(GFC, DFC),

food web, niche , Gause's exclusion principle, Leibig's law, ecological pyramids, Autecology and Synecology, r- & k-selections, carrying capacity, population dynamics,(exponential & logistic growth curves),keystone species

- Pollution Pollution of Soil, water, air (types of pollutants and sources), noise pollution, radiation pollution, remedial measures, bioamplification Disaster management : Types of disasters & Management strategy
- Behavioral ecology: social, reproductive & territorial behavior, evolution of optimal life history, reproductive structure and mating system, microbial ecology

Unit 4: Biomolecules

- **Biomolecules: Diversity and distribution Lipids:** Role of lipids in cellular architecture and functions. Definition and classification of lipids. Structure and function of fatty acids, triacylglycerols, phospholipids and sterols. Carbohydrates: Biological roles of carbohydrates. Structure of monosacharides- Hexoses and pentoses. Disacharides-Sucrose, lactose, maltose. Storage and structural polysacharidesGlycogen, starch and cellulose. Nucleic acids: Role of nucleic acids in living system. Composition of nucleic acids-the purine and pyrimidine bases. Structure of nucleosides and nucleotide, deoxynucleotides, cyclic nucleotides and polynucleotides. Watson and Crick model for DNA. Different classes of RNA.
- Proteins Classification of proteins on the basis of composition, conformation and function-functional diversity of proteins. The amino acid building blocks-classification, structure and physical properties of the standard amino acids. Proteinaceous and non-proteinaceous, essential and non-essential amino acids. Primary, secondary, tertiary and qua ternary structure of proteins. Structure of myoglobin and hemoglobin. Molecular physiology of myoglobin and hemoglobin, Bohr effect, Hill's coefficient. Concerted and sequential models for allosteric proteins
- Enzymes as biological catalysts. Enzyme classification and nomenclature. Chemical nature of enzymes, ribozymes. Concept of active site, specificity. Coenzymes, cofactors and prosthetic groups. Kinetics of enzyme catalyzed reactions - MichaelisMenten equation. Determination of Km and Vmax. Factors influencing the rate of enzyme catalyzed reactions. Enzyme inhibitions- competitive, non-competitive and uncompetitive inhibitions. Catalytic mechanism of lysozyme, chymotrypsin and Hexokinase. Regulation of enzyme activityallosteric enzymes, feedback inhibition with ATcase as an example.
- Medicinal Chemistry and Role of Metal ions in Biology Structure based drug design, combinatorial chemistry and high throughput screening. Combinatorial synthesis in medicinal chemistry-solid phase synthesis, Houghton's teabag method, mix split method. Introduction to pharmacology, pharmacokinetics, safety and efficacy of the candidate drugs, toxicity and adverse reactions, clinical trials; Metalloprotein, Metaloenzymes,

metal base drug interaction and inhibition; metalloporphyrins, Redox carriers in mitochondrial electron transport chain

Unit-5 METABOLISM, INTEGRATION AND ADAPTATION

- Concept of Metabolism :Experimental approaches to study metabolism; Primary and secondary metabolism
- Major metabolic pathways & Regulation : Glycolysis, the TCA cycle, Oxidative degradation of fatty acids and amino acids in animal tissues; correlation between carbohydrate, amino acids and fatty acid degradation Selected metabolic pathways (for example biosynthesis of rubber, antibiotics etc.); Regulation of metabolism and environmental cues. Metabolic inter relationships – starve feed cycle. Mechanisms involved in switching liver metabolism between the well feed and starved states. Inter relationship of tissue in nutritional and hormonal states
- Special aspects of metabolic regulation, Tissue specialization : Function. Intracellular communications and signal transduction mechanisms; developmental adaptations – eg: rat, C3, C4 plants; Metabolic basis of health and disorders – Jaundice – diabetes mellitus, exercise, alcohol abuse
- Use of microbes for specific metabolic tasks : Alternate metabolic cycles, Carbon metabolism of intracellular bacterial pathogens; Environmental cleaning, biotransformation of metals; Metabolic handling of xenobiotics and drug resistance; Photo and lithotrophic metabolic capabilities; myporia

Unit 6 SYSTEM PHYSIOLOGY & BEHAVIOUR

- Movements and Bulk Transport Cellular movements, ciliary and flagellar structure and function; Introduction to musculo skeletal system; Terrestrial, aquatic and aerial locomotion; Locomotory cost; Bulk transport of water and nutrients in plants; General plan of circulatory system in vertebrates and invertebrates; Cardiovascular system ; structure and function
- Gas exchange in organism; Generation and utilization of energy Exchange in unicellular organisms and plants; Respiratory organs in aquatic and terrestrial systems ; Physiology of aquatic breathing and aerial breathing; Feeding patterns, digestive tract systems; Digestion of food
- Regulatory Physiology Regulation of water in aquatic and terrestrial animals; Water and solute excretion in organisms,; osmoregulatory organs; Transpiration in plants; Excretion of nitrogenous wastes in animals; Patterns of Thermoregulation : Ectotherms and Endotherms; Structural and functional adaptation to stress
- Integrative Physiology An overview of neuronal structure and function; Sensory physiology –mechano, chemo, thermo, photo and electro receptors; Endocrine systems in

animals and their physiological effects; Plant hormones and their physiological effects; Regulation of metabolism and response to environmental cues; Neuronal basis of behaviour; Behaviour concepts and measurement

Unit 7:DEFENCE MECHANISM

- Adaptive Immunity in Plants; Abiotic- Strategies and mechanisms; Biotic- interactions with symbionts, pathogens, Biochemical host defences, Basal resistance,Gene for gene concept, Cytological protection and induced resistance; Passive defences; Active defences
- Adaptive Immunity in Animals; Antigens; Adaptive immunity; B-Cell Biology - Antibody structure, B-cell development, Receptor diversity, Monoclonl Antibodies, Humoral response ; T-Cell Biology - T cell development , Structure of TCR, Thymic education, Antigen Processing and Presentation, Cell mediated immune response; Mucosal immune system; Techniques based on antigen- antibody interactions:
- Immune Mechanism Dysfunction & Applications; Hypersensitivity; Autoimmunity; Immunodeficiency; Immune response against major classes of pathogens; Applications: In agriculture, Pharmaceuticals and biopest control.

Unit 8 Biophysics

- Origin and Evolution of Life. Introduction.Prebiotic earth.Theories of Origin and Evolution of life.
- Biophysics of Water. Molecular structure of water, hydrogen bonds and physical properties of water.
- Electrochemistry.Ionization; theories of electrolytic dissociation; classification of electrolytes; Electrolysis;Conductance; solubility product; common ion effect; Ostwald's dilution law; Dielectric Constant.
- Photophysics. Nature and measurement of light; Light sources , Optical components and their calibration Radiometry; Actinometry; UV radiation dosimetry with poly sulphonification; Molecular structure and excited states; Physical properties of excited molecules; PhotoPhysical processes; Fluorescence; Photophosphorescence;Internal conversion; Intersystem crossing; Photophysical spectra; Atomic spectra; Optical activity; Photophysical kinetics of biomolecular processes.
- Spectroscopic Techniques. Principle, Instrument design, methods and application of UV spectroscopy; circular Dichroism and optical rotatory dispersion(ORD); Flurescence spectroscopy; Infrared spectroscopy; NMR and ESR spectroscopy.
- Hydrodynamic Techniques.Principle , Instrument design, methods and application of Centrifugation; Ultracentrifugation ; Viscometry; Osmosis; Diffusion and Surface tension.

- Optical Techniques.Principle, Instrument design, methods and application of Bright field; Dark field; Phase Contrast; Fluorescence; Polarising; Scanning and Transmission Electron Microscopy. Flowcytometry and Cytophotometry.
- Diffraction Techniques.Crystals, Molecular crystal symmetry, X ray diffraction by crystals, Bragg's Law, von Laue conditions and rotation methods. Calculating electron density and Patterson maps (Fourier transform and structure factors, convolutions), phase model building and evaluation, Newton diffraction, Application to Biology.
- Radioactivity and measurement. Radioactivity, Radioactive decay, Isotopes, Biological application of radioisotopes, Detection and measurement of radioactivity, Instruments used for measurement of radiation intensities, Biological effects of radiation and radiation hazards.

Unit 9 History of development of Microbiology

- Development of microbiology as a discipline, Spontaneous generation vs. biogenesis, development of various microbiological techniques, concept of fermentation, establishment of fields of medical microbiology, immunology and environmental microbiology with special reference to the work of following scientists : Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty
- Salient features of viral genomes Unusual bases (TMV, T4 phage), overlapping genes (ΦX174, Hepatitis B virus), alternate splicing (Picornavirus), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), ambisense genomes (arenavirus), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (influenza virus) and non segmented genomes (picornavirus), capping and tailing (TMV).
- Metabolite Transport () Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

Unit 10 : Biochemical Techniques

- Separation Techniques. Different methods of protein precipitation: Precipitation using inorganic salts (salting out) and organic solvents, isoelectric precipitation,Dialysis, Ultrafilteration, Lyophilization
- Chromatography. Basic principles of chromatography: Partition coefficient, concept of theoretical plates, various modes of chromatography (paper, thin layer, column), preparative and analytical applications, LPLC and HPLC. Different types of chromatography: Paper Chromatography, Thin Layer Chromatography. Molecular Sieve

Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Liquid Chromatography .

- **Electrophoresis.** Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weight determination, Isoelectric Focusing of proteins.
- **Centrifugation.** Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic) .
- **Spectrophotometry.** Principle of UV-Visible absorption spectrophotometry, instrumentation and applications .
- **Flourimetry.** Phenomena of fluorescence, intrinsic and extrinsic fluorescence, instrumentation and applications

Unit-11 Pollution

- Air Pollution: Sources of air pollution; Properties of air pollutants; Meteorological factors influencing dispersion of air pollutants; Gaussian plume model for dispersion of air pollutants and its application; Effects on human health. Control technology for particulate and gaseous pollutants from industries; formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere. Oxygen and Ozone chemistry. Photochemical smog.

- Noise Pollution: Sources, weighting networks, measurement of noise indices (Leq, L10, L90, L50, LDN, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health.

- Water Pollution (Waste Water/Industrial Waste Water Analysis): Physical, chemical and biological characteristics of water, waste water and Sewage, performance evaluation of waste water treatment system: Concepts of DO, BOD and COD, Sedimentation, Coagulation, Flocculation, Filtration, PH and Redox Potential.

Physics

Unit 1 Thermodynamics:

Heat and Temperature, Zeroth law of thermodynamics: thermal equilibrium, thermometry and temperature scales, First law of thermodynamics, Thermodynamic systems and processes, Internal energy and heat capacity, adiabatic processes. Second law of thermodynamics. Reversible and irreversible processes

Unit 2 Optics: Interference:

Interference of light, Bi prism experiment, displacement of fringes, interference in thin films-wedge shaped film, Newton's rings. Diffraction - Single, Double & N- Slit, Diffraction grating, Grating spectra, Rayleigh's criterion and resolving power of grating. Polarization-Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Fresnel's theory of optical activity, Polarimeters. Laser applications-Spontaneous and stimulated emission of radiation, Einstein's Coefficients, construction and working of Ruby, He-Ne lasers and laser applications.

Unit 3Nuclear Physics

Nucleus, constituent of nucleus, Properties of Nucleus size, mass, density, energy, charge, binding energy, nuclear angular momentum, Nuclear force, Radiation. detector- types of detectors, gas filled detectors, Ionization Chamber, Proportional Counter, GM Counter, Scintillation Detector and Semiconductor Detectors.

Unit 4 Fluid Mechanics

Fluid properties; Surface Tension, Viscosity, equation, Bernoullis equation; Navier-Stokes Equations; Differential form of Energy equation. Reynold number, Incompressible and compressible Flow, Laminar and turbulent flows, Flow through pipes

Unit 5 Mechanics

Dynamics of a System of Particles.Centre of Mass. Conservation of Momentum.Idea of Conservation of Momentum from Newton's Third Law.Impulse. Momentum of Variable Mass System : Motion of Rocket. Work and Energy Theorem :- Work and Kinetic Energy Theorem. Conservative and NonConservative Forces.Potential Energy.Energy Diagram.Stable and Unstable Equilibrium.Gravitational Potential Energy.Elastic Potential Energy. Force as Gradient of Potential Energy. Work and Potential energy.Work done by Non-conservative Forces.Law of Conservation of Energy.

Unit 6 : Oscillations & Waves

- SHM :- Simple Harmonic Oscillations. Differential Equation of SHM and its Solution. Amplitude, Frequency, Time Period and Phase. Velocity and Acceleration. Kinetic, Potential and Total Energy and their Time Average Values. Reference Circle. Rotating Vector Representation of SHM.
- Free Oscillations of Systems with One Degree of Freedom :- (1) Mass-Spring system, (2) Simple Pendulum, (3) Torsional Pendulum, (4) Oscillations in a U-Tube, (5) Compound pendulum: Centres of Percussion and Oscillation, and (6) Bar Pendulum.
- Superposition of Two Collinear Harmonic Oscillations :- Linearity and Superposition Principle. (1) Oscillations having Equal Frequencies and (2) Oscillations having Different Frequencies (Beats). Superposition of N Collinear Harmonic Oscillations with (1) Equal Phase Differences and (2) Equal Frequency Differences.

Waves

- 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.
- Velocity of Waves :- Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.
- Superposition of Two Harmonic Waves :- Standing (Stationary) Waves in a String : Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes wrt Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

Unit 7 :Electricity and Magnetism

- Electric Circuits 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: (1) Thevenin theorem, (2) Norton theorem, (3) Superposition theorem, (4) Reciprocity theorem, and (5) Maximum Power Transfer theorem.
- Electric Field and Electric Potential Electric Field :- Electric Field and Lines. Electric Field E due to a Ring of Charge. Electric Flux. Gauss's law. Gauss's law in Differential form. Applications of Gauss's Law : E due to (1) an Infinite Line of

Charge, (2) a Charged Cylindrical Conductor, (3) an Infinite Sheet of Charge and Two Parallel Charged Sheets, (4) a Charged Spherical Shell, (5) a Charged Conducting Sphere, (6) a Uniformly Charged Sphere, (7) Two Charged Concentric Spherical Shells and (8) a Charged Conductor. Force on the Surface of a Charged Conductor and Electrostatic Energy in the Medium surrounding a Charged Conductor.

- **Dielectric Properties of Matter Dielectrics:-** Electric Field in Matter. Dielectric Constant. Parallel Plate Capacitor with a Dielectric. Polarization, Polarization Charges and Polarization Vector. Electric Susceptibility. Gauss's law in Dielectrics. Displacement vector D. Relations between the three Electric Vectors. Capacitors filled with Dielectrics.
- **Magnetic Field Magnetic Effect of Currents :-** Magnetic Field B. Magnetic Force between Current Elements and Definition of B. Magnetic Flux. Biot-Savart'sLaw : B due to (1) a Straight Current Carrying Conductor and (2) Current Loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital law (Integral and Differential Forms): B due to (1) a Solenoid and (2) a Toroid. Properties of B. Curl and Divergence of B. Vector Potential.
- **Magnetic Properties of Matter Magnetism of Matter:-** Gauss's law of magnetism (Integral and Differential Forms). Magnetization current. Relative Permeability of a Material. Magnetic Susceptibility. Magnetization Vector (M). Magnetic Intensity (H). Relation between B, M and H. Stored Magnetic Energy in Matter. Magnetic Circuit. B-H Curve and Energy Loss in Hysteresis.

Maths

Unit-I: Relations and Functions

- Relations and Functions, Types of relations: reflexive, symmetric, transitive and equivalence relations. One to one and onto functions.

Unit-II: Algebra

- Matrices ,Concept, notation, order, equality, types of matrices, zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices. Operations on matrices: Addition and multiplication and multiplication with a scalar. Simple properties of addition, multiplication and scalar multiplication.
- Determinant of a square matrix (up to 3 x 3 matrices), minors, co-factors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix.

Unit-III: Logical Reasoning

- Understanding the structure of arguments: Argument forms, the structure of categorical propositions, mood and figure, formal and informal fallacies, uses of language, connotations, and denotations of terms, the classical square of opposition
- Evaluating and distinguishing deductive and inductive reasoning
- Venn diagram: Simple and multiple uses for establishing the validity of arguments

Unit-IV: Mathematical Reasoning and Aptitude

- Types of reasoning.
- Number series, Letter series, Codes and Relationships.

- Mathematical aptitude (fraction, time & distance, ratio, proportion and percentage, profit and loss, interest and discounting, averages etc.), boat stream,
- Data interpretation (bar-chart, histograms, pie-chart, table-chart and line-chart)
- Vienn Diagram: Simple and multiple uses for establishing the validity of arguments

Unit-V: Applications of derivatives:

- Rate of change of quantities, increasing/decreasing functions, maxima and minima (first derivative test motivated geometrically and second derivative test given as a provable tool).

Unit-VI : Vectors and Three-Dimensional Geometry

- Vectors and scalars, magnitude and direction of a vector. Direction cosines and direction ratios of a vector. Types of vectors (equal, unit, zero, parallel and collinear vectors), position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio.

Unit-VII : Probability

- Attributes and Variables: types of variables, scales of measurement, measurement of Central tendency and Dispersion, Standard error, Moments – measure of Skewness and Kurtosis, Basic concept of probability theory.
- Correlation, Regression, linear, simple and multiple regression models, tests of hypothesis (t-test, 2 - test ANOVA: one-way and two-way), hypothesis testing, Tests of hypothesis and significance.