CHEMISTRY

1. Organic Chemistry

Organic Nomenclature: IUPAC nomenclature of organic molecules including regio- and stereoisomers.

Stereochemistry: Principles, chirality of organic molecules with or without chiral centres and determination of their absolute configurations, configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.

Aromaticity: Principles, generation and reactions of benzenoid and non-benzenoid compounds.

Reaction Mechanism: Organic reactive intermediates; generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes. Organic reaction mechanisms concerning addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.

Name reactions and rearrangements: Common named reactions, rearrangements and their applications in organic synthesis. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo-regio- and stereo- selective transformations.

Organic Synthesis: Basic concepts in organic synthesis, retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.

Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction– substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination; Optical and kinetic resolution.

Pericyclic reactions and Photochemistry: Electrocyclic, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Photochemistry of alkenes, arenes and

carbonyl compounds, photooxidation and photoreduction, di-π-methane rearrangement, Barton reaction.

Heterocyclic compounds: Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).

Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids. **Characterization Techniques:** Structure determination of organic compounds by IR, UV-Vis, ^{1}H &^{13}C NMR and Mass spectroscopic techniques.

2. Inorganic Chemistry

Chemical periodicity: Basic concept of periodicity, periodic properties of s-, p-, d- and f-block elements, spectra and magnetic properties of Lanthanides and Actinides.

Chemical bonding: Structure and bonding in homo- and hetero- nuclear molecules, including shapes of molecules (VSEPR Theory).

Acids and bases: Basic concepts, Hard-Soft acid and base, Non-aqueous solvents.

Elements and their compounds: Allotropy, synthesis, structure, bonding and industrial importance of main group elements and their compounds.

Transition elements and coordination compounds: Structure, bonding theories, spectral and magnetic properties, reaction mechanisms. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.

Organometallics: 18-Electron rule; metal-alkyl, metal-carbonyl, metal-olefin and metal-carbene complexes and metallocenes. Fluxionality in organometallic complexes. Types of organometallic reactions. Homogeneous catalysis - Hydrogenation, hydroformylation, acetic acid synthesis, metathesis and olefin oxidation. Heterogeneous catalysis - Fischer-Tropsch reaction, Ziegler-Natta polymerization.

Cages and metal clusters: Basic concepts, general characteristics and applications, different types of metal clusters and their industrial applications.

Analytical chemistry: Separation, spectroscopic, electro- and thermo analytical methods.

Bioinorganic chemistry: Photosystems, porphyrins, metalloenzymes, oxygentransport, electron- transfer reactions; nitrogen fixation, metal complexes inmedicine.

Inorganic spectroscopy: Characterization of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-Vis, NQR, MS, electron spectroscopy and microscopic techniques.

Nuclear chemistry: Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis. Radioactivity: Decay processes, half-life of radioactive elements, fission and fusion processes.

3. **Physical Chemistry**

Quantum mechanics: Basic principles, operator algebra; exactlysolvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.

Atomic structure and spectroscopy: Terms and symbols, many-electron systems and antisymmetry principle.

Chemical bonding in diatomics: Elementary concepts of VB and MO theories; Huckel theory for conjugated π-electron systems.

Group theory: Chemical applications, symmetry elements; point groups character tables; selection rules.

Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.

Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.

Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance-Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.

Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.

Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.

Solid state: Crystal structures; Bragg's law and applications; band structure of solids.

Polymer chemistry: Molar masses; kinetics of polymerization.

Recent and Applied Chemistry: General concepts and applications

Environmental and Green chemistry.

Nanaotechnology in chemistry.

Medicinal chemistry.

Supramolecular chemistry.