1. Atomic Structure:
   Heisenberg's uncertainty principle Schrödinger wave equation (time independent);
   Interpretation of wave function, particle in one-dimensional box, quantum numbers, hydrogen atom wave functions; Shapes of s, p and d orbitals.

2. Chemical bonding:
   Ionic bond, characteristics of ionic compounds, lattice energy, Born-Haber cycle;
   Covalent bond and its general characteristics, polarities of bonds in molecules and
   their dipole moments; Valence bond theory, concept of resonance and resonance
   energy; Molecular orbital theory (LCAO method); bonding H2+, H2 He2+ to Ne2,
   NO, CO, HF, CN–,
   Comparison of valence bond and molecular orbital theories, bond order, bond
   strength and bond length.

3. Solid State:
   Crystal systems; Designation of crystal faces, lattice structures and unit cell; Bragg's law;
   X-ray diffraction by crystals; Close packing, radius ratio rules, calculation of some
   limiting radius ratio values; Structures of NaCl, ZnS, CsCl, CaF2; Stoichiometric and
   nonstoichiometric defects, impurity defects, semi-conductors.

4. The Gaseous State and Transport Phenomenon:
   Equation of state for real gases, intermolecular interactions, and critical phenomena
   and liquefaction of gases; Maxwell’s distribution of speeds, intermolecular
   collisions, collisions on the wall and effusion; Thermal conductivity and viscosity
   of ideal gases.

5. Liquid State:
   Kelvin equation; Surface tension and surface energy, wetting and contact angle, interfacial
   tension and capillary action.

6. Thermodynamics:
   Work, heat and internal energy; first law of thermodynamics.
   Second law of thermodynamics; entropy as a state function, entropy changes in various
   processes, entropy-reversibility and irreversibility, Free energy functions;
   Thermodynamic equation of state; Maxwell relations; Temperature, volume and
   pressure dependence of U, H, A, G, Cp and Cv, and ; J-T effect and inversion
   temperature; criteria for equilibrium, relation between equilibrium constant and
   thermodynamic quantities; Nernst heat theorem, introductory idea of third law of
   thermodynamics.

7. Phase Equilibria and Solutions:
   Clausius-Clapeyron equation; phase diagram for a pure substance; phase
   equilibria in binary systems, partially miscible liquids—upper and lower critical solution
   temperatures; partial molar quantities, their significance and determination; excess
   thermodynamic functions and their determination.
8. **Electrochemistry:**

Debye-Huckel theory of strong electrolytes and Debye-Huckel limiting Law for various equilibrium and transport properties.

Galvanic cells, concentration cells; electrochemical series, measurement of e.m.f. of cells and its applications fuel cells and batteries.

Processes at electrodes; double layer at the interface; rate of charge transfer, current density; overpotential; electroanalytical techniques: amperometry, ion selective electrodes and their use.

9. **Chemical Kinetics:**

Differential and integral rate equations for zeroth, first, second and fractional order reactions; Rate equations involving reverse, parallel, consecutive and chain reactions; Branching chain and explosions; effect of temperature and pressure on rate constant. Study of fast reactions by stop-flow and relaxation methods. Collisions and transition state theories.

10. **Photochemistry:**

Absorption of light; decay of excited state by different routes; photochemical reactions between hydrogen and halogens and their quantum yields.

11. **Surface Phenomena and Catalysis:**

Adsorption from gases and solutions on solid adsorbents; Langmuir and B.E.T. adsorption isotherms; determination of surface area, characteristics and mechanism of reaction on heterogeneous catalysts.

12. **Bio-inorganic Chemistry:**

Metal ions in biological systems and their role in ion-transport across the membranes (molecular mechanism), oxygen-uptake proteins, cytochromes and ferredoxins.

13. **Coordination Chemistry:**

(i) Bonding in transition of metal complexes. Valence bond theory, crystal field theory and its modifications; applications of theories in the explanation of magnetism and electronic spectra of metal complexes.

(ii) Isomerism in coordination compounds; IUPAC nomenclature of coordination compounds; stereochemistry of complexes with 4 and 6 coordination numbers; chelate effect and polynuclear complexes; trans effect and its theories; kinetics of substitution reactions in square-planar complexes; thermodynamic and kinetic stability of complexes.

(iii) EAN rule, Synthesis structure and reactivity of metal carbonyls; carboxylate anions, carbonyl hydrides and metal nitrosyl compounds.

(iv) Complexes with aromatic systems, synthesis, structure and bonding in metal olefin complexes, alkyne complexes and cyclopentadienyl complexes; coordinative unsaturation, oxidative addition reactions, insertion reactions, fluxional molecules and their characterization; Compounds with metal—metal bonds and metal atom clusters.

14. **Main Group Chemistry:**
Boranes, borazines, phosphazenes and cyclic phosphazene, silicates and silicones, Interhalogen compounds; Sulphur—nitrogen compounds, noble gas compounds.

15. **General Chemistry of f Block Element:**
Lanthanides and actinides: separation, oxidation states, magnetic and spectral properties; lanthanide contraction.

PAPER-II

1. **Delocalised Covalent Bonding:**
Aromaticity, anti-aromaticity; annulenes, azulenes, tropolones, fulvenes, sydnones.

2. **(i) Reaction mechanisms:** General methods (both kinetic and non-kinetic) of study of mechanisms or organic reactions: isotopies, method cross-over experiment, intermediate trapping, stereochemistry; energy of activation; thermodynamic control and kinetic control of reactions.

(ii) **Reactive intermediates**: Generation, geometry, stability and reactions of carboniumions and carbonanions, free radicals, carbenes, benzynes and nitrenes.

(iii) **Substitution reactions**: — SN 1, SN 2, and SN i, mechanisms; neighbouring group participation; electrophilic and nucleophilic reactions of aromatic compounds including heterocyclic compounds—pyrrole, furan, thiophene and indole.

(iv) **Elimination reactions**: — E1, E2 and E1cb mechanisms; orientation in E2 reactions—Saytzeff and Hoffmann; pyrolytic syn elimination—acetate pyrolysis, Chugaev and Cope eliminations.

(v) **Addition reactions**: — Electrophilic addition to C=C and C C; nucleophilic addition to C=O, C N, conjugated olefins and carbonyls.

(vi) **Reactions and Rearrangements**: (a) Pinacol-pinacolone, Hoffmann, Beckmann, Baeyer-Villiger, Favorskii, Fries, Claisen, Cope, Stevens and Wagner—Meerwein rearrangements.

(b) Aldol condensation, Claisen condensation, Dieckmann, Perkin, Knoevenagel, Witting, Clemmensen, Wolff-Kishner, Cannizzaro and von Richter reactions; Stobbe, benzoin and acyloan condensations; Fischer indole synthesis, Skraup synthesis, Bischler-Napieralski, Sandmeyer, Reimer-Tiemann and Reformatsky reactions.

3. **Pericyclic reactions**: — Classification and examples; Woodward-Hoffmann rules—electrocyclic reactions, cycloaddition reactions [2+2 and 4+2] and sigmatropic shifts [1, 3; 3, 3 and 1, 5], FMO approach.

4. **(i) Preparation and Properties of Polymers:** Organic polymers—polyethylene, polystyrene, polyvinyl chloride, teflon, nylon, terylene, synthetic and natural rubber.

(ii) Biopolymers: Structure of proteins, DNA and RNA.

5. **Synthetic Uses of Reagents:**
OsO4, HlO4, CrO3, Pb(OAc)4, SeO2, NBS, B2H6, Na-Liquid NH3, LiAlH4, NaBH4, n-BuLi, MCPBA.
6. **Photochemistry** — Photochemical reactions of simple organic compounds, excited and ground states, singlet and triplet states, Norrish-Type I and Type II reactions.

7. **Spectroscopy**:
   
   Principle and applications in structure elucidation:
   
   (i) **Rotational** — Diatomic molecules; isotopic substitution and rotational constants.
   
   (ii) **Vibrational** — Diatomic molecules, linear triatomic molecules, specific frequencies of functional groups in polyatomic molecules.
   
   (iii) **Electronic** — Singlet and triplet states. $n$ and transitions; application to conjugated double bonds and conjugated carbonyls Woodward-Fieser rules; Charge transfer spectra.
   
   (iv) **Nuclear Magnetic Resonance (1HNMR)**: Basic principle; chemical shift and spin-spin interaction and coupling constants.
   
   (v) **Mass Spectrometry** — Parent peak, base peak, metastable peak, McLafferty rearrangement.