CHEMISTRY
PAPER- I

1. **Atomic Structure:**

   Heisenberg's uncertainty principle, Schrödinger wave equation (time independent): Interpretation of wave function. Particle in one –dimensional box, quantum numbers, hydrogen atoms 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 H_2+, H_2 He_2 + to Ne_2, 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, CaF_2; Stoichiometric and nonstoichiometric defects, impurity defects, semi-conductors.

4. **The Gaseous State and Transport Phenomenon:**

   Equation of state 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, α and β; $J-T$ effect and inversion temperature; criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities; Nernst heat theorem, introductory ideal 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 cell and it applications fuel cells ad batteries.

   Processes at electrodes; double layer at the interface; rate of charge transfer, current density; over potential; electro analytical 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; 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 reactions 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 ferrodoxins.

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; carbonylate 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. **Delocalized Covalent Bonding:**

Aromaticity, anti-aromaticity; annulenes, azulenes, tropolones, fulvenes, sydnones.

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

(ii) **Reaction Intermediates:** Generation, geometry, stability and reactions of Carbonium ions and carbanions, free radicals, carbenes, benzynes and nitrenes,

(iii) **Substitution Reactions:-** -S_N1. S_N2. And S_Ni. Mechanisms, neighboring group participation; electrophilic and nucleophilic reaction of aromatic compounds including heterocyclic compounds-pyrrole, furan, thiophene and indole.

(iv) **Elimination Reactions:-** E_1, and E_2 and E_1 cb mechanisms; orientation in E_2 reactions Saytzeff and Hoffmann; pyrolytic syn elimination –acetate pyrolysis, Chugaev and Cope eliminations.

(v) **Addition Reaction:-** 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, Favorski, 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 acyloin condensations; Fischer indole synthesis, Skraup synthesis, Bischler Napieralski, Sandmeyer, Reimer-Tiemann and Reformatsky reactiosns.

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 Reactions:**

   OsO_4, HIO_4, CrO_3, $Pb(OAc)_4$, SeO_2, NBS, B_2H_6, Na Liquid NH_3, $LiAlH_4$, $NaBH_4$ 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) **Rotational** – Diatomic molecules, linear triatomic molecules, specific frequencies of functional groups in polyatomic molecules.

   (iii) **Electronic** – Singlet and triplet states $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ transitions; application to conjugated double bonds and conjugated carbonyls Woodward –Fieser rules; Charge transfer spectra.