CHEMISTRY—CODE NO. (03)

SECTION—A (Inorganic Chemistry)

1.1 **Atomic structure**.—Schrodinger wave equation, significance of Ψ^1 and Ψ^2, quantum numbers and their significance, radial and angular probability, shapes of orbitals, relative energies of atomic orbitals as a function of atomic number. Electronic configurations of elements; Aufbau principle, Hund's multiplicity rule, Pauli exclusion principle.

1.2 **Chemical periodicity**.—Periodic classification of elements, salient characteristics of s, p, d and f block elements. Periodic trends of atomic radii, ionic radii, ionisation potential, electron affinity and electronegativity in the periodic table.

1.3 **Chemical bonding.—**Types of bonding, overlap of atomic orbitals, sigma and pi bonds, hydrogen and metallic bonds. Shapes of molecules, bond order, bond length, V.S.E.P.R. theory and bond angles. The concept of hybridization and shapes of molecules and ions.

1.4 **Oxidation states and oxidation number**.—Oxidation and reduction, oxidation numbers, common redox reactions, ionic equations. Balancing of equations for oxidation and reduction reactions.

1.5 **Acids and bases**.—Bronsted and Lewis theories of acids and bases. Hard and soft acids and bases. HSAB principle, relative strengths of acids and bases and the effect of substituents and solvents on their strength.

1.6 **Chemistry of elements** :

(i) **Hydrogen**.—Its unique position in the periodic table, isotopes, ortho and para hydrogen, industrial production, heavy water.

(ii) **Chemistry of s and p block elements.—**Electronic configuration, general characteristics properties, inert pair effect, allotropy and catenation. Special emphasis on solutions of alkali and alkaline earth metals in liquid ammonia. Preparation, properties and structures of boric acid, borates, boron nitrides, borohydride (diborane), carboranes, oxides and oxyacids of nitrogen, phosphorous, sulphur and chlorine; interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens. Chemical reactivity of noble gases, preparation, structure and bonding of noble gas compounds.

(iii) **Chemistry of d block elements**.—Transition metals including lanthanides, general characteristic properties, oxidation states, magnetic behaviour, colour. First row transition metals and general properties of their compounds (oxides, halides and sulphides); lanthanide contraction.

1.7 **Extraction of metals**.—Principles of extraction of metals as illustrated by sodium, magnesium, aluminium, iron, nickel, copper, silver and gold.

1.8 **Nuclear Chemistry.—**Nuclear reactions; mass defect and binding energy, nuclear fission and fusion. Nuclear reactors; radioisotopes and their applications.

1.9 **Coordination compounds.—**Nomenclature, isomerism and theories of coordination compounds and their role in nature and medicine.

1.10 **Pollution and its control.—**Air pollution, types of air pollutants; control of air and water pollution; radioactive pollution.

SECTION—B (Organic Chemistry)

2.1 **Bonding and shapes of organic molecules**.—Electronegativity, electron displacements—inductive, mesomeric and hyperconjugative effects; bond polarity and bond polarizability, dipole moments of organic molecules; hydrogen bond; effects of solvent and structure on dissociation constants of acids and bases; bond formation, fission of covalent bonds ; homolysis and heterolysis; reaction intermediates—carbonations, carbanions, free radicals and carbenes; generation, geometry and stability; nucleophiles and electrophiles.

2.2 **Chemistry of aliphatic compounds**.—Nomenclature; alkenes—synthesis, reactions (free radical halogenation) — reactivity and selectivity, sulphonation—detergents; cycloalkanes-Baeyer's strain theory; alkenes and alkynes—synthesis, electrohilic addition reactions, Markownikov's rule, peroxide affects, 1, 3—dipolar addition; nucleophilic addition to electron-deficient alkenes; polymerisation; relative acidity; synthesis and reactions of alkyl halides, alkanols, alkanals, alkanones, alkanoic acids, esters, amides, nitriles, amines, acid anhydrides, £, ß- unsaturated ketones, ethers and nitro compounds.

2.3 **Stereochemistry of carbon compounds.—**Elements of symmetry, chiral and achiral compounds. Fischer projection formulae; optical isomerism of lactic and tartaric acids, enantiomerism and diastereoisomerism; configuration (relative and absolute); conformations of alkanes upto four carbons, cyclohexane and dimethylcyclo hexanes—their potential energy. D, L- and R, S-notations of compounds containing chiral centres; projection formulae—Fischer, Newman and Sawhorse—of compounds containing two adjacent chiral centres; meso and dl-isomers, erythro and threoisomers; racemization and resolution; examples of homotopic, enantiotopic and diasteretopic atoms and groups in organic compounds, geometrical isomers; E and Z notations. Stereochemistry of SN1, SN2, E1 and E2 reactions.

2.4 **Organometallic compounds.—**Preparation and synthetic uses of Grignard reagents, alkyl lithium compounds.

2.5 **Active methylene compounds**.—Diethyl malonate, ethyl acetoacetate, ethyl cyanoacetate—applications in organic synthesis; tautomerism (ketoenol).

2.6 **Chemistry of aromatic compounds.—**Aromaticity; Huckel's rule; electrophilic aromatic substitution—nitration, sulphonation, halogenation (nuclear and side chain), Friedel-Crafts alkylation and acylation, substituents effect; chemistry and reactivity of aromatic halides, phenols, nitro-, diazo, diazonium and sulphonic acid derivatives, benzyne reactions.

2.7 **Chemistry of biomolecules.—**(i) Carbohydrates Classification, reactions, structure of glucose, D, L-configuration, osazone formation; fructose and sucrose; step-up and step-down of aldoses and ketoses, and their interconversions,

(ii) **Amino Acids** : Essential amino acids; zwitterions, isoelectric point, polypeptides; proteins; methods of synthesis of £ amino acids.

(iii) Elementary idea of oils, fats, soaps and detergents.

2.8 **Basic principles and applications**.—Of UV, visible, IR and NMR spectroscopy of simple organic molecules.

SECTION—C (Physical Chemistry)

3.1 **Gaseous state.—**Deviation of real gases from the equation of state for an ideal gas, Van der Waals and Virial equation of state, critical phenomena, principle of corresponding states, equation for reduced state. Liquification of gases, distribution of molecular speed, collisions between molecules in a gas; mean free path, specific heat of gases

3.2 **Thermodynamics.—**(i) **First law and its applications**: Thermodynamic systems, states and processes, work, heat and internal energy, zeroth law of thermodynamics, various types of work done on a system in reversible and irreversible processes. Calorimetry and thermochemistry, enthalpy and enthalpy changes in various physical and chemical processes, Joule-Thomson effect, inversion temperature. Heat capacities and temperature dependence of enthalpy and energy changes.

(ii) **Second law and its applications.—**Spontaneity of a process, entropy and entropy changes in various processes, free energy functions, criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities.

3.3 **Phase rule and its applications.—**Equilibrium bewteen liquid, solid and vapours of a pure substance, Clausius-Clapeyron equation and its applications. Number of components, phases and degrees of freedom; phase rule and its applications; simple systems with one (water and sulphur) and two components (lead-silver, salt hydrates). Distribution law, its modifications, limitations and applications.

3.4 **Solutions.—**Solubility and its temperature dependence, partially miscible liquids, upper and lower critical solution temperatures, vapour pressures of liquids over their mixtures, Raoult's and Henry's laws, fractional and steam distillations.

3.5 **Colligative Properties.—**Dilute solutions and colligative properties, determination of molecular weights using colligative properties.

3.6 **Electrochemistry.—**Ions in solutions, ionic equilibria, dissociation constants of acids and bases, hydrolysis, pH and buffers, theory of indicators and acid-base titrations. Conductivity of ionic solutions, its variation with concentration, Ostwald's dilution law, Kohlrausch law and its application. Transport number and its determination. Faraday's laws of electrolysis, galvanic cells and measurements of their e.m.f., cell reactions, standard cell, standard reduction potential, Nernst equation, relation between thermodynamic quantities and cell e.m.f., fuel cells, potentiometric titrations.

3.7 **Chemical kinetics.—**Rate of chemical reaction and its dependence on concentrations of the reactants, rate constant and order of reaction and their experimental determination; differential and integral rate equations for first and second order reaction, half-life periods; temperature dependence of rate constant and Arrhenius parameters; elementary ideas regarding collision and transition state theory.

3.8 **Photochemistry**.—Absorption of light, laws of photochemistry, quantum yield, the excited state and its decay by radiative, non radiative and chemical pathways; simple photochemical reactions.

3.9 **Catalysis.—**Homogeneous and heterogeneous catalysis and their characteristics, mechanism of heterogeneous catalysis; enzyme catalysed reactions (Michaelis-Menten mechanism).

3.10 **Colloids.—**The colloidal state, preparation and purification of colloids and their characteristics properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.