SYLLABUS FOR CHEMISTRY

PART-I

Physical Chemistry

UNIT-I


UNIT-II


UNIT-III


Ultraviolet absorption spectroscopy: Absorption laws. Concept of molar absorptivity, energy level, types of electronic excitations, Frank-Condon principal (explanation about red shift and blue shift). Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and α,β-unsaturated carbony compounds.

IR spectroscopy: Principles & applications.

Nuclear Magnetic Resonance Spectroscopy: Origin of spectra, instrumentation, solvents, nuclear shielding and deshielding, chemical shift spin-spin splitting, coupling constants, interpretation of PMR spectra.
UNIT-IV

Photoelectron spectroscopy: Basic principles, valence and core binding energies, shifts in energies due to chemical forces photoelectron spectra.

Mass spectrometry: Principal and instrumentations of mass spectrometer. Applications in the determinations of Molecular mass and isotopic abundance. Nitrogen rule, even electron rule, Meclafferty rearrangement.


UNIT-V


UNIT-VI


Physical properties and molecular structure: Optical activity, polarization (Clausius-Mosotti equation), orientation of dipoles in an electric field, dipole moment.

Refraxtometry: Abbe's refractometer and its applications

UNIT-VII

Binary mixtures: Liquid-liquid mixtures, completely miscible liquids, ideal liquid mixtures non-ideals systems showing positive and negative deviation from Raoul'ts law, Vapour pressure, Azeotropes, partially miscible liquids. Miscibility temperature and critical solution temperature.
(CST). Effect of impurity on CST. Immiscible liquids, Steam distillation-principle and experimental details, Nernst Distribution law.


UNIT -VIII

Chemical Kinetics: Concentration dependence of rates, differential rate laws of simple chemical reactions, zero, first, second, nth and pseudo first order reaction.

Derivation of rate constants for second order and nth order reactions with equal initial concentrations. Determination of order as a reaction - Differential, Integration. Half life period and Isolation methods. Transition state theory - Derivation of relationship between rate constant and equilibrium constant thermodynamic aspects of activation.

Catalysis: Role of catalyst in altering reaction rate. Acid base catalysis, specific and general acid base catalysis mechanism and kinetics. Enzyme catalysis. Derivation of Michaelis-Menten equation.

UNIT-IX

Chemical Equilibrium: Derivation of relationship between equilibrium constant and free energy equation. Thermodynamic derivation of law of mass action, Le Chatelier’s Principal. Van’t Hoff’s reaction isotherm and reaction isochore (Van’t Hoff equation).

Phase Equilibrium: Phase rule. Derivation of phase rule from phase equilibrium of one and two component system with examples.

UNIT-X


Corrosion & its prevention.
UNIT-XI


UNIT-XII


Elementary Quantum Mechanics: Quantum theory of radiation (Black body radiation), Planck’s radiation law, Heat capacities of solids, Photoelectric effect, Compton effect. Quantum numbers and their imporrtance.

UNIT-XIII


Nuclear Chemistry: nuclear reactions, fission, and fusion, radio analytical techniques and activation analysis.
PART - II

Inorganic Chemistry

UNIT I

Periodic Properties: Methods of determination of Atomic properties—Atomic size, ionization energy, Electron affinity and Electronegativity, Effective nuclear charge-shielding effect, Slater’s rule and its applications, Ionic radii.

UNIT II

Chemistry of s-Block Elements: Hydrides and Complex hydrides, Comparative study of lattice energy, enthalpy of formation, enthalpy of hydration and solubility of alkali metal and alkaline earth metal halides, hydroxides and sulphates. Complexation tendencies of alkali metals with crown ether, Boranes, Silicates & Phosphorous acids.

UNIT III

Chemistry of d- and f-block elements: Electronic configuration, stabilities of oxidation states and complexing ability. Magnetic property, Expression for magnetic moment, Comparative treatment of 4d and 5d series with their 3d analogues, Lanthanide contraction, Comparison between lanthanides and actinides, Extraction of metals and Ellingham diagram.

Alloys: Principles and purpose of alloying, effect of alloying, Stainless steel and inverse steel-constituents, properties and applications.

Nano Chemistry: General methods of synthesis, characterization techniques, preparation of nano particle by chemical method, application of nano materials.

UNIT IV


UNIT V

Theories of acids and bases: Bronsted and Lewis acids and bases, Lux-Flood theory, solvent leveling effects, HSAB concept, super acids. Reactions in non-aqueous media: Reactions in molten salts.
UNIT VI

Co-ordination Compounds: Nomenclature, Isomerism in coordination compounds.

Metal-ligant Bonding in Transition Metal Complexes: Valence bond theory-examples for sp\(^3\), dsp\(^2\), dsp\(^3\), d\(^2\)sp\(^3\), and sp\(^3\)d\(^2\) hybridisation. Explanation for magnetic properties. Crystal field theory-importan concepts of CFT, Crystal fields splitting in octahedral, tetrahedral and square planar complexes, crystal field stabilization energy. Calculation of CFSE, spectrochemical series. Factors affecting the crystal field splitting, Limitation of CFT.

Spectral Properties of Metal Complexes: Term symbols, selection rules for electronic transitions-spin selection rule, the Laporte selection rule, Orgel diagrams, Tanabe-Sugano diagrams, stereo isomerism, chirality, CD, ORD, Cotton effect and magnetic circular dichroism, absolute configuration.

Metal-Ligand Equilibria in Solution: Step-wise and over-all formation constant and their relationships, trends in step wise constant, kinetic and thermodynamic stability of metal complexes. Determination of binary formation constants by PH meter, spectrophotometry, polarography, and by ion exchange methods.


Electron Transfer Reaction (Redox Reactions): Inner and outer sphere mechanisms, one electron, two electron, complimentary and non complimentary electron-transfer reactions.

UNIT VII

Bio-inorganic Chemistry:

Metal Ions in Biological Systems: Essential and trace metals, active transport of cations, ionophores, metalloproteins as enzymes carboxy peptidase, (catalases, peroxidases, cytochorome P450, copper oxidases) super oxide dismutase, vitamin B12, coenzyme, enzyme action inhibition and poisoning. Metals in medicine- Metal deficiency, chelation therapy and metal complexes as drugs. Chlorophyll and its role in photosynthesis.

UNIT VIII

Group Theory and Symmetry: Symmetry elements and Symmetry operations, groups, subgroups, molecular point groups, Schoenflies notations, matrix representations of symmetry operation, matrix representations of groups, Reducible and Irreducible representations, characters
of representations, The great orthogonality theorem, character tables and their construction (C2v, C2h, C3v)- Mullikan symbols, molecular models. Determination of vibration modes, hybridization, molecular orbitals on the basis of group theory.

UNIT IX

Analytical Chemistry

Errors and Sampling: Limitations of analytical methods, errors, accuracy and precision, mean and standard deviation, Paired t-test, correlation and regression, linear regression, Quality control and quality assurance. The basis of sampling.

Titrimetric and Gravimetric analysis:

Acid base titrations: Titration curves determination of equivalence point – theory, acid base indicators, colour change, range of indicators.

Complexometric Titrations: Titration curves, EDTA titrations, titrations of mixtures, masking and demasking agents, metal ion indicators.

Precipitation Titrations: Precipitation reactions, titration curves, factors influencing the sharpness of end points, chemical indicators for precipitation titrations, applications of precipitation titration analysis.

Oxidation – Reduction Titrations: Redox process, titration curves, redox indicators and applications.

Gravimetric analysis: Requirements & conditions of precipitations, co-precipitation, post precipitation, nature of the precipitate, super saturation, precipitation from homogeneous solution and effect of excess of precipitant, temperature, PH and complex formation of completeness of precipitation.

Organic Reagents in Inorganic Analysis: Organic precipitants, general properties, reagents as precipitants.

Conductometry: Theory-Measurement of Conductivity – Basis for Conductometric titrations.


Amperometry: Principles, amperometric titrations
Electrogravimetry: Theory, completeness and nature of the deposit, instrumentation, electrolytic separation of metals and applications.

UNIT X

Chromatographic Techniques:
Separation Techniques - Solvent extraction, Principles, classifications and theory of chromatographic separation. This layer chromatography, column chromatography, size exclusion chromatography, ion exchange chromatography, Paper chromatography, Gas Chromatography and HPLC

UNIT XI


UNIT XII

Air Pollution: Types and sources of air pollutants; concentrations of air pollutants; principles and methods of sampling; causes, consequences of air pollution and their remedies.


Water Pollution: Types of water pollutants and their effects; sources of water pollution; Objectives of analysis. Parameters of analysis.

UNIT XIII

Biochemistry

Carbohydrates: Introduction, Ring size determination of monosaccharides, configuration and conformations of monosaccharides, anomic effect, Hudson’s rules, epimerization and mutarotation.

Synthesis, industrial and biological importance of glycosides, amino sugars, sucrose, maltose and lactose.
Chemistry of reactive intermediates: carbocations, carbanions, free radicals, carbenes, nitrenes, benzyne and ylides.

Unit IV

Reaction mechanisms II: Substitution reactions- aliphatic electrophilic and nucleophilic substitution reactions, aromatic electrophilic and nucleophilic substitution reactions.

Unit V

Elimination reactions: E1, E2, E1Cb and syn eliminations.

Addition reactions: addition across carbon-carbon and carbon-hetero atom multiple bonds

Formation and hydrolysis of esters, decarboxylation reactions and free radical reactions.

Condensation reactions: Claisen, Dieckmann, Perkin, Knoevenangol, Stobbe, Benzoin and Darzen's reactions.

Unit VI


Unit VII

Name reactions: Clemenson & Wolf-Kishner reduction, Remier-Tiemann reaction, Reformatsky reactions, Kolbe's electrolysis, Barton reaction, Hoffmann- Lofter-Freytag reaction, Mitsunobu reaction, Suzuki coupling reaction, Heck reaction, Stork-enamine reaction, Stillic-Kelley coupling, Barton decarboxylation, Sharpless assymmetric epoxidation, Woodward-Prevost hydroxylation and Peterson reaction.

Unit VIII

Photochemistry and pericyclic reactions: Jablonski diagram, Norrish type-I and II reaction, photochemistry of alkenes, carbonyl compounds, aromatic hydrocarbons, Di-pi rearrangement, photoreduction and autooxidation.

Pericyclic reactions: Classification, Woodward-Hoffmann rules for electrocyclic, cycloaddition reactions and sigmatroic rearrangements (FMO approach and correlation diagram)

Unit IX

Oxidations: Oxidation with chromium and manganes salts, lead tetraacetate, periodic acid, SeO₃, chloramine-T, OsO₄, ozone, peracids, H₂O₂.
Polysaccharides: General methods of structure elucidation. Industrial importance and biological importance of cellulose, starch, glycogen, dextran, hemicelluloses, pectin, agar-agar. Biosynthesis of carbohydrates.

Lipids: Nomenclature, classification, purification, synthesis of lipids, phospholipids, sphingolipids, biological importance of lipids: Lecithin, sphingolipids, oils and fats.

Prostaglandins: Introduction, classification and biological importance, constitution of PGEL.

Amino acids, Peptides and Proteins: General methods of preparation, properties and reactions of amino acids. Peptide bond; Proteins; biological importance, classification based on structure and composition, primary structure of proteins and its determinations; Denaturation and renaturation, Biosynthesis of peptides.

Vitamins: Biological importance and synthesis of Vitamin A, Vitamin B, Vitamin C and Vitamin E, Vitamin K, Vitamin H & Vitamin E(tocopherol).

UNIT XIV


Hormones: Classification, sex hormones, Non-steroidal oestrogens, and their clinical applications. Synthesis and mode of action of hormones.

Organic chemistry

Unit I

IUPAC nomenclature of organic compounds: Alkanes, alkenes, alkynes, alkyl halides, alcohols, carboxylic acids, aldehydes, ketones. Aromatic hydrocarbons and heterocyclic compounds. Concept of resonance, inductive and hyper conjugation effect, hydrogen bonding.

Unit II


Unit III

Reaction mechanism I: Classification, methods of determination (kinetic and non-kinetic methods), Hammett equation.
Reductions: Dissolving metal reduction, Catalytic reduction, Complex metal hydride reductions, dibrane (hydroboration).

Unit X

Synthetic reagents: NBS, AIBN, benzyol peroxide, DDQ, DCC, trimethyl silane, trimethyl silyl chloride/ iodide / cyanide, Fenton’s reagent, dithiane, acyl amion equivalents, n-butyl lithium, Gilman reagents, PPA, Zeigler-Natta catalyst, organo tin and organoaluminium reagents.

Unit XI

Protection and deprotection of functional groups, asymmetric synthesis, retrosynthesis.

Unit XII

Heterocyclic compounds: Chemistry of furan, pyrrole, thiphene, indole, pyridine, coumarins, pyrazoles, oxazoles, sydnone, thiazoles, quinolines and isoquinolines.

Unit XIII

Medicinal Chemistry: Modern theories of drug action, concept of receptors, computer aided drug design, quantitative and qualitative SAR. Sulfur drugs, analgesics, antibiotics, anti-inflammatory, anticancer, antidiabetic, antiviral and antihypertensive drugs.

Agrochemicals: Pesticides, herbicides, insecticides and pheromones.

Food additives: Edible colours, flavours; sweeteners, antioxidants and preservatives.

Unit XIV

Chemistry of alkaloids and terpenoids.

Chemistry of synthetic polymers: Polyethylene, poly vinyl chloride, Teflon, terylenes, nylons, urethans, polystyrene, poly carbamate and synthetic resins. Synthetic and natural rubbers, biodegradable polymers, conducting polymers.

Unit XV

Green chemistry: Principles and applications, microwave and solvothermal reactions, solvent free synthesis, phase transfer catalysts and reactions involving ionic liquids.

Unit XVI

Joint applications of UV, IR, NMR (H and 13C-) and mass spectroscopy.