Department of Applied Chemistry
Faculty of Engineering & Technology
Syllabus for Ph.D. Admission Test (2024-25) onward

UNIT-I: Physical Chemistry: Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities. Thermodynamics of ideal and non-ideal gases, and solutions. **Chemical Kinetics**: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects. **Electrochemistry:** Electrochemical cells - Electrolytic and Galvanic cells, electrode potentials including standard electrode potential, half-cell and cell reactions, emf of a Galvanic cell; Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change. **Chemistry of colloids and surfactants:** General structural features and classification, Kraft point. Micelle formation by surfactants: Critical micelle concentration and cmc measurement.

UNIT-II: Organic Chemistry: IUPAC nomenclature of organic molecules including Regio- and stereoisomers. Organic reactive intermediates: Generation, reactivity and stability of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes. Organic reaction mechanisms involving addition, elimination and substitution reactions. Common named reactions and rearrangements: Aldol Condensation, Beckmann Rearrangement, Favorskii Reaction, Fries Rearrangement, Grignard Reaction, Hell-Volhard-Zelinsky Reaction, Knoevenagel Condensation, Michael Addition, Reformatsky Reaction, Shapiro Reaction, Sharpless Epoxidation, Wittig Reaction. Pd catalysed coupling reactions, Heck, Suzuki, Glazer-Ellington coupling, reactions of alkenes and alkynes, stereo and enantioselective hydroboration, hydrogenation, hydroxylation, epoxidation, oxymercuration, halolactonisation. Organic reagents: $LiAlH_4$, $NaBH_4$, Boranes, HIO_4, *m*-CPBA, B*u*Li, LDA, AIBN, Wilkinson Catalyst, Phase transfer catalyst, crown ethers. Retrosynthetic analysis: One group and two group C-C disconnections. Photochemistry and Pericyclic reactions: electrocyclization, cycloaddition, sigmatropic rearrangements

UNIT-III: Inorganic Chemistry: Chemical periodicity- Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory). Main group elements and their compounds: trends in their properties, allotropy, peroxides, superoxides, diborane, borazine, diamond, graphite, fullerenes, phosphazenes, interhalogens and psuedohalogens. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, inner and outer reaction mechanisms. Inner transition elements: spectral and magnetic properties, redox chemistry. Organometallic compounds: synthesis, bonding and structure, and reactivity. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine.

UNIT-IV: Analytical chemistry: Data analysis: Mean and standard deviation, absolute and relative errors, methods of least square. Chromatography: Basic concept, principle, instrumentation and applications of adsorption, partition, ion-exchange, size exclusion chromatography. Electron microscopy (SEM and TEM): Basic concepts and principles, principles of image formation and applications. X-ray diffraction, Bragg's law of x-ray diffraction. UV-Vis spectroscopy: Transitions, Beer-Lambert's law, Effect of solvent and conjugation on λ_{max}, electronic states and term symbols for the ground state. Vibrational spectroscopy: Molecular vibrations and modes of vibrations. Factors influencing vibrational frequencies: hydrogen bonding, conjugation, inductive, resonance, field effects and bond angles. Proton NMR: concept, chemical shift and its measurement, spectral correlation with simple organic molecules, Basic concepts COSY, HETCOR, NOESY, ^{13}C DEPT NMR spectroscopy.

UNIT-V: Environmental Chemistry: Environmental segments, Atmosphere: composition, particles, ions and radicals. chemical and photochemical reactions, Green house effect/Global warming, ozone layers, acid rains, chemical interactions; Toxic chemicals in environment; environmental health hazards; Biochemical effects- arsenic, lead, mercury, carbon monoxide, nitrogen oxides, sulfur dioxide, ozone and PAN, cyanide, pesticides. Air pollution- types and sources; Air pollutants classification and properties; Control methods- particulate and gaseous emissions; Automobile pollution and roles of catalytic converters.

UNIT-VI: Polymer Chemistry: Basic concepts, Classification of polymers, mechanism of Polymerization, condensation and addition polymers, kinetics of condensation (step-wise) polymerisation, size distribution in linear condensation polymers, molecular size control, degree of polymerization; mechanism of vinyl radical polymerisation, effect of temperature and pressure on chain polymerisation, stereochemistry of polymer chain & stereo regular polymerisation, Ionic polymerisation (similarities and contrast), kinetics of cationic, anionic polymerisation, kinetics of copolymerisation, criteria for polymer solubility; Mass number and Mass average molecular weight, Measurement of molecular weight of polymers by osmometry, viscometry, light scattering and ultracentrifugation methods. Preparation and Properties of some commercial Polymers: Polyethylene, polyvinyl chloride, Teflon, polyamides, polyesters, phenolic resins, epoxy resins, synthetic rubbers. Concept of vulcanization and rubber compounding. Functional polymers- conducting and fire-resistant polymers.