

**DEPARTMENT OF CHEMISTRY**  
**FACULTY OF SCIENCE**  
**A.M.U., ALIGARH**

**Syllabus for Ph.D Admission Test 2022-23 onwards**

**Section – B**

Atomic X-ray spectrometry: Generation of X-ray spectra, X-ray absorption: Principle, X-rays absorption edge method, instrumentation, application; X-ray fluorescence: principle, instrumentation and application. Radiochemical methods: nuclear reactions and radiations, interaction of nuclear radiation with matter, radioactive decay, detection of radiation, Neutron activation method, Isotope dilution method. Solid phase extraction: principle, apparatus; supercritical fluid chromatography and extraction: Principle, Instrumentation and application; Acid - Base equilibria in non-aqueous media, metal complex equilibria, chelate extraction system, Redox equilibria and titration; equilibrium constant of redox reactions, oxidation-reduction titrations, redox indicator, redox titration using potentiometry; capillary electrophoresis: theory of capillary electrophoresis, instrumentation, capillary electrophoresis method- capillary zone electrophoresis, capillary gel electrophoresis, capillary isotachopheresis, capillary isoelectronic focusing. Thermogravimetric analysis (TGA), differential thermal analysis (DTA) and derivative thermogravimetry-methodology, instrumentation and applications, thermometric titrimetry and its applications to acid-base and complexometric titrations. Advances in Ion-

Exchange: Basic principles and capacity determination, Ion-exchange equilibria, Ion exchange kinetics, polymerization reactions, Carothers theory, statistical theory, Polymer characterization, structure and properties, kinetics of chain polymerization, Electroanalytical Methods: separation by electrolysis, coulometric methods, amperometric titrations, voltammetry and polarography, potentiometry and conductometry.

Differential and derivative spectrophotometry, photometric accuracy, Job's method, mole-ratio and slope ratio methods, photometric titrations, Factors affecting fluorescence and phosphorescence, relationship between fluorescence intensity and concentration. Atomic absorption spectrometry: basic principle, sample introduction methods, atomic absorption spectrometer, Interferences and their elimination-spectral & chemical interferences, application; Atomic emission spectrometry-Flame photometry-principle, theory of flame, instrumentation, Atomic emission spectrometry with plasma sources-ICP and DCP, instrumentation, interferences and applications, AES with electrical discharge- arc & spark sources, Flow injection analysis-principle, instrumentation and applications.

Synthesis, bonding, structural characteristics of Alkylidenes, alkylidynes, low valent carbenes and carbines. Nucleophilic and Electrophilic reactions on the ligands. Complexes with unsaturated organic molecules, alkenes, alkynes, allyl,  $\pi$  transition metal diene, dienyl, arene and trienyl complexes. Bonding and structural features of fluxional and dynamic molecules.

Electronic spectra and its selection rules. Spectra in solids and spectra of aqueous solutions of  $M(H_2O)^{n+}$ . The spectra of individual ions e.g.  $d^1 (Ti^{3+})$ ,  $d^9 (Cu^{2+})$ ,  $d^8 (Ni^{2+})$ ,  $d^3 (Cr^{3+})$ ,  $d^7 (Co^{2+})$ ,  $d^6 (Fe^{2+})$  and  $d^5 (Mn^{2+}, Fe^{3+})$ . Spectra of spin free and spin paired  $[ML_6]^{n+}$ , Jahn. Teller distortion in Octahedral complexes. The spectrochemical and nephelauxetic series, Charge Transfer transition. Molecular Orbital Theory (MOT) as applied to octahedral and tetrahedral complexes. The MO concept of sigma bonded compounds. Supramolecular Chemistry, self assembly and molecular recognition. Molecular ionic and photonic devices, DNA as supramolecular motif.

Reaction Mechanism in Octahedral transition metal complexes, Reaction mechanism in Square Planar complexes, Metal-Ligand Bonding, Crystal Field theory, Electronic spectra and magnetic properties of transition metal complexes. Metal Carbonyls, Nitrosyls and Metal Clusters, Metal-Ligand Equilibria in Solution. Metal Ions in biological Systems,  $Fe^{2+}$ ,  $Co^{2+}$ ,  $Cu^{2+}$ ,  $Zn^{2+}$  etc. Structure of metalloporphyrins, Haemoglobin, and Myoglobin and their dioxygen binding affinities, Electron

transfer molecule in biology, cytochromes and  $Fe_4S_4$  Cluster, Nitrogenase, Bioenergetic and ATP Cycle, Transport of Ions,  $Na^+/K^+$  ATPase ion Pump

Organic Synthesis: Organometallic Reagents-Principle, preparation, properties and applications in organic synthesis with mechanistic details of organometallic compounds of: Li, Mg, Hg, Cd, Zn, Pd, Ni and Rh. Oxidation, Reduction, Rearrangements, Reagents in organic synthesis, Protection of the groups, Disconnection approach to syntheses of organic molecules, One group C-C

disconnection, Two Group C-C Disconnection, Application of the above for designing the organic synthesis. Spectroscopic methods (UV, IR,  $^1H$  NMR,  $^{13}C$  NMR, Mass) for identification of organic compounds.

Heterocyclic Chemistry: Nomenclature of heterocycles, aromatic and non-aromatic heterocycles, Three-membered, four-membered and six-membered heterocycles with one heteroatom, six-membered heterocycles with two or more heteroatoms, seven- and large-membered heterocycles. Chemistry of Natural Products: alkaloids, steroids, terpenoids and flavonoids.

Nature of bonding in organic molecules, Stereochemistry, Reaction mechanism: Structure and reactivity. Aliphatic electrophilic substitution, Aromatic electrophilic substitution, Aliphatic nucleophilic substitution, Aromatic nucleophilic substitution, Free radical reactions, Elimination reactions, Addition to Carbon-Carbon multiple bonds, Addition to carbon-hetero multiple bonds, Pericyclic reactions.

Photochemistry of alkenes, 1,4 and 1,5 dienes, carbonyl compounds,  $\alpha$ ,  $\beta$  and  $\beta$ ,  $\gamma$ -unsaturated carbonyl compounds, cyclohexenone and cyclohexadienone aromatic compounds, Photo-Fries rearrangement, Barton reaction, Hoffmann-Loeffler-Freytag reaction, Singlet molecular oxygen reactions, Photo-Bergman cyclisation, Photochemical Nazarov cyclisation, Photo-Favorskii rearrangement, Bicycle rearrangement and Photochemical Wolff rearrangement.

Chemical Dynamics: Reactions Kinetics: Kinetics of Polymerisation, Heterogeneous Reactions, Kinetics of Enzyme Catalysed Reactions, Photochemical Reactions. Surfactants.

Electrochemistry: Interfacial Potential difference, Selective electrodes, Non-Faradaic Processes and Nature of Electrode/Solution Interface, Kinetics of Electrode Reactions, Mass Transfer, Controlled Potential Microelectrode Techniques, Potential Step Methods, Potential Sweep Methods.

Statistical Thermodynamics: Distribution Laws, Fermi-Dirac and Bose-Einstein statistics, Partition Functions and Thermodynamic Functions, Chemical Equilibrium, Nuclear Spin Statistics & Isotope Effects, Ensembles, Fluctuations, Real Gases.

Solid State Chemistry; Solid State Reactions, Defects in Solids, thermodynamics of defects, solid solutions, solid ionic conductors, conductivity in metals, Band theory, Intrinsic and Extrinsic semiconductor.

Symmetry Group theory in Chemistry; Quantum Chemistry: Theory, (Angular Momentum, Electronic Structure of Atoms, Approximate Methods, Molecular Orbital Theory) Thermodynamics, Non-Equilibrium Thermodynamics, Surface Chemistry, Electrochemistry, Biopolymers.