Ethics University

Ph.D. Entrance Examination Syllabus

Chemistry (Paper-II)

Unit I: Inorganic Chemistry

- **Chemical Periodicity:**

  Periodic trends in properties, atomic and ionic radii, ionization energy, electron affinity, electronegativity

- **Chemical Bonding and Molecular Structure:**

  Ionic, covalent bonding; VSEPR theory; shapes of molecules; hybridization; MO theory (homo- and heteronuclear molecules)

- **Main Group Chemistry:**

  Allotropy, synthesis, structure, bonding and industrial applications of compounds

- **Transition Elements & Coordination Chemistry:**

  Crystal field theory (CFT), ligand field theory (LFT), bonding theories

  Spectral and magnetic properties

  Reaction mechanisms (substitution and electron transfer reactions)

- **Inner Transition Elements:**

  Lanthanides and actinides: spectral and magnetic properties, redox behavior, analytical applications

- **Organometallic Chemistry:**

  Synthesis, structure, bonding (18-electron rule), and reactivity

- **Bioinorganic Chemistry:**

  Photosystems, porphyrins, metalloenzymes

  Oxygen transport (hemoglobin, myoglobin)

  Electron transfer reactions and nitrogen fixation

  Metal complexes in medicine

- **Analytical Techniques:**

  IR, Raman, NMR, EPR, Mössbauer, UV-Visible spectroscopy

  Mass spectrometry, electron spectroscopy, microscopic techniques

Unit II: Physical Chemistry

- **Quantum Chemistry:**

  Postulates of quantum mechanics, operators, eigenfunctions

  Exactly solvable systems: particle in a box, harmonic oscillator, hydrogen atom

  Atomic orbitals and tunnelling

- **Approximate Methods & Group Theory:**

  Variational and perturbation methods

  Symmetry elements and point groups

  Character tables and selection rules

- **Molecular Spectroscopy:**

  Rotational, vibrational and electronic spectra

  IR and Raman spectroscopy: selection rules

- **Thermodynamics:**

  Laws of thermodynamics

  State and path functions

  Phase equilibria and phase rule

  Ideal and non-ideal gases and solutions

- **Electrochemistry & Statistical Thermodynamics:**

  Nernst equation, redox systems, electrochemical cells

- **Chemical Kinetics:**

  Rate laws, collision theory, transition state theory

  Enzyme kinetics, unimolecular reactions, salt effects

  Homogeneous catalysis and photochemical reactions

- **Surface Chemistry & Colloids:**

  Adsorption isotherms, surface area

  Stability and properties of colloids

  Heterogeneous catalysis

Unit III: Organic Chemistry

- **Basic Concepts & Nomenclature:**

  IUPAC nomenclature, regioselectivity and stereochemistry

- **Stereochemistry:**

  Optical isomerism, chirality, conformational analysis

- **Reaction Mechanisms:**

  Addition, elimination and substitution reactions

  Electrophilic, nucleophilic and radical reactions

  Reaction intermediates and pathway determination

- **Named Reactions & Rearrangements:**

  Applications in organic synthesis

- **Reagents and Transformations:**

  Functional group interconversions

  Oxidation and reduction reactions

  Use of catalysts (organic, inorganic, organometallic, enzymatic)

- **Advanced Organic Synthesis:**

  Retrosynthesis, disconnection approach, synthons

- **Asymmetric & Pericyclic Reactions:**

  Electrocyclization, cycloaddition, sigmatropic rearrangements

- **Photochemistry:**

  Principles and synthetic applications

- **Structure Determination:**

  IR, UV-Vis spectroscopy

  ^{1}H and ^{13}C NMR spectroscopy

  Mass spectrometry

Recommended Readings

- Atkins & Friedman – *Molecular Quantum Mechanics*
- Cotton & Wilkinson – *Advanced Inorganic Chemistry*
- J.D. Lee – *Concise Inorganic Chemistry*
- Morrison & Boyd – *Organic Chemistry*
- Clayden, Greeves & Warren – *Organic Chemistry*
- P.W. Atkins – *Physical Chemistry*