Syllabus
Ph.D., Entrance Examination
Chemistry
Faculty of Applied Science &Technology

INORGANIC CHEMISTRY

Chemical periodicity- Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory). Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications. Organometallic compounds: synthesis, bonding and structure, and reactivity. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mossbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.

PHYSICAL CHEMISTRY

Basic principles of quantum mechanics: Postulates; operator algebra; exactly-solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; tunneling. Approximate methods of quantum mechanics: Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gasses, and solutions. Statistical thermodynamics: Nernst equation, redox systems, electrochemical cells; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical

reactions. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.

ORGANIC CHEMISTRY

IUPAC nomenclature of organic molecules including Regio- and stereoisomers. Principles of stereochemistry: Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways. Common named reactions and rearrangements – applications in organic synthesis. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Concepts in organic synthesis: Retrosynthesis, disconnection, synthons. Asymmetric synthesis: Pericyclic reactions – electrocyclization, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry. Structure determination of organic compounds by IR, UV-Vis, ^{1}H & ^{13}C NMR and Mass spectroscopic techniques.

Interdisciplinary topics

1. Chemistry in nanoscience and technology.
2. Catalysis and green chemistry.
3. Medicinal chemistry.
4. Supramolecular chemistry.
5. Environmental chemistry.