Ph.D. Entrance Syllabus
Department of Chemistry & Biochemistry
Sharda School of Basic Sciences and Research

Subject: Chemistry

Course	Content
Physical Chemistry	**Quantum Mechanics:** 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; orbital and spin angular momenta; tunnelling.Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems. **Molecular spectroscopy:** Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance. **Chemical thermodynamics:** Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gasses, and solutions.**Electrochemistry:** Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations. **Chemical kinetics:** Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; 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. **Solid state:** Crystal structures; Bragg's law and applications; band structure of solids. **Polymer chemistry:** Molar masses; kinetics of polymerization
Organic Chemistry	IUPAC nomenclature of organic molecules including regio- and stereoisomers. **Concept of aromaticity**: Benzenoid and non-benzenoid compounds. Organic reactive intermediates: Generation, stability, and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes. **Principles of stereochemistry**: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity, and asymmetric induction. **Reaction mechanism**, common name reactions, and rearrangement; important reagents (organic, inorganic, organometallic, and

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	enzymatic) for functional group transformation. **Concepts in organic synthesis**: Retrosynthesis, disconnection, and protecting groups. **Asymmetric synthesis**: Chiral auxiliaries, methods of asymmetric induction, Resolution – optical and kinetic. **Pericyclic reactions** – electrocyclization, cycloaddition, sigmatropic rearrangements, and other related concerted reactions. **Principles and applications of photochemical reactions** in organic chemistry. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S). **Chemistry of natural products**: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids, and alkaloids. **Structure determination** of organic compounds by IR, UV-Vis, ^{1}H & ^{13}C NMR, and Mass spectroscopic techniques.
Inorganic Chemistry	**Chemistry of *s*, *p*, *d*, and *f*** block elements; Structure and bonding in homo- and heteronuclear molecules including shapes of molecules (**VSEPR** Theory); **Periodic properties**; Concepts of acids and bases; Non-aqueous solvents; **Organometallic compounds**: synthesis, bonding and structure, and reactivity; Organometallics in Homogeneous Catalysis; Cages and metal clusters; **Bioinorganic chemistry**: photosynthesis, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, metal complexes in medicine; **Characterization of inorganic compounds** by IR, Raman, NMR, EPR, Mössbauer, UV-vis, MS and microscopic techniques; **Nuclear chemistry**: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis; **Coordination compounds**: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.

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