SECTION – A

(Common for all candidates)

RESEARCH METHODOLOGY

Total Marks: 50

Unit	Content
1	**Basics of Research:** Research: Meaning, Objective, Characteristics, Steps of research, Methods of research, Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.
2	**Research Problem and Research Design:** Introduction to Research Problem, Necessity of Defining the Problem, Selecting the Problem, Techniques Involved in Defining a Problem, Meaning and Types of Research Design, Important Concepts Relating to Research Design
3	**Sampling Design:** Census and sample survey, Implications of a Sample Design, Steps in sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, Different Types of sample Designs, How to Select a Random Sample?, Random Sample from an Infinite Universe, Complex Random Sampling Designs
4	**Data Collection and Analysis:** Methods of Data Collection- Observation, Interview, Questionnaires, Schedules, Survey and Experimental. Selection of Appropriate Method for Data Collection, Different Techniques of Sampling such as Probability and Non-Probability, Basic Statistical Methods of Data Analysis such as Frequency distribution, Measures of central tendency, Measures of Dispersion, Coefficient of variation, correlation and regression.
5	**Research Ethics and Morals:** Environmental impacts and Ethical issues, Commercialisation, Copy right, Royalty, Intellectual property rights and Patent law, Plagiarism, Citation, Referencing style and acknowledgement.

SECTION – B

(Faculty of Science)

Total Marks: 50

Department: Chemistry

CONTENT	
1	**ORGANIC CHEMISTRY**
	• IUPAC nomenclature of organic molecules including regio- and stereoisomers. • **Principles of stereochemistry:** Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction. • **Aromaticity:** Benzenoid and non-benzenoid compounds – generation and reactions. • **Organic reactive intermediates:** Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes. • **Organic reaction mechanisms**: addition, elimination and substitution reactions with Electrophillic, 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). Chemo, regio and stereo selective transformations. • **Concepts in organic synthesis:** Retro synthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups. • **Asymmetric synthesis:** Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic. • **Pericyclic reactions**: electrocyclisation, cycloadditions, 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 hetero atoms (O, N, S). • **Chemistry of natural products:** Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids. • **Structure determination of organic compounds** by IR, UV-Vis, ^{1}H & ^{13}C NMR and Mass spectroscopic techniques.
2	**INORGANIC CHEMISTRY**
	• Chemical periodicity • Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory). • Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents. • **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. Organometallics in homogeneous catalysis. • Cages and metal clusters. • **Analytical chemistry:** separation, spectroscopic, electro- and thermo analytical methods. • **Bioinorganic chemistry:** photo systems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine. • **Characterization of inorganic compounds** by IR, Raman, NMR, EPR, Mossbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques. • **Nuclear chemistry:** nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.
3	**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; orbital and spin angular momenta; tunneling. • **Approximate methods of quantum mechanics:** Variational principle; perturbation theory up to second order in energy; applications. • **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's principle; elementary description of phase transitions; phase Equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions. • **Statistical thermodynamics:** Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems. • **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.