

SECTION – A

(Common for all candidates)

Total Marks: 50

Ph.D. Entrance Examination Syllabus (Research Methodology)

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

Total Marks: 50

Ph.D. Entrance Examination Syllabus (Chemistry)

Inorganic Chemistry and Analytical chemistry

Chemical periodicity, Structure and bonding in homo and hetero nuclear 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: photosystems, 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.

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, benzyne and nitrenes,. 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). Chemo, regio and stereoselective transformations, Concepts in organic synthesis: Retrosynthesis, 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 - 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 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, ^1H & ^{13}C NMR and Mass spectroscopic 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; orbital and spin angular momenta; tunneling, Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications,. Atomic structure and spectroscopy; term symbols; many-electron systems and anti-symmetry principle, Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated p-electron systems, 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; 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 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; DebyeHuckel 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, Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

