

# **DEPARTMENT OF CHEMISTRY**

**Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh**

Syllabus for Vishwavidyalaya Research Entrance Test (VRET)

For the Admission in Ph.D. Program in

## **CHEMISTRY**

### **PART-A – RESEARCH METHODOLOGY**

**UNIT-I:** Basic Laboratory skills: Laboratory safety management, hazardous and non-hazardous chemicals, volatile and non-volatile solvents, Purification and Separation techniques like recrystallization, chromatography (thin layer chromatography, column chromatography, gas chromatography etc.), Solvent extraction, melting point determination.

**UNIT-II:** Qualitative and Quantitative Analysis: Volumetric and gravimetric analysis, identification and systematic analysis of inorganic acid and basic radicals and organic compounds. Structure determination of organic molecules.

**UNIT-III:** Experimental Techniques: Conventional experiment – co-precipitation, post-precipitation, sol-gel, heating, refluxing, complexation, grinding, blending, composites. Non-conventional methods – modern green techniques – Microwave, sonication, ball milling, aqueous medium.

**UNIT-IV:** Characterization Techniques in Research: Basic principles and applications of FT-IR, UV-Vis, NMR, Mass, EPR, X-ray diffraction, Mössbauer spectroscopy.

**UNIT-V:** Data analysis: Determinate and Indeterminate errors. Normal error curve. Accuracy and Precision, relative and standard deviation. Methods for minimizing errors. Criteria for rejection of an observation. Significant figures and computation rules. Basic concept of computers- Hardware and Software units.

## **PART-B: Subject: Chemistry**

### **UNIT-I: ORGANIC CHEMISTRY:**

(i) IUPAC nomenclature of organic molecules including region -and stereoisomers. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.

(ii) Aromaticity: Benzenoid and non-benzenoid compounds—generation and reactions.

(iii) Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzyne and nitrenes.

(iv) Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction mechanism.

(v) 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.

(vi) 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.

(vii) Pericyclic reactions – electrocycloisatation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.

(viii) Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).

(ix) Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids.

**UNIT-II: INORGANIC CHEMISTRY:**

- (i) Chemical periodicity; Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
- (ii) Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
- (iii) 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.
- (iv) Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis. Clusters compounds.
- (v) Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, metal complexes in medicine.

**UNIT-III: PHYSICAL CHEMISTRY:**

- (i) 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; Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications
- (ii) 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
- (iii) Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.
- (iv) 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.

## *Chemistry Syllabus for VRET*

(v) Polymers Chemistry – definition, classification, average molecular weight determination, poly dispersity index and kinetics of polymerization.

### **UNIT-IV: ANALYTICAL CHEMISTRY:**

(i) Statistical Evaluation: Determinate and Indeterminate errors. Accuracy and Precision, relative and standard deviation. Methods for minimizing errors. Significant figures.

(ii) Useful statistical test: Test of significance, the F test, the student ‘t’ test, the chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least square method for linear plots).

(iii) Treatments of equilibria: Solvents and solutions, leveling of aqueous and non-aqueous solvent effects, general treatment of equilibria in aqueous medium involving monoprotic weak acid and weak base, and salts of weak acids and weak bases. Activity and concentration, Effect of electrolytes on chemical equilibria, Calculation of pH, Hammett acidity function Acid-base titrations and theory of pH indicators, Complexation equilibria and complexometric titrations, Redox equilibria and redox titration, Theory of redox indicators, precipitation titrations.

**UNIT-V: SPECTROSCOPY:** Basic principles of rotational, vibrational, FT-IR, UV-Vis, NMR, Mass, EPR, Raman, Mössbauer spectroscopy and its applications in structural elucidation of simple organic molecules.