

## **Post Graduate Department of Chemistry**

### **M.Sc. Chemistry**

#### **Programme Outcome**

The course teaches the advance topics in chemistry. Experts from the academics and industry field have structured course. It enables a student to have a detailed knowledge of the inorganic, organic, physical and analytical chemistry. Chemistry offers a wide variety of opportunities in pharmaceutical, biotechnology, and medical device companies. Most chemists use their research skills to formulate, produce, characterize, and analyze new compounds for specific applications. The chemists are mainly involved in finding new cures and discovering new molecules through a wide variety of techniques like. Many chemists start out in the lab and then move on to other laboratory career such as process chemistry, formulation chemistry, quality control or quality assurance. They may also move to non-laboratory careers such as regulatory affairs, project management and production.

#### **Programme Specific Outcomes (PSO I) :M.Sc. I Chemistry**

1. The learners should be able to apply theories of chemical bonding, reaction mechanism, electronic structure and magnetic properties of complexes to identify the occurrence, active site structure and functions.
2. To give students a comprehensive understanding of the principles of Chemistry .
3. To gain the skill to design and carry out scientific experiments and interpret the data. .

#### **Programme Specific Outcomes (PSO II) :M.Sc. II Chemistry**

1. To build a scientific temper and to learn the necessary skills to succeed in research or industrial field. .
2. To be able to define and resolve new problems in Chemistry and participate in the future development of Chemistry Course.
3. To understand the interdisciplinary nature of Chemistry and to be aware of the emerging fields in Chemistry .

## **Course Outcomes**

### **CO 1 Inorganic Chemistry**

To have a basic idea about Inorganic Chemistry, chemical bonding and various theories of bonding in metal complexes. To study the important aspects of bioinorganic chemistry. To understand the functions and applications of bioorganic compounds. The students will acquire knowledge of main group elements, Concepts of symmetry and group theory in solving chemical structural problems, Use of character tables and Application of symmetry and group theory in spectroscopy. Enable the students to predict the point group of important molecules. To understand the idea of space groups and to learn the theory of molecular symmetry. To gain skill to apply group theory to vibrational and electronic spectroscopy.

### **CO 2 Organic Chemistry**

To understand the basic concepts and mechanism in organic chemistry. To get an idea about the various kinetic and thermodynamic factors which control the organic reactions. To know stereochemistry and various possible conformations of organic compounds and how it affects the rate of reaction, To have a basic idea of Aromaticity, nonaromaticity and antiaromaticity in carbocyclic and heterocyclic compounds; Molecular orbital symmetry elements and possibility of thermally and photochemically pericyclic reactions.

The students will acquire knowledge of mechanistic aspects in nucleophilic and electrophilic substitution. Reaction conditions, products formation and mechanisms of some named reactions. Mechanisms of addition reactions of C=C and C=O bonds and elimination reactions.

### **CO 3 Physical Chemistry**

To provide an insight into the thermodynamic and kinetic aspects of chemical reactions and phase equilibria. To derive some thermochemical equations and kinetic equations. To study phase diagrams and elementary idea of catalysis. To understand the requirement of approximation methods in quantum mechanics. To gain the knowledge to apply important approximation methods to problems in quantum mechanics. To gain insight in to valence bond theory molecular orbital theory and the concept of hybridization. To impart the students concepts of the fundamentals of quantum mechanics and its applications in the study of structure of atoms, bonding in molecules

To develop skills in doing experiments in kinetics, Potentiometry and pH metric. Enable the students to prepare data analysis using spreadsheet program. To provide an insight into the characteristics of different types of solutions and electrochemical phenomena. To learn ionic equilibria and electrical properties of ions in solution. To learn the concepts of acids and bases, pH and buffer solutions.

### **Outcomes of Inorganic Chemistry**

#### **CO 4 Reaction mechanism of Transition metal complexes**

The students will acquire knowledge of

- Formation, reaction mechanism and stability of the coordination complexes
- Interpretation of the electronic and magnetic properties

#### **CO 5 Ligand Field**

A broad but still detailed overview of ligand field aspects used in chemistry with a particular focus on the most advanced topics addressed by surrounding ligands.

#### **CO 6 Inorganic Spectroscopy I**

Student will be able to know the

- Utility of spectroscopic methods such as IR, Raman, Mossbauer techniques for the characterization of inorganic complexes,
- Application of UV-Vis, FT-IR and magnetic moment measurement.
- Photochemistry of inorganic compounds, preparation and purification of different inorganic complexes.

#### **CO 7 Advance topics in inorganic chemistry**

On completion of course the student will be able to

- Achieve advanced knowledge about spectroscopic terms and symbols which further implies for qualifying the national eligibility test for lectureship.

#### **CO 8 Chemistry of Organometallic compounds**

Students will be able to understand the

- Preparation, bonding, chemical properties, stability of organometallic compounds and clusters and their applications as industrial catalysts

## **CO 9 Inorganic Spectroscopy II**

Students will be able to understand the

- Systematic qualitative analysis of mixtures containing two acid and two basic radicals with one interfering radical by semi-micro method.
- Basic and advance applications of NMR, ESR for the characterization of coordination complexes, stability of organometallic compounds and clusters, and their applications as industrial catalysts.

## **Outcomes of Organic Chemistry**

### **CO 10 Organic Photo Chemistry and Pericyclic Reactions**

Students will be able to understand the

- The theory of photoreaction, application of photochemistry and photophysical principles on simple and macromolecules.
- Mechanism for chemical reactions for optimizing the experimental conditions, molecular orbital symmetry elements ,thermally and photochemically pericyclic reactions.

### **CO 11Chemistry of Natural Products**

Students will be able to understand the

- Classification, importance of various natural products, structural illustration,
- Synthesis of various natural products useful for the identification and the detection of natural products.
- Fundamentals of terpenoids, alkaloids, vitamins, lipids and steroids.
- An elementary idea of supramolecular chemistry and Green Fluorescent Proteins.

### **CO 12 Heterocyclic chemistry**

Students will be able to understand the

- Nomenclature of different heterocyclic compounds, Synthesis and reactivity of three, four, five and six membered heterocyclic compounds and biological importance of heterocyclic compounds.

### **CO 13 Organic Synthesis**

Students will be able to understand the

- Mechanistic pathway of organic reactions, Retrosynthetic approach to planning organic syntheses and Conversion of different functional group via rearrangement reaction.

### **CO 14 Modern Synthetic Reactions and Molecular Rearrangements**

Students will be able to understand the

- Experimental techniques for different catalytic reactions, Physical and chemical characterization of catalysts and catalytic reaction and their applications in industry.
- Structure-reactivity pattern of reactive intermediates involved in organic reactions. T
- Mechanism of organic reactions involving reactive intermediates and concerted processes and can apply these reactions in organic synthesis.

### **CO 15 Applications of molecular organic spectroscopy**

Students will be able to understand the

- IR range for functional groups,  $\lambda_{\max}$  for polyenes and  $\alpha$ ,  $\beta$ -unsaturated carbonyl compounds and solve structural problems based on UV-Vis, IR, <sup>1</sup>HNMR, <sup>13</sup>CNMR and mass spectral data.

### **Outcomes of Physical Chemistry**

#### **CO 16 Fundamentals of Spectroscopy**

Students will be able to understand the

- Molecular structure
- Capable of understanding and studying electrical properties of molecules.
- Origin, instrumentation and important applications of Microwave, IR, Raman, UV, NMR, EPR and EQR techniques. Microwave, Infrared-Vibration-rotation Raman and infra-red Spectroscopy and their applications for chemical analysis.
- Electronic spectroscopy of different elements and simple molecules. Nuclear Magnetic and Electron Spin Resonance Spectroscopy for organic compounds analysis, medical diagnostics

#### **CO 17 Statistical thermodynamics**

Students will be able to understand the

- Basic concepts in classical thermodynamics
- Thermodynamic aspects of various processes and reactions.
- Different aspects of statistical thermodynamics and its applications. Account for the physical interpretation of partition functions and be able to calculate thermodynamic properties of model systems with using Boltzmann -, Fermi-Dirac and Bose-Einstein statistics.
- Account for the physical interpretation of distribution functions and discuss and show how these can be used in calculations of basic thermodynamic properties.

- Calculate physical characteristics of non-ideal gases and liquids using the most common models for fluids.
- Account for the fundamental ideas in the Debye-Hückel theory and use the theory for calculations of properties of electrolytes.

### **CO 18 Photo and Surface Chemistry**

Students will be able to understand the

- Photochemistry and photophysical principles.
- Identification and characterization of transient intermediates by ultrafast modern techniques. Theory of photoreaction.
- Application of photochemistry and photophysical principles on simple and macromolecules.
- Mechanism for chemical reactions for optimizing the experimental conditions.
- Application of homogeneous and heterogeneous catalysis in chemical synthesis.
- Importance of adsorption process and catalytic activity at the solid surfaces.
- Concept of colloidal material and their stability for many practical uses.

### **CO 19 Polymer Chemistry**

Students will be able to understand the

- Fundamental concepts, principles and processes in main branches of polymer science namely, basics of polymers science, processing and applications, and biopolymer science.
- Width results from the choice of electives that students are offered.
- Step-growth and chain-growth polymerization, with respect to synthesis mechanisms and kinetics
- Crystalline melting temperature and glass transition temperature, including the influence of kinetics
- Flow properties of polymer melts and polymer solutions, with respect to both temperature and molecular weight
- Different mechanisms of polymerization
- Number, weight and viscosity average molecular weights with various techniques
- Processing of thermoplastic and thermosetting polymers
- Concept of conducting polymers and their applications

## **CO 20 Nano Chemistry and Advance Spectroscopy**

The students will get a basic understanding of

- Nanochemistry and nanotechnology.
- The Nanoscience and related fields.
- The Nanoscience and Applications.
- Nanoscience and Nanotechnology.
- Synthesis, characterisation, Electrical and optical properties and applications of nano systems. · Nanoparticle based Drug Delivery
- The molecular structure and Nano composites.

## **CO 21 X-ray Diffraction and Other Techniques**

Students will be able to understand the

- Basics and theoretical concepts of X-ray diffraction
- process of crystal structure analysis
- Types of instrumentation, hardware and technology used in X-ray diffraction. Independent collection of single crystal XRD data
- Evaluation of crystals, diffraction data and their suitability for single crystal structure analysis
- Independent workup and reduction of raw diffraction data
- Solving and refinement of crystal data up to refinement of simple disorder

## **CO 22 Analytical Chemistry**

Students will be able to understand the

- Fundamental concepts and principles that are very essential in the study of chemistry
- Atomic structure, basics of thermodynamics and the concept of equilibrium.
- Fundamentals of principles of analytical chemistry chromatographic techniques and thermo gravimetric analysis
- Theoretical principles and important applications of classical analytical methods within titration (acid/base titration, complexometric titration, redox titration)
- Various techniques within gravimetric and calorimetric methods

- Assess and suggest a suitable analytical method for a specific purpose and evaluate sensitivity
- Important sources of interferences and errors and also suggest alternative analytical methods for quality assurance.

### **CO 23 Environmental Chemistry**

Students will be able to understand the

- Chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
- Different types of toxic substances & responses and analyze toxicological information.
- Basic chemical concepts to analyze chemical processes involved in different environmental problems (air, water & soil).
- Theoretical principles of selected instrumental methods within electroanalytical and spectrometric/spectrophotometric methods, and main components in such analytical instruments. theoretical principles of various separation techniques in chromatography, and typical applications of chromatographic techniques.
- Stratospheric chemistry
- Ozone layer hole
- Ground level air pollution & Health consequences.
- Water purification and waste treatment processes and the practical chemistry involved.
- Causes and effects of environmental pollution by energy industry and discuss some mitigation strategies.



## **Bachelor of Science Chemistry (Hons)**

### **Programme Outcomes**

Chemistry is a versatile and stimulating field as it links many scientific disciplines and allows for collaboration with other experts in the industry. The goal of the Programme is to familiarize the participant with the updated theoretical and practical aspects of the Chemistry to gain access to this challenging and interesting field.

### **Programme Specific Outcomes**

#### **PSO I B.Sc I (Honors Chemistry)**

To develop interest among students in various branches of chemistry. Students will learn essential theoretical knowledge on atomic structure, periodic properties, chemical bonding, and nuclear chemistry. It will make students capable of understanding and studying nomenclature and classification of organic compounds, organic reactions.

#### **PSO II B.Sc II (Honors Chemistry)**

Students will get thorough knowledge of fundamentals of chemistry. Students will develop skills for quantitative estimation using the different branches of volumetric Analysis. The students will get training in the quantitative analysis of metal ions and anions using gravimetric method.

#### **PSO III B.Sc III (Honors Chemistry)**

Students will develop interest in the principle of qualitative analysis, applications of radioactivity and radioisotopes the different analytical techniques, preparation and applications of inorganic polymers and nano materials. This will give an idea of organic spectroscopy, photochemistry, identify organic compound using UV, IR and PMR spectroscopic techniques, fundamentals of quantum mechanics and its applications in the study of structure of atoms, bonding in molecules.

### **CO 1 Inorganic Chemistry**

Students will be able to understand the

- Branches of inorganic chemistry.
- Atomic structure, periodic properties, chemical bonding, and nuclear chemistry.
- d and f block elements
- Theories to explain the bonding in coordination compounds.
- Atomic theory of matter, composition of the atom, which defines the identity of a given element.

- Relative sizes, masses, and charges of the proton, neutron, and electron, and their assembly to form different atoms.
- Use the Periodic Table to rationalize similarities and differences of elements, including physical and chemical properties and reactivity.
- Predict common ionic charges of group 1A, 2A, 3A, 6A, and 7A elements based on position in the periodic table.

## **CO 2 Organic Chemistry**

Students will be able to understand the

- Nomenclature and classification of organic compounds, organic reactions .
- Various emerging new areas of organic chemistry.
- Chemistry of carbohydrate
- Molecular structure and bonding in organic molecules
- Classification of organic compounds by structure, use the IUPAC nomenclature, and identify conformational effects in organic compounds
- The products of reactions of alkenes and describe the mechanisms showing how the products are formed
- Types of isomerism in organic compounds, to identify and classify chiral centers, and explain the physical and chemical consequences of chirality
- Compounds in which resonance is important, predict the effect of resonance on the stability of compounds and reactive intermediates, and draw resonance structures.
- Conjugated pi systems and explain the effect of conjugation on molecular structure and reactivity; and predict the products of reactions of dienes.
- Mechanisms for substitution and elimination reactions, and predict the effect of nucleophile, leaving group, and solvent on the relative rates of S<sub>1</sub> versus S<sub>2</sub> reactions, and E<sub>1</sub> versus E<sub>2</sub> reactions, as well as on the relative rates of substitution versus elimination.

## **CO 3 Physical Chemistry**

Students will be able to

- Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors
- Present the results of a practical investigation in a concise manner

- Write the rate of reaction taking into account the stoichiometry of all species, express a rate law for elementary processes
- Do numerical problems related to errors
- Explain the origin of  $K_{eq}$  and its relation to fugacity and activity and apply these concepts to ideal and real solutions of electrolytes and non-electrolytes and to colligative properties
- List the methods for arriving at a plausible mechanism and/or rate law based on kinetic information
- Manipulate the gas laws to describe real and ideal gas behavior
- Apply the steady-state hypothesis to obtain rate equations
- Explain the basic principles of photochemical and radiation-chemical reactions
- Describe the Three Laws of Thermodynamics and their development
- Use the Maxwell equations and other thermodynamic relations to compute thermodynamic quantities from thermodynamic data tables

#### **CO 4 Inorganic Chemistry**

To impart students a thorough knowledge of

- Systematic qualitative analysis of mixtures containing two acid and two basic radicals with interfering radical by semi micro method
- Skills for quantitative estimation using the different branches of volumetric Analysis
- Quantitative analysis of metal ions and anions using gravimetric method
- Transition metal complexes play in Inorganic Chemistry.
- Structure and bonding theories, electronic and magnetic properties of the transition metal complexes and their kinetic studies
- Theories of bonding in coordination compounds and their experimental behavior
- Interaction of metal ions with biological ligands
- Explain the role of Inorganic “substances” in living systems and the use of metal ions in medicinal therapy and diagnosis

#### **CO 5 Organic Chemistry**

To impart students a thorough knowledge of

- Selected functional groups with a view to develop proper aptitude towards the study of organic compounds and their reactions.
- Organic reaction mechanisms.
- Skills required for the qualitative analysis of organic compounds, determination of physical constants
- Some selected functional groups. Alcohols, Phenols, Ethers and Epoxides
- Enable the students to study the structure, preparation and reactivity of carbonyl compound
- Importance of natural products

### **CO 6 Physical Chemistry**

To impart students a thorough knowledge of

- Thermodynamics viability of reactions.
- Kinetics of fast reactions
- Order of reactions with respect to given species by applying the initial rate method and isolation method, express the rate law from the orders with respect to the species involved.
- Energy versus reaction coordinate diagram, predict the dependence of rate constants on temperature and calculate the activation energy and pre exponential factors.
- Steady state approximation and derive the rate law of a complex mechanism such as that found in unimolecular reactions.
- Principles of electrochemistry to conductance, voltaic, and electrolytic systems.
- Physical basis for Debye-Huckel theory.
- Langmuir, Freundlich and BET adsorption isotherms.
- Phase equilibria help in understanding the formation of various materials, allotropic forms of different substances

### **CO 7 Inorganic Chemistry**

Students will be able to understand the

- General characteristics of different states of matter.
- Intermolecular forces in gases and liquids, the structure of solids, Defects in solids
- Principle of inorganic qualitative analysis, applications of radioactivity and radioisotopes the different

- Analytical techniques, preparation and applications of inorganic polymers and nanomaterials
- Chemical industry and identify the distinguishing features of its component
- Importance and roles of process optimization in chemical processing
- Industrial production of a number of important organic and inorganic compounds /chemicals
- Environmental issues pertaining to the chemical industry
- Use modern instrumentation techniques for chemical analysis and separation

### **CO 8 Organic Chemistry**

Students will be able to understand the

- mechanism of reactions of some selected functional groups in organic compounds
- applications of organic chemistry in various spheres of chemical sciences
- elementary idea of chemotherapy, organic spectroscopy and photochemistry
- organic compound using UV, IR and PMR spectroscopic techniques
- harmonious and synchronous progress of chemical reactions in body which leads to life
- chemical reactions involve certain molecules called biomolecules or molecules of life and that these molecules constitute the source of energy in body, build the body, act as catalyst in many processes and also responsible for the transfer of characters to off springs.
- structures of biomolecules (carbohydrates, proteins, enzymes, lipids and nucleic acids)and their role in life related processes
- basic types of molecules included are carbohydrates, proteins, enzymes, lipids and nucleic acids.

### **CO 9 Physical Chemistry**

Students will be able to understand the

- Concept of the fundamentals of quantum mechanics and its applications in the study of structure of atoms, bonding in molecules and molecular spectroscopy
- Valence bond and molecular orbital theory
- Fundamentals of microwave, infra red, Raman, electronic and magnetic resonance spectroscopy, mass spectrometry and photochemistry.
- Quantum chemistry and quantization of energy

- Atomic structure and the application of the concept of quantization of energy of different orbitals
- Absorption of energy by the molecules produces spectra which help in structure determination and identification of the molecules, and how this energy can initiate the photo-chemical reactions

### **CO 10 Green Chemistry**

Students will be able to understand the

- impact of green chemistry on human health and the environment
- twelve principles of Green Chemistry which they can apply to a range of work places for a safer, less toxic and healthier environment.

### **CO 11 Inorganic materials of Industrial importance**

Students will be able to understand the

- Manufacture and classification of Glass, Ceramics , fertilizers and cement
- Petroleum and petrochemical industry
- Principle and working of Batteries, catalysis and classification of alloys

### **CO 12 Industrial chemicals and Novel Inorganic solids**

Students will be able to understand the

- Industrial gases, industrial metallurgy
- Relationship between energy and environment
- Synthesis and modification of Inorganic solids

### **CO 13 Instrumental methods of chemical analysis**

Students will be able to understand the

- Basic introduction to spectroscopic methods of analysis like UV , IR , Flame Photometry
- Various separation techniques based on Chromatography

**Bachelor of Science**  
**Chemistry**  
**BSc I(Non-Medical/Medical/Biotech)**

**Programme Outcomes**

- i. Have firm foundations in the fundamentals and application of current chemical and scientific theories.
- ii. Are able to design, carry out, record and analyze the results of chemical experiments.
- iii. Are able to use modern instrumentation and classical techniques, to design experiments, and to properly record the results of their experiment.
- iv. Are skilled in problems solving, critical thinking and analytical reasoning.
- v. Are able to identify and solve chemical problems and explore new areas of research.

**Programme Specific Outcomes**

**PSO I B.Sc I Chemistry (Non-Medical/Medical/Biotech)**

This helps the student to understand basic chemistry which helps them to inter-relate with other subjects. This helps them to know and recall fundamental principles of chemistry as well to demonstrate ability to work independently as well as within a team.

**PSO II B.Sc II Chemistry (Non-Medical/Medical/Biotech)**

Students are able to design, carry out, record and analyze the results of chemical experiments. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

**PSO III B.Sc III (Non-Medical/Medical/Biotech)**

The aim of the program is to provide students with specific competences related to the use of spectroscopic techniques in chemistry and with systematic and instrumental transferable skills. A mobility scheme ensures that in addition to high specialization and access to advanced technologies, students will attend a common core curriculum of studies in the different higher education institutions.

**CO 1 Inorganic Chemistry**

Students will be able to understand the

- various branches of inorganic chemistry
- atomic structure, periodic properties, chemical bonding, and nuclear chemistry

- relative sizes, masses, and charges of the proton, neutron, and electron, and their assembly to form different atoms
- Periodic Table to rationalize similarities and differences of elements, including physical and chemical properties and reactivity

### **CO 2 Organic Chemistry**

Students will be able to understand the

- nomenclature and classification of organic compounds, organic reactions
- structure, use the IUPAC nomenclature, and identify conformational effects in organic compounds.
- products of reactions of alkenes and describe the mechanisms showing how the products are formed
- types of isomerism in organic compounds,
- chiral centers and explain the physical and chemical consequences of chirality
- resonance and its effect on the stability of compounds and reactive intermediates and draw resonance structures.

### **CO 3 Physical Chemistry**

Students will be able to understand the

- data from an experiment, including the construction of appropriate graphs and the evaluation of errors.
- practical investigation in a concise manner
- rate of reaction taking into account the stoichiometry of all species, express a rate law for elementary processes

### **CO 4 Inorganic Chemistry**

Students will be able to understand the

- general characteristics of the d and f block elements.
- theories to explain the bonding in coordination compounds.
- Organo metallic compounds, metal carbonyls and metal clusters.

### **CO 5 Organic Chemistry**

Students will be able to understand the



- functional groups with a view to develop proper aptitude towards the study of organic compounds and their reactions
- Organic reaction mechanisms

### **CO 6 Physical Chemistry**

Students will be able to understand the

- Thermodynamics
- rate constants and half-life for 0, 1st and 2nd order reactions from experimental datasets  
Boltzman distribution and its effect on the observed spectra
- integrate most functions encountered in chemical practice
- order of reactions with respect to given species by applying the initial rate method and isolation method, express the rate law from the orders with respect to the species involved
- Steady state approximation and derive the rate law of a complex mechanism such as that found in unimolecular reactions.

### **CO 7 Inorganic Chemistry**

Students will be able to understand the

- structure, synthesis and reactions of commonly known organometallics compounds
- applications of organometallics compounds in catalysis
- organometallics polymers
- coordination compounds
- magnetic properties of complexes and to know how magnetic moments can be employed for the interpretation of their structure

### **CO 8 Organic Chemistry**

Students will be able to understand the

- Fundamental aspects of organic chemistry
- organic reactions, classification of polymers, structure and uses of some commercial and natural polymers.
- systematic qualitative analysis of simple organic compound

## **CO 9 Physical Chemistry**

Students will be able to understand the

- concept of a particle in a box and the solutions to the Schrödinger equation for particles in 1D, 2D and 3D boxes
- concept of degeneracy
- Sketch energy level diagrams corresponding to spectroscopic transitions for the various spectroscopic methods covered
- fundamental properties of molecules using spectroscopic data and similarly predict spectroscopic features given the fundamental properties
- selection rules to predict observed spectroscopic transitions