# Postgraduate Department of Chemistry

# M.Sc. Chemistry

## Programme Outcomes

| | |
|---|---|
| **PO1** | Provides a fundamental insight into the changes taking place in and around our fascinating nature. |
| **PO2** | Understand the issues of environmental contexts and sustainable development |
| **PO3** | Through lectures, laboratory work, exercises, project work, and its independent master's thesis, students will gain knowledge about relevant working methods for research, industry, administration, and education. |
| **PO4** | Lays the foundation for doctoral programs in Chemistry. |
| **PO5** | Acquire the ability to engage in independent and lifelong learning in the broadest context |

## Programme Specific Outcomes

| | |
|---|---|
| **PSO1** | Acquires ability to synthesise , separate and characterise compounds using laboratory and instrumentation techniques |
| **PSO2** | Develops analytical skills and problem solving skills requiring application of chemical principles |
| **PSO3** | Know and predict the structure and bonding in molecules/ions |
| **PSO4** | Understand theoretical concepts of instruments that are commonly used in most chemistry fields as well as interpret and use data generated in instrumental chemical analysis |
| **PSO5** | Develop an understanding of eco-friendly chemical processes and impact of chemistry on health and environment. |

# M.Sc. Chemistry

## SEMESTER I

### Course Title- CH500101: ORGANOMETALLICS AND NUCLEAR CHEMISTRY

| CO | Course Outcome |
|---|---|
| 1 | To understand the structure, bonding and reactivity of organometallic compounds |
| 2 | To apply and analyze the methods of synthesis and mechanism of organometallic compounds |
| 3 | Describe the mechanisms by which organometallic catalysts facilitate chemical reactions. |
| 4 | Understand the functions of transition metal ions in biological systems. |
| 5 | Understand the applications of radioactive isotopes in various fields |

### Course Title- CH500102: STRUCTURAL AND MOLECULAR ORGANIC CHEMISTRY

| **CO** | **Course Outcome** |
|---|---|
| **1** | Understand fundamental concepts in organic chemistry, including bonding, hybridization, and molecular orbital theory, as foundational knowledge. |
| **2** | Analyze energy profiles, kinetic versus thermodynamic product control, Hammond postulate, and kinetic isotope effects to evaluate reaction mechanisms. |
| **3** | Apply the principles of photochemical reactions, such as Norrish reactions, Patterno-Buchi reaction, and Barton reactions, in understanding and predicting photochemical transformations. |
| **4** | Evaluate stereochemistry concepts, including chirality, enantiomers, and diastereoisomers, to predict the properties and reactivity of stereoisomeric compounds. |
| **5** | Apply conformational analysis techniques to predict and rationalize the stability and reactivity of different conformers in organic molecules. |

### Course Title- CH500103: QUANTUM CHEMISTRY AND GROUP THEORY

| **CO** | **Course Outcome** |
|---|---|
| **1** | Analyze the symmetry properties of molecules, determine their point groups, and apply these to the nature of chemical bonding in various compounds. |
| **2** | Construct character tables and perform SALCs for different molecular systems. |
| **3** | Apply the postulates of quantum mechanics to analyze and interpret quantum systems. |
| **4** | Apply quantum principles to analyze translational, vibrational, and rotational motion in quantum systems |
| **5** | Utilize the separation of variables method to solve the wave equation for hydrogen-like atoms. |

**Course Title- CH500104: THERMODYNAMICS, KINETIC THEORY AND STATISTICAL THERMODYNAMICS**

| CO | Course Outcome |
|---|---|
| 1 | Applies laws of equilibrium thermodynamics to three component systems |
| 2 | Understand the theories and properties of gases |
| 3 | Calculate thermodynamic properties of ideal gases and real gases using principles and techniques of statistical thermodynamics |

## SEMESTER II

**Course Title- CH500201: COORDINATION CHEMISTRY**

| CO | Course Outcome |
|---|---|
| 1 | Understand the principles of coordination chemistry, bonding theories, stability, kinetics, stereochemistry |
| 2 | Predicts the spectral and magnetic properties of metal complexes |
| 3 | Analyze the behavior of coordination compounds in various chemical reactions. |
| 4 | Differentiate coordination chemistry of lanthanoids and actinoids. |

**Course Title- CH 500202: ORGANIC REACTION MECHANISM**

| CO | Course Outcome |
|---|---|
| 1 | Analyze organic reaction mechanisms with a focus on reaction pathways and intermediates. |
| 2 | Evaluate the influence of substrate, reagent, leaving group, solvent, and neighboring groups on nucleophilic substitution and elimination reactions. |
| 3 | Examine carbanions, their formation, stability, and reactivity, including their role in nucleophilic additions to carbonyl groups and name reactions in carbanion chemistry. |
| 4 | Investigate carbocations, their formation, structure, stability, and involvement in C-X bond formation and molecular rearrangements, elucidating key reactions and rearrangement mechanisms. |
| 5 | Analyze carbenes, carbenoids, nitrenes, and arynes, including their structures, generation, and reactions, with a focus on important name reactions and rearrangements in these areas. |
| 6 | Explore radical reactions, including the generation of radical intermediates, their addition, fragmentation, rearrangements, and participation in name reactions involving radical intermediates. |
| 7 | Examine the chemistry of carbonyl compounds, including their reactions, oxidation, reduction, and addition reactions, along with the structure and reactions of α, β-unsaturated carbonyl compounds. |

**Course Title- CH500203: CHEMICAL BONDING AND COMPUTATIONAL CHEMISTRY**

| CO | Course Outcome |
|---|---|
| 1 | Apply, analyse and evaluate group theoretical concepts in spectroscopy |
| 2 | Understands approximation methods in quantum mechanics |
| 3 | Applies quantum mechanical treatment of hybridisation and conjugated dienes |
| 4 | Understand the basic concepts of various tools in computational chemistry. |
| 5 | Solve chemical problems using GAMESS / Firefly. |

**Course Title- CH500204: MOLECULAR SPECTROSCOPY**

| CO | Course Outcome |
|---|---|
| 1 | To understand the basic principles and theory of microwave, NMR, IR, Raman and electronic spectroscopy. |
| 2 | Apply knowledge of molecular spectroscopy to interpret experimental spectra and extract molecular information. |
| 3 | Analyze spectra to determine molecular parameters, such as bond lengths, vibrational frequencies, electronic transitions, and chemical shifts. |
| 4 | Analyze the factors influencing the position and intensity of spectral peaks. |

**Course Title- CH500205: INORGANIC CHEMISTRY PRACTICAL-1**

| CO | Course Outcome |
|---|---|
| 1 | Apply the principles of qualitative and quantitative analytical techniques in inorganic chemistry for identification of ions and preparation and characterization of inorganic complexes |

**Course Title- CH500206: ORGANIC CHEMISTRY PRACTICAL-II**

| CO | Course Outcome |
|---|---|
| 1 | Apply acquired academic insights in the separation and purification of organic compounds and binary mixtures. |
| 2 | Apply computational tools for constructing reaction schemes and interpreting spectral data in various organic reactions. |

**Course Title- CH500207:PHYSICAL CHEMISTRY PRACTICAL-1**

| CO | Course Outcome |
|---|---|
| 1 | Comprehensive understanding of physical chemistry principles, experimental techniques, and computational chemistry applications |

## SEMESTER III

### Course Title- CH 500301: STRUCTURAL INORGANIC CHEMISTRY

| CO | Course Outcome |
|---|---|
| 1 | Understands solid state reactions |
| 2 | Understands electrical, magnetic and optical properties of solids |
| 3 | Understand the different types of organometallic polymers. |
| 4 | Understand various synthetic approaches of solids and describe the applications of magnetic nanoparticles. |

### Course Title- CH 500302: ORGANIC SYNTHESES

| CO | Course Outcome |
|---|---|
| 1 | Apply various methods of oxidation and reduction in organic synthesis, including metal-based and non-metal-based reactions for transforming alcohols, alkenes, ketones, and other functional groups. |
| 2 | Evaluate the use of catalytic hydrogenation, metal-based reductions, and enzymatic reduction in synthetic processes, demonstrating proficiency in a wide range of reduction reactions. |
| 3 | Apply modern synthetic methods to efficiently construct complex organic molecules. |
| 4 | Employ a variety of synthetic reagents for constructing carbocyclic and heterocyclic ring systems, showcasing the versatility of organic synthesis techniques. |
| 5 | Analyze the synthesis of heterocyclic compounds with five-membered rings containing heteroatoms like N, S, or O, applying retrosynthetic analysis principles to plan efficient routes. |
| 6 | Demonstrate expertise in protecting group chemistry, including the protection and deprotection of hydroxy, carboxyl, carbonyl, and amino groups, with a focus on chemo- and regio-selective transformations. |
| 7 | Apply retrosynthetic analysis principles to plan the synthesis of aromatic compounds, amines, and alkenes, and understand key strategies for functional group transposition and interconversions in organic synthesis. |

### Course Title- CH500303: CHEMICAL KINETICS, SURFACE CHEMISTRY AND CRYSTALLOGRAPHY

| CO | Course Outcome |
|---|---|
| 1 | Understand the fundamental theories of reaction rates ,chain reactions,fast reactions, mechanism of enzyme catalysis and oscillating chemical reactions. |
| 2 | Understand the principles of surface chemistry, various surface analysis techniques, adsorption phenomena.Analyze surfaces in different contexts. |
| 3 | Understands the concept of structure factor |

**Course Title- CH 500304 SPECTROSCOPIC METHODS IN CHEMISTRY**

| CO | Course Outcome |
|---|---|
| 1 | Interpret and analyse various spectral data |
| 2 | Apply knowledge of spectroscopic techniques to identify the structures of unknown organic compounds. |
| 3 | Apply knowledge of reaction mechanisms and spectroscopic techniques to analyze and interpret the spectral data of the selected reactions/functional transformations. |

## SEMESTER IV

**Course Title- CH 800401 : ADVANCED INORGANIC CHEMISTRY**

| CO | Course Outcome |
|---|---|
| 1 | Analyse bonding in complexes using group theoretical principles |
| 2 | Apply knowledge of Infrared and Raman spectroscopy to analyze and interpret the vibrational spectra of coordination compounds containing specific ligands. Understand the role of Mössbauer spectroscopy in identifying specific compounds with high oxidation states |
| 3 | Discuss the photochemistry of coordination complexes |
| 4 | Understands evolving interfaces of nanotechnology |
| 5 | Comprehend the principles of non-silicon semiconductors in LED technology. Understand the thermoelectric properties and applications of materials. |
| 6 | Comprehend the design principles of metal organic frameworks. and explain how post-synthetic modification can be used to design functional MOFs. |
| 7 | Explain the role of hydrogen bonds and organometallic interactions in inorganic crystal engineering and understand the driving forces for supramolecular self-assembly involving hydrocarbyls, amides, and phosphides. |

**Course Title- CH 800402 ADVANCED ORGANIC CHEMISTRY**

| CO | Course Outcome |
|---|---|
| 1 | Evaluate the principles of Green Chemistry and apply them in planning environmentally friendly organic syntheses. |
| 2 | Analyze the biosynthesis of various biomolecules and explore biomimetic synthesis approaches. |
| 3 | Examine stereoselective transformations and their significance in organic synthesis. |
| 4 | Assess the synthesis of natural products and the chemistry of biomolecules, including the structure of proteins and nucleic acids. |
| 5 | Evaluate the principles of medicinal chemistry and drug design, understanding drug-receptor interactions and the mode of action of various drugs. |
| 6 | Analyze advances in polymer chemistry, including conducting polymers, dendrimers, and hyperbranched polymers. |
| 7 | Examine research methodology in chemistry, covering the scientific methods, types of research, chemical literature, and scientific writing |

**Course Title- CH800403: ADVANCED PHYSICAL CHEMISTRY**

| CO | Course Outcome |
|---|---|
| 1 | Understand common photochemical processes, principle of utilization of solar energy and quenching of fluorescence and its kinetics. |
| 2 | Understand the fundamental principles of fluorescence spectroscopy and its role in the study of molecular properties |
| 3 | Understand various diffraction methods, atomic spectroscopic techniques, electrochemistry, and electroanalytical technique. |
| 4 | Apply the theories in electrochemistry for analyzing kinetics of electrode reactions. |
| 5 | Apply advanced physical techniques in practical situations and research |
| 6 | Understand the thermodynamics of irreversible processes and the basic principles of bioenergetics |

**Course Title- CH 01 04 05: INORGANIC CHEMISTRY PRACTICAL-2**

| CO | Course Outcome |
|---|---|
| 1 | Analyze experimental data to calculate the concentrations of metallic ions in binary mixtures using volumetric and gravimetric data. |
| 2 | Application of paper chromatography to separate a mixture of three cations |

**Course Title- CH 010406: ORGANIC CHEMISTRY PRACTICAL-2**

| CO | Course Outcome |
|---|---|
| 1 | Design and carry out multi step synthesis, microwave assisted synthesis and Green Synthesis |

**Course Title- CH010407: PHYSICAL CHEMISTRY PRACTICAL-2**

| CO | Course Outcome |
|---|---|
| 1 | Analyse and apply the theoretical principles of physical chemistry |