M.Sc. Chemistry

Programme Outcomes

Sl. No.	At the time of graduation the students of MSc Degree programme in Chemistry will be able to develop	PO No.
1.	**Fundamental Knowledge and Critical Thinking:** An in-depth knowledge of the fundamental concepts of Chemistry and critical thinking for scientific investigation.	**PO1**
2.	**Problem Solving Skill**: Train students to observe and analyse problems, logical thinking to formulate a hypothesis, evaluate and validate the results with a sensible conclusion.	**PO2**
3.	**Analytical Expertise:** Design, plan and execute advanced laboratory experiments and structural characterization using various spectroscopic techniques. Also to develop skills in handling sophisticated analytical instruments.	**PO3**
4.	**Innovation and Scientific Exploration:** Prepare students about the importance of basic and applied scientific research and the importance of scientific education for the growth of our country.	**PO4**
5.	**Industrial Outlook:** To develop skills in the proper handling of apparatus and chemicals. To be exposed to the different processes used in industries and their applications.	**PO5**
6.	**Research Aptitude**: Inculcate the spirit of research and its importance in higher education and Nation building.	**PO6**
7.	**Competitive Examination and Employability:** Adequate training for the preparation of National as well as International competitive examination and also provide an insight into the various opportunities for employment. .	**PO7**
8.	**Environmental Conscience:** To provide awareness about the protection of environment, pollution control and importance of renewable energy resources for the society.	**PO8**
9.	**Ethics:** Identify different value systems including one's own, understand the moral principle that govern a person's behaviour, and accept responsibility for them.	**PO9**
10.	**Communication Skill:** Prepare students to present their views and findings with confidence and personality development.	**PO10**

Programme Specific Outcome

Sl. No.	Upon completion of MSc Degree programme in Chemistry, students	PSO No.
1.	Develop a better understanding of the current chemical principles, methods and theories with the ability to critically analyse at an advanced level.	**PSO1**
2.	Acquire solid knowledge of classical and modern experimental techniques and interpretation of results; thereby acquire the ability to plan and carry out independent projects.	**PSO2**
3.	Develop the qualities of time management and organization, planning and executing experiments.	**PSO3**
4.	Have a good level of awareness of the problems associated with health, safety and environment.	**PSO4**
5.	Understand how chemistry relates to the real world and be able to communicate their understanding of chemical principles to a lay audience and as well apply the knowledge when situation warrants.	**PSO5**
6.	Learn to search scientific literature and databases, extract and retrieve the required information and apply it in an appropriate manner.	**PSO6**
7.	Demonstrate proficiency in undertaking individual and/or team-based laboratory investigations using appropriate apparatus and safe laboratory practices.	**PSO7**
8.	Develop analytical solutions to a diversity of chemical problems identified from application contexts; critically analyse and interpret qualitative & quantitative chemical information's.	**PSO8**
9.	Develop analytical solutions to a diversity of chemical problems identified from application contexts; critically analyse and interpret qualitative & quantitative chemical information's.	**PSO9**

Course Outcome

Course Code	Course Title	Course Outcomes	
SEMESTER 1			
CH 211	**Inorganic Chemistry I**	CO1	Employ crystal field theory in analysing the splitting of d orbitals in octahedral, tetragonal, square planar, tetrahedral, trigonal bipyramidal and square pyramidal fields; calculate Crystal Field Stabilization Energy and Interpret Octahedral Site Stabilization Energy.
		CO2	Apply Jahn-Teller theorem and demonstrate evidence for JT effect, static and dynamic JT effect
		CO3	Illustrate MOT for octahedral and tetrahedral complexes with and without pi bonds and construct MO diagrams
		CO4	Critically evaluate data from a variety of analytical chemistry techniques and apply knowledge of the statistical analysis of data.
		CO5	Interpret complexometric titrations, redox titrations, gravimetric titrimetric and titrations in non-aqueous solvents.
		CO6	Apply TG, DTA and DSC in the study of metal complexes.
		CO7	Explain the functioning other frontier materials in inorganic chemistry like Solid Electrolytes, Solid oxide fuel cells, Rechargeable battery materials, Molecular materials and fullerides.
		CO8	Explain the preparation, properties and structure of isopoly acids of Mo, W and V and heteropoly acids of Mo and W.
		CO9	Explain preparation and properties of xenon fluorides, and noble gas compounds, alumina silicates, zeolites and silicones and identify the importance of shape selectivity.
		CO10	Identify the chemical processes occurring naturally in earth's atmospheric, aquatic and soil environments and evaluates the impacts of human perturbations to these processes.
CH212	**Organic Chemistry I**	CO1	Write down the IUPAC name of polycyclic, spiro cyclic and heterocyclic compounds and draw the structures from the IUPAC name of these compounds.
		CO2	Determine R and S, P and M, E and Z configuration of compounds with chiral centres, biphenyls, allenes, spiranes and draw the configurations in dash and wedge formula, or zig –zag configurations.
		CO3	Detect prochirality in a compound and explain relevance of prochirality.

		CO4	Explain chiral centre, chiral axis and chiral plane with examples, stability of conformations, stereo selective and stereospecific reactions
		CO5	Calculate Cotton effect of a compound from its structure and configuration
		CO6	Explain different methods for generation of free radical and different types of free radical reactions- Predict the products in a free radical reaction.
		CO7	Describe different types of mechanism of substitution, elimination, hydrolysis and addition reactions.
		CO8	Differentiate the rate, mechanism and stereochemistry influenced by solvent, substrate structure, and intermediate stability.
		CO9	Predict the products or reactants or reagents in selected types of reactions.
		CO10	Design the mechanism of selected reactions.
CH213	**Physical Chemistry I**	CO1	Outline the development of quantum mechanics and its tools and apply them in determining the wave functions and energies of moving particles.
		CO2	Recognize the nature of adsorption and propose theories and choose theoretical and instrumental methods of measurements of surface property.
		CO3	Understand theory and mechanism of catalytic action.
		CO4	Correlate thermodynamic properties and apply them in systems.
		CO5	Understand theories, mechanism and, kinetics of reactions and solve numerical problems.
		CO6	Identify point groups and construct character table and predict hybridisation and spectral properties of molecules.
CH 214	**Inorganic Chemistry Practicals – I**	CO1	Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors.
		CO2	Estimate volumetrically the concentration of Zn, Mg and Ni using EDTA and the volumetric estimation of Fe.
		CO3	Estimate volumetrically the hardness of water and concentration of Ca in water samples using EDTA.
		CO4	Estimate colorimetrically the concentration of Chromium – (using Diphenyl carbazide), Iron (using thioglycollic acid), Iron (using thiocyanate), Manganese (using potassium periodate), Nickel(using dimethyl glyoxime).

		CO5	Carry out the preparation of the metal complexes Potassium trioxalatochromate (III), Tetraammonium copper (II) sulphate, Hexammine cobalt (III) chloride.
		CO6	Record the UV spectra, IR spectra, magnetic susceptibility, TG, DTA and XRD of the complexes prepared.
CH 215	**Organic Chemistry Practicals – I**	CO1	Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors.
		CO2	Determine the correct method for separation of a binary mixture and make the separated compounds in pure form.
		CO3	Develop thin layer chromatogram of a compound and determine its purity.
		CO4	Separate two compounds by column chromatography.
		CO5	Utilize the synthetic procedures and reagents to convert a compound into another. Differentiate the products by spectroscopic methods.
		CO6	Use green chemical principles in the synthesis.
		CO7	Solve GC MS and LC MS of a compound to ascertain purity and identity, apply the basic principles
CH 216	**Physical Chemistry Practicals – I**	CO1	Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors.
		CO2	Construct the Freundlich and Langmuir isotherms for adsorption of acetic/oxalic acid on active charcoal/ alumina and determine the concentration of acetic/ oxalic acid
		CO3	Determine the rate constant, Arrhenius parameters, rate constant and concentration using kinetics
		CO4	Construct the phase diagram and determine the composition of an unknown mixture
		CO5	Construct the ternary phase diagram of acetic acid chloroform-water system and out the procedure in an unfamiliar situation to find out the composition of given homogeneous mixture.
		CO6	Construct the tie-line in the ternary phase diagram of acetic acid chloroform-water system
		CO7	Determine distribution coefficient and equilibrium constant using distribution law
		CO8	Determine the coordination number of Cu^{2+}in copper-ammonia complex.

		CO9	Determine K_f of solid solvent, molar mass of non-volatile solute, mass of solvent and composition of given solution
		CO10	Determine K_T of salt hydrate, molar mass of solute, mass of salt hydrate and composition of given solution.
		CO11	Determine surface tension and parachor of liquids.
		CO12	Ascertain the relationship between surface tension with concentration of a liquid and use this to find out the composition of given homogeneous mixture.
		CO13	Determine the concentration of given strong acid/alkali.
		CO14	Determine the heat of ionisation of acetic acid.
		CO15	Determine the heat of displacement of Cu^{2+} by Zn.
SEMESTER 2			
CH 221	**Inorganic Chemistry II**	CO1	Obtain the term symbols of d^n system and determine the splitting of terms in weak and strong octahedral and tetrahedral fields.
		CO2	Explain the correlation diagrams for d^n and $d1^{0-n}$ ions in octahedral and tetrahedral fields and interprets electronic spectra of complexes.
		CO3	Applies magnetic measurements in the determination of structure of transition metal complexes.
		CO4	Relates crystalline structure to X-ray diffraction data and the reciprocal lattice and explains the diffraction methods
		CO5	Explains crystal defects
		CO6	Elaborates the structure of selected compounds of AX, AX_2, AmX_2, ABX_3 and spinels
		CO7	explains the electronic structure of solids using free electron theory and band theory
		CO8	Understands the differences in semiconductor and dielectric materials and their electrical and optical properties
		CO9	Explain the structure and reactions of S–N, P–N, B–N, S–P compounds and boron hydrides
		CO10	Analyse the topological approach to boron hydride Structure and estimates styx numbers and apply Wade's rules in borane and carboranes.
		CO11	Identify the electronic configurations and term symbols of lanthanides and actinides

		CO12	Sketches the shapes of f orbital and shows their splitting in cubic ligand field
		CO13	Elaborates the importance of the beach sands of Kerala and their important components.
CH 222	**Organic Chemistry II**	CO1	Discuss the fundamentals, operating principles and instrumentation of separation techniques
		CO2	Differentiate the principle and applications of phase transfer catalysis with examples.
		CO3	Describe the various methods of determining reaction mechanisms and basic thermodynamic principles of organic reactions.
		CO4	Explain the Hammet parameters of reaction and design an experiment to confirm the mechanism of a reaction
		CO5	Identify different types of rearrangement reactions, determine the product of the reaction applying migratory aptitude, and reproduce the evidences for the mechanism of the reaction
		CO6	Understand that the outcomes of pericyclic reactions may be understood in terms of frontier orbital interactions, correlation diagram, Mobius and Huckel approach
		CO7	Recall and define the various types of pericyclic reaction; define such terms as 'conrotatory', 'suprafacial'
		CO8	Predict and rationalise the outcomes of pericyclic reactions including stereospecificity, regioselectivity, and stereoselectivity
		CO9	State the synthetic importance of the above cyclo addition and rearrangement reactions, and give disconnections of target compounds corresponding to these reactions
		CO10	Describe the fate of excited molecule based on Jabolonoski diagram, predict the course of an organic photochemical reaction and identify the product with the type of functional group
		CO11	Propose synthetic routes to a variety of molecules, starting from simple precursors with correct stereochemistry and reagents of selected reactions
CH 223	**Physical Chemistry II**	CO1	Apply quantum mechanical principles in solving both real and imaginary spherical harmonics systems-multi electron systems and analyse spectral lines
		CO2	Describe and explain the physical and chemical principles that underlie molecular structure determination techniques like microwave, vibrational, Raman and electronic spectroscopy

		CO3	Predict likely spectral characteristics of given molecular species, and be able to rationalise those characteristics on the basis of structural and electronic arguments
		CO4	Acquire knowledge of basics of statistical mechanics and compare statistical methods
		CO5	Understand and apply of theories of heat capacity.
		CO6	Understand theories of electrolytes and electrochemical reactions
		CO7	Ascertain the application of electrochemistry in industrial fields.
		CO8	Understand the theories and applications behind various types of analytical techniques in electrochemistry
		CO9	Acquire skill in solving numerical problems.
SEMESTER 3			
CH 231	**Inorganic Chemistry III**	CO1	Demonstrate knowledge of advanced content in the areas of inorganic chemistry such as in organometallic compounds, bioinorganic compounds, spectroscopic methods in inorganic Chemistry and nuclear chemistry
		CO2	Examine the bonding in simple and polynuclear carbonyls with and without bridging and complexes with linear πdonor ligands
		CO3	Explain the structure and bonding of ferrocene and dibenzene chromium with the help of MO theory.
		CO4	Understand fundamental reaction types and mechanisms in organometallics and to employ them to understand selected catalytic processes in industry
		CO5	Contrasts the thermodynamic and kinetic stability of complexes, analyses the factors affecting stability of complexes and explains the methods of determining stability constants
		CO6	Classifies ligand substitution reactions and explains its kinetics and various mechanisms
		CO7	Analyze the chemical and physical properties of metal ions responsible for their biochemical action as well as the techniques frequently used in bioinorganic chemistry such as oxygen transport, e-transfer, communication, catalysis, transport, storage etc
		CO8	Explain the principles of spectroscopic methods employed in inorganic chemistry and their applications in the study of metal complexes.
		CO9	Demonstrate a knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions, counting techniques

		CO10	Evaluate the role of nuclear chemistry to find the most suitable measures, administrative methods and industrial solutions to ensure sustainable use of the world's nuclear resources
CH 232	**Organic Chemistry III**	CO1	Describe and explain the physical and chemical principles that underlie molecular structure determination techniques such as UV-visible, IR, mass and NMR spectroscopy.
		CO2	Apply knowledge of molecular structure determination using UV-visible, IR, mass and NMR spectroscopic techniques to identify and/or characterise chemical compounds from experimental data.
		CO3	Calculate λ_{max} of a compound, apply IR frequency table to determine the functional groups present in the molecule, interpret mass spectrum of compound from fragmentation.
		CO4	Predict likely spectral characteristics of given molecular species; solve the structures of unknown molecules using appropriate spectroscopic techniques
		CO5	Devise a 2D NMR of a compound based on learned principles and solve the structure of a compound based on NMR data.
		CO6	Discuss organic transformations with organometallic compounds and predict the products of the reactions.
		CO7	Propose the retro synthetic pathways to a variety of molecules
		CO8	Propose mechanisms for chemical reactions, given starting materials, reagents, conditions, and/or products.
		CO9	Compare the reactions and mechanism and determine the products of a selected set of reactions; identify protecting group strategies.
		CO10	Devise combinatorial method to create a library of compounds
		CO11	Give examples of stereoselective, regioselective and chemoselective reductions and oxidations.
CH 233	**Physical Chemistry III**	CO1	Understand the theories of chemical bonding and their application with help of approximate methods predict the nature of orbitals and molecular spectra.
		CO2	Compare MO and VBT.
		CO3	Understand the properties of gases and liquids and the nature of the intermolecular forces in them
		CO4	Describe the principle behind the determination of surface tension and coefficient of viscosity
		CO5	Describe and explain the physical and chemical principles that underlie molecular structure determination techniques like NMR,

			ESR, Mossbauer, NQR and PES spectroscopy
		CO6	Judge the degrees of freedom of systems and understand theories of irreversible thermodynamic systems.
		CO7	Understand the quantum mechanical and non-quantum mechanical methods in computational chemistry, potential energy surface and basis functions
		CO8	Write the Z matrix of simple molecules
		CO9	Acquire skill in solving numerical problems
CH 234	**Inorganic Chemistry Practicals II**	CO1	Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors
		CO2	Perform COD, BOD, DO, TDS analysis
		CO3	Estimate a simple mixture of ions (involving quantitative separation) by volumetric and gravimetric methods
		CO4	Predict likely spectral characteristics of given metal complexes solve the structures of unknown metal complexes using appropriate spectroscopic techniques and magnetic measurements
		CO5	Analyse the XRD of simple substances.
		CO6	Interpret TG and DTA curves
CH 235	**Organic Chemistry Practicals II**	CO1	Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors
		CO2	Predict likely spectral characteristics of given molecular species; solve the structures of unknown molecules using appropriate spectroscopic techniques
		CO3	Develop paper chromatogram of a compound and determine its purity
		CO4	Estimate quantitatively the Aniline, Phenol, glucose, Ascorbic acid and Aspirin in a sample
		CO5	Estimate colorimetricaly paracetamol, protein and ascorbic acid
		CO6	Use green chemical principles in the synthesis
CH 236	**Physical Chemistry Practicals II**	CO1	Interpret data from an experiment, including the construction of appropriate graphs and the evaluation of errors
		CO2	Determine the strength of strong/ weak acids by conductometric titrations

		CO3	Verify Onsager equation and Kohlraush's law conductometrically
		CO4	Determine the activity and activity coefficient of electrolyte
		CO5	Determine the concentration of a solution potentiometrically or pH metrically
		CO6	Employ spectrophotometry in determining unknown concentration
		CO7	Determine the viscosity of liquid mixtures and use this in determining the concentration of a component in a mixture
		CO8	Determine the concentration of a liquid mixture using a refractometer
		CO9	Determine the unknown concentration of a given glucose solution
SEMESTER 4			
CH 241	**Chemistry of Advanced Materials**	CO1	Understand dimensions, synthesis, physicochemical properties of nanomaterials and its applications
		CO2	Understand and apply characterization tools for analysing nano structures
		CO3	Outline and recognize the types of polymerization, kinetics and mechanisms
		CO4	Understand the stereochemical aspects and methods for the determination of molecular weights of polymers
		CO5	Discuss the synthesis and applications of selected classes of speciality polymers
		CO6	Distinguish the types and important applications of smart materials
CH 242 (a)	**Inorganic Chemistry IV**	CO1	Explain the schemes for σ and π bonding with examples
		CO2	Explain MO and Ligand field theory with the support of group theory and construct the MO diagram of octahedral complexes.
		CO3	Apply character tables to find out the Infrared and Raman active modes for C2v, C3vand D4h.
		CO4	Assimilate the concepts of molecular recognition, self-assembly, dynamic combinatorial chemistry and supramolecular chirality, and be aware of the most important work in the field
		CO5	Understand the nature of bonding in metal atom clusters and distinguish Low nuclearity and High nuclearity carbonyl clusters

		CO6	Perform the electron counting schemes in cluster compounds
		CO7	Differentiate the different types of cluster molecules and understand their utility in catalysis
		CO8	Understand and explain the role of metal ions in biological systems and give examples for the use of metals in medicine
		CO9	Differentiate the defects arising due to deficiency and excess presence of metal ions in the body
		CO10	Explain the acid base concept in non-aqueous media and identify the reactions taking place in selected non aqueous solvents.
CH 242 (b)	**Organic Chemistry IV**	CO1	Define secondary metabolites from plants and animals.
		CO2	Explain the biosynthesis of terpenes and sterols, illustrate the structural elucidation and synthesis of natural products
		CO3	List the forces involved in molecular recognition and recognize molecular receptors
		CO4	Quote molecular recognition events in biological systems.
		CO5	Discuss the methods of creating combinatorial libraries and its processing to locate lead molecule
		CO6	Explain the various stages in drug development process, and outline the synthesis of paracetamol, phenobarbital, diazepam, sulphamethoxazole, benzylpenicillin, and chloramphenicol
		CO7	Construct a solid phase synthesis of tripeptide from any three amino acids, explain protection, deprotection and automated synthesis of peptides and nucleotides
		CO8	Describe twelve principles green chemistry
		CO9	Illustrate reactions in which green chemistry principles are applied and calculate atom economy
CH 242 (c)	**Physical Chemistry IV**	CO1	Apply the group theory in the identification of IR and Raman active normal modes in molecules coming under various point groups such as C2v, C3v, C4v, D3h, Td and Oh.
		CO2	Apply group theory in solving spectroscopic problems.
		CO3	Solve the problems in Exactly solvable systems like Simple Harmonic Oscillator, rigid rotor and the Hydrogen atom.
		CO4	Explain the approximation methods used in quantum mechanics
		CO5	Illustrate trial wave functions for calculation of H atom and particle in a 1Dbox as examples.

		CO6	Set up secular determinants
		CO7	Explain the variation in the state of a system with time
		CO8	Apply computational methods as potential tools for practicing chemistry
		CO9	Construction of Z-matrices of simple molecules H_2, H_2O, H_2O_2, H_2CO, CH_3CHO, CH_4, C_2H_6 and with dummy atom, CO_2, NH_3, C_6H_6.
		CO10	Explain the commonly using force fields (MM3, MMFF, AMBER and CHARMM) and Software.
		CO11	Compare Molecular Mechanics, Ab-initio method, Semi empirical method and DFT method of computations.
CH 243 (a)	**Dissertation**	CO1	Demonstrate an advanced theoretical and technical knowledge of chemistry as a creative endeavour; analyse, interpret and critically evaluate scientific information
		CO2	Present information, articulate arguments and conclusions, in a variety of modes, to audiences in their field of research.
		CO3	As part of a team or individually, design, conduct, analyse and interpret results of an experiment, and effectively communicate these in written reports and other formats.
		CO4	Develop an understanding of the requirements to undertake independent research in a chemistry field.
		CO5	Demonstrate an understanding of the relationship between scientific research and the progress of new knowledge in a global scenario.
CH 243 (b)	**Visit to R & D Centre**	CO1	Understand the relevance of independent supervised research in a chemistry field and the need of well-developed judgement, adaptability and accountability as a practitioner or learner