School of Studies in Chemistry

Program Outcomes

PO-1	Knowledge: Demonstrate the basic understanding of concepts, theories and principles of chemical sciences
PO-2	Critical Thinking and Reasoning: Exhibit advanced critical thinking and reasoning skills, enabling them to critically evaluate and analyze complex chemical arguments, theories, and experimental data.
PO-3	Problem Solving: Applying their chemical knowledge and problem-solving skills to tackle intricate scientific and real-world issues.
PO-4	Advanced Analytical and Computational Skills:
PO-5	Proficient in employing advanced analytical techniques and computational tools to conduct in-depth chemical analyses and research.
PO-6	Effective Communication: Effectively communicate complex scientific concepts and research findings to both technical and non-technical audiences, using written reports, presentations, and teaching.
PO-7	Social/ Interdisciplinary Interaction: Integrate chemical concepts and methodologies into interdisciplinary contexts, collaborating effectively with professionals from various fields to address complex scientific and societal challenges.
PO-8	Self-directed and Life-long Learning: Recognize the importance of ongoing professional development and lifelong learning in the dynamic field of Chemistry and acquire knowledge and skills in chemistry throughout their professional careers.
PO-9	Effective Citizenship: Leadership and Innovation: Capable to identify, formulate, investigate and analyze the scientific problems and innovatively to design and create products and solutions to real life problems
PO-10	Ethics: Maintain the highest ethical standards in research and professional conduct within the field of chemistry
PO-11	Further Education or Employment: Pursue for Ph.D. program and get employment in academia, research institutions, industry, government, and other related sectors.

Program Specific Outcomes

PSO-1	Comprehensive understanding of fundamental theoretical principles and practical aspects of chemistry.
PSO-2	Apply the knowledge of chemistry concepts in interdisciplinary fields to address and solve societal issues.
PSO-3	Apply the analytical instruments and computation programs ensuring precision, efficiency, and innovation in scientific research, industry, healthcare, and education.
PSO-4	Proficiently convey and promote ideas in the field of chemical sciences to disseminate knowledge and enhance the awareness of the chemical community.
PSO-5	Qualify national and state-level examinations like GATE, NET, SLET, and SET can lead to career opportunities in academia, research, and related fields.

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M.Sc. First Semester: Course Outcomes

CHE101:Group Theory and Chemistry of Metal Complex	
At the end of the course, the students will be able to :	
CO1	Understand the symmetry elements, group definitions, subgroups, matrix representations, and character tables empowers students to apply these concepts in spectroscopy with a deep understanding of underlying principles.
CO2	Analyze and predict the properties of transition metal complexes using various bonding theories, including Valence Bond Theory, Crystal Field Theory, and Molecular Orbital Theory, Jahn-Teller distortion and metal complexes.
CO3	Understand of metal-ligand equilibria in solution, factors affecting stability, chelate effect, and determination methods. Additionally, they will explore the chemistry of main group elements, encompassing classification, preparation, properties, and structures of borides, carbon allotropes, carbides, nitrides, silicides, silicate classification and structure, as well as the preparation, properties, and applications of silicones.
CO4	Understand metal clusters, including higher boranes, carboranes, metalloboranes, metallocarboranes, metal carbonyl, halide clusters, and compounds featuring metal-metal multiple bonds, chains, and rings.
CHE102:Concepts in Organic Chemistry	
At the end of the course, the students will be able to :	
CO1	Demonstrate a deep comprehension of the principles governing the nature of chemical bonding in organic molecules, including localized and delocalized bonds, aromaticity, and the influence of structure on reactivity.
CO2	Understand the intricacies of stereochemistry, including the identification and manipulation of chiral centers, methods of resolution, and the principles of stereospecific and stereoselective synthesis.
CO3	Examine diverse reaction intermediates (carbocations, carbanions, radicals, carbenes, nitrenes), predicting their generation, structure, stability, reactivity, and applications in chemical transformations. Understand elimination reactions, including mechanisms and influencing factors.
CO4	Understand the classification and mechanisms of pericyclic reactions, including electrocyclic reactions, cycloadditions, and sigmatropic rearrangements, and their applications in organic synthesis, guided by Woodward-Hoffmann correlation diagrams and frontier molecular orbital (FMO) and pericyclic molecular orbital (PMO) approaches.
CHE103:Quantum Chemistry, Thermodynamics and Chemical Dynamics - I	
At the end of the course, the students will be able to :	
CO1	Develop a strong foundation in mathematical concepts, including vector properties, complex numbers, and basic calculus, and apply these skills to quantum chemistry problems. Understand the Schrödinger equation, its postulates, and its solutions for model systems like the particle in a box, harmonic oscillator, rigid rotator, and hydrogen atom.
CO2	Gain a deep comprehension of thermodynamics, encompassing Maxwell's relations, partial molar properties, and the behavior of chemical potential in different phases.
CO3	Learn the principles of electrochemistry, including the Nernst equation, electrolytic conductance, and Debye-Hückel theory, and apply these concepts to understand electrochemical systems and reactions.
CO4	Understand the methods of determining rate laws, collision theory, reaction rate steric factors, and understand dynamic chain reactions and oscillatory reactions, enabling the analysis of reaction mechanisms and control.
CHE104:Therory and Applications of Spectroscopy- I	
At the end of the course, the students will be able to :	
CO1	Acquire an in-depth understanding of spectroscopic principles, including electromagnetic radiation-matter interactions and the interpretation of various spectra. Understand the fundamental quantum concepts to enhance spectral analysis skills, encompassing the uncertainty relation, natural line width, selection rules, and the Born-Oppenheimer approximation.
CO2	Understand the microwave spectroscopy, molecule classification by internal rotation, determining rotation energy, analyzing spectral line intensities, and exploring isotopic substitution effects. They'll apply these skills to study non-rigid rotators, linear, symmetric top polyatomic molecules, and employ microwave spectroscopy for bond length determination.
CO3	apply infrared spectroscopy concepts, covering oscillators, diatomic-vibrating rotators, polyatomic vibrations, Fourier Transform instrumentation, and interpretation of diverse compound spectra.
CO4	Understand classical and quantum theories of the Raman effect, various Raman spectra, selection rules, resonance phenomena, and advanced techniques like SERS and CARS. This knowledge enables applications in molecular structure analysis.

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M.Sc. Second Semester: Course Outcomes

CHE201:Transition Metal Complexes

At the end of the course, the students will be able to :

CO1	Examines the reaction mechanisms of transition metal complexes, addressing energy profiles, reactivity, and kinetic applications. It covers topics such as substitution kinetics, anation reactions, and features in square planar complexes, along with exploring redox reactions, electron transfer mechanisms, and the Marcus-Hush theory for inner-sphere reactions, providing st udents a thorough understanding of transition metal complex reactions.
CO2	Explores the electronic spectra and magnetic properties of transition metal complexes, covering topics such as spectroscopic ground states, correlation diagrams, selection rules, absorption intensity, complex geometries, parameter calculations, spin-forbidden transitions, and magnetic properties based on crystal field models, including spin-free and spin-paired equilibria in octahedral stereochemistry.
CO3	Understand the transition metal complexes with diverse ligands, including unsaturated organic molecules and hydrogen, exploring their preparations, properties, bonding nature, structural features, and their application in nucleophilic and electrophilic reactions for organic synthesis.
CO4	Comprehensive understanding of transition metal alkyls and aryls, including synthesis, stability, and organocopper applications; explores compounds with transition metal-carbon multiple bonds, focusing on alkylidenes and low valent carbenes; and delves into fluxional organometallic compounds, examining dynamic equilibria in complexes like olefin, -allyl, and dienyl compounds.

CHE202:Reaction Mechanism

At the end of the course, the students will be able to :

CO1	Understanding of aliphatic and aromatic nucleophilic and electrophilic substitution reactions, including their mechanisms and factors influencing reactivity, enhancing their knowledge of reaction mechanisms in organic chemistry.
CO2	Understand the addition reactions to carbon-carbon multiple bonds, emphasizing mechanistic and stereochemical aspects, regio- and chemoselectivity, and various reactions such as hydrogenation, hydroboration, Michael reaction, and Sharple's asymmetric epoxidation.
CO3	Understand the mechanisms of metal hydride reduction for various carbonyl compounds, addition reactions involving Grignard reagents, organo-zinc, and organo-lithium, as well as condensation reactions like Aldol, Knoevenagel, and Stobbe reactions. Additionally, it covers the hydrolysis of esters and amides, along with ammonolysis of esters.
CO4	Understand and apply the heterocyclic chemistry, including structure, reactivity, and synthesis of various heterocycles, as well as important name reactions like Favorskii, Shapiro, Baeyer-Villiger oxidation, Stork Enamine, Mannich, and Heck reactions, among others.

CHE203:Quantum Chemistry, Thermodynamic and Chemical Dynamic-II

At the end of the course, the students will be able to :

CO1	Develop a strong foundation in the application of matrices in quantum chemistry, enabling them to solve complex problems involving quantum systems, angular momentum concepts and their application in quantum chemistry.
CO2	Understanding of statistical thermodynamics, including ensembles, partition functions, and statistical basis of entropy, allowing them to analyze the behavior of molecular systems.
CO3	Apply their knowledge of electrochemistry to understand electrified interfaces and double layers, and delve into chemical dynamics, which includes fast reactions, transition state spectroscopy, and theories of unimolecular reactions.
CO4	Understand chemical dynamics, exploring fast reactions through flow, relaxation, flash photolysis, and nuclear magnetic resonance methods. They'll delve into transition state spectroscopy, femtochemistry, ultrafast dynamics, molecular reaction dynamics.

CHE204:Theory and Applications of Spectroscopy –II

At the end of the course, the students will be able to :

CO1	Understand UV and visible spectroscopy, vibrational-electronic spectra intensity, the Frank-Condon principle, and rotational fine structure. They'll analyze molecular orbitals, electronic spectra of organic molecules, and chromophores, applying electronic spectroscopy for spectrophotometric studies, ligand/metal ratio determination, compound identification, and stability constant determination.
CO2	Understand the scattering spectroscopy, covering Auger spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), turbidimetry, nephelometry, fluorometry, fluorescence, phosphorescence, and factors influencing them. They'll gain practical insights into instrumentation and applications in various analytical techniques.
CO3	Develop expertise in mass spectrometry, including the interpretation of mass spectral fragmentation of organic compounds, enabling them to determine molecular weight and formula and apply mass spectrometry in different in several chemical analysis.
CO4	Gain a strong foundation in nuclear resonance spectrophotometry, including NMR spectroscopy and Carbon-13 NMR spectroscopy, equipping them with the skills to determine the structure of organic compounds and analyze chemical environments through various NMR techniques

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M.Sc. Third Semester: Course Outcomes

CHE301:Resonance Spectroscopy, Photochemistry and Organocatalysis	
At the end of the course, the students will be able to :	
CO1	Understand the Electron Spin Resonance Spectroscopy, exploring hyperfine and spin-orbit couplings, g-tensors, and their applications in transition metal complexes with unpaired electrons. Additionally, they'll understand Nuclear Quadrupole Resonance Spectroscopy.
CO2	Understand Photoelectron Spectroscopy principles, including the photoelectric effect, ionization processes, Koopman's theorem, and spectra of simple molecules. They'll also understand the determination of dipole moments and X-ray photoelectron spectroscopy (XPS). In addition, they'll grasp the basic principles of Photoacoustic Spectroscopy (PAS).
CO3	Explore various miscellaneous photochemical reactions, including the Photo-Fries reactions of anilides, Barton reaction, and photodegradation of polymers, fostering a comprehensive understanding of the broader field of photochemistry.
CO4	Acquire knowledge of the principles and applications of organocatalysis, including homogeneous and heterogeneous catalytic reactions, enabling the design and optimization of catalytic processes for chemical transformations.
CHE302:Chemistry of Biomolecules	
At the end of the course, the students will be able to :	
CO1	Acquire a thorough grasp of bioenergetics, calculating standard free energy changes, distinguishing exergonic and endergonic processes, and explaining ATP hydrolysis and synthesis. Gain insights into electron transfer in biology, focusing on metalloproteins like cytochromes and iron-sulfur proteins, and applying synthetic models to understand these systems.
CO2	Understand enzyme nomenclature, classification, and the induced fit hypothesis. They will identify active sites using inhibitors. Additionally, students will understand coenzyme structures and functions and explore enzyme immobilization techniques, their effects, and applications in medicine, industry, and recombinant DNA technology.
CO3	Acquire a deep understanding of metalloenzymes and their various roles in biological processes, including zinc enzymes, iron enzymes, copper enzymes, and molybdenum oxatransferase enzymes, as well as the importance of these enzymes in catalysis.
CO4	Understand forces in biopolymer interactions, thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction, energy generation, cell membrane structure, ion transport, and nerve conduction.
CHE303:Catalysis, Solid State and Surface Chemistry	
At the end of the course, the students will be able to :	
CO1	Develop a strong foundation in the fundamental concepts of acids, bases, electrophiles, and nucleophiles, enabling students to assess electronic and structural effects, quantify reactivity, and apply these principles to understand acid-base catalysis and enzyme catalysis.
CO2	Gain expertise in the chemistry of micelles and adsorption, including the classification of surface-active agents, micellization, critical micellar concentration, and the thermodynamics of micellization, as well as the application of these concepts to understand surface tension, capillary action, and catalysis at interfaces.
CO3	Acquire knowledge of solid-state chemistry, encompassing crystal systems, lattice structures, crystal defects, and non-stoichiometry, leading to a comprehensive understanding of ionic crystal structures, electronic properties, and band theory in metals and semiconductors.
CO4	Explore macromolecules, including their types, kinetics of polymerization, and synthesis and application of conducting polymers, providing students with insights into the diverse properties and applications of polymers in various industries.
CHE304:Analytical Techniques and Data Analysis	
At the end of the course, the students will be able to :	
CO1	Expertise in sample collection, preservation, and preparation for analysis, using diverse digestion methods. They'll acquire a deep understanding of statistical analysis, precision, accuracy, error analysis, and graphical data presentation for confident evaluation and interpretation of analytical data.
CO2	Gain expertise in separation techniques, including solvent extraction and chromatography, and apply these principles to efficiently separate and identify various compounds in complex mixtures.
CO3	Understand the principles, instrumentation, and applications of TGA, DTA, DSC, C/H/S/N/O Analyzer, and organic and elemental carbon analyzers, gaining skills in thermal and elemental analysis techniques.
CO4	Develop a strong foundation in electrochemical methods, including pH potentiometry, coulometry, and conductometry, as well as various voltammetry techniques, facilitating the quantitative analysis and characterization of electrochemical processes and substances.

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M.Sc. Four Semester: Course Outcomes

CHE401:Instrumental Methods of Analysis	
At the end of the course, the students will be able to :	
CO1	Develop expertise in advanced chromatography techniques, including ion chromatography, size exclusion chromatography, supercritical fluid chromatography, capillary electrophoresis, and capillary electrochromatography, enabling students to separate and analyze complex mixtures of compounds.
CO2	Gain a comprehensive understanding of X-ray and proton-induced spectroscopy, including X-ray fluorescent and proton-induced X-ray spectroscopy, and their respective principles, instrumentation, and applications in qualitative and quantitative analysis.
CO3	Acquire knowledge and practical skills in atomic emission and atomic absorption spectroscopy, including flame photometry, atomic emission spectroscopy (AES), inductively coupled plasma atomic emission spectroscopy (ICP-AES), atomic absorption spectroscopy (AAS), cold-vapor, and hydride generation AAS, facilitating precise elemental analysis.
CO4	Understand the principles, instrumentation, and applications of hyphenated techniques such as GC-MS, LC-MS, HPLC, IC-MS, and ICP-MS for advanced analytical and diagnostic purposes.
CHE402:(Natural Product and Medicinal Chemistry	
At the end of the course, the students will be able to :	
CO1	Gain a deep understanding of the chemistry and properties of natural compounds, including terpenoids, carotenoids, alkaloids, steroids, and plant pigments, along with their isolation, synthesis, and physiological roles in plants.
CO2	Understand the steroids, covering isolation, structure determination, synthesis, and cholesterol biosynthesis. They'll explore plant pigments, understanding occurrence, nomenclature, and structure determination, while isolating and synthesizing various compounds.
CO3	Acquire knowledge of drug metabolism, absorption, disposition, elimination, enzyme interactions, and the role of biotransformation in medicinal chemistry, enabling a deeper understanding of pharmaceutical development and optimization.
CO4	Develop a comprehensive understanding learn about antineoplastic agents, antibiotics, antimalarials, antivirals, antibacterials, antioxidants, and antifungal drugs, focusing on their synthesis, properties, and classifications to understand their therapeutic applications.
CHE403:Material and Nuclear Chemistry	
At the end of the course, the students will be able to :	
CO1	Understand the non-equilibrium thermodynamics, including entropy production, irreversible processes, and Onsager relations, and apply these principles to heat flow, chemical, and electrochemical reactions in open systems.
CO2	Understand material chemistry, covering the preparation and properties of nanoparticles, metal oxides, quantum dots, carbon-based materials, conducting polymers, ceramics, and composites. They'll understand various synthesis methods, optical, electrical, and magnetic properties, and applications of nanomaterials, along with advanced characterization techniques.
CO3	Acquire competence in supramolecular chemistry, including intermolecular forces, molecular recognition, and catalysis, enhancing their ability to design and understand molecular assemblies and interactions.
CO4	Understanding of nuclear theory, fission, and energy, covering nuclear structure, reactions, and reactor applications. They'll also develop expertise in applied radiochemistry, using radioactive isotopes and tracers for investigations in medical, agricultural, and analytical chemistry.
CHE404:Environmental & Applied Chemical Analysis	
At the end of the course, the students will be able to :	
CO1	Understand the classification of air pollution monitoring levels, understand air quality standards, and analyze airborne pollutants, using various analytical techniques and control devices, while comprehending atmospheric chemistry impacts.
CO2	Understand the soil and water quality standards, analyze pollutants, and learn pollution control methods. They will also gain skills in chemical analysis of coal, cement, and steel using modern techniques.
CO3	Acquire expertise in the analysis of food and cosmetic products, including the evaluation of constituents, additives, and adulterants, enabling them to ensure the quality and safety of these consumer products.
CO4	Possess a comprehensive understanding of cosmetics formulation, materials, and clinical drug analysis methods. They'll adeptly analyze cosmetic products and clinical specimens, demonstrating proficiency in assessing various components and maintaining quality standards.