M.Sc. I Semester I	
CHE- 501, Physical Chemistry I	
CO1	Students should be able to remember the concepts of thermodynamic parameters, quantum mechanical postulates, rate laws of chemical reactions and computation of macroscopic properties of matter.
CO2	Students should understand the basics like state function and path function, Schrodinger wave equation, kinetics of fast reactions, partition functions and ensembles.
C03	Students should be able to apply the knowledge of various quantum mechanical methods to determine the different molecular properties and built the concept of the relation between thermodynamics and quantum mechanics.
C04	Students should be able to analyze the rates of various chemical reactions both theoretically and experimentally and also observe the effect of catalyst and determine energies of activation of such reactions.
C05	Students should be able to evaluate variation of thermodynamic parameters for multi component systems and their variation with other extensive properties, Schrodinger wave equation and its application to hydrogen and hydrogen like atoms.
C06	Students should be able to create the solutions to avoid excess use of energy in chemical reactions by applying their knowledge of thermodynamics and chemical kinetics.

M.Sc. I Semester I	
CHEOD-502, Inorganic Chemistry-I	
CO1	Define symmetry elements and symmetry operations, classes, properties of a group, group multiplication table, etc.
CO2	Classify symmetry elements, point group, Group, sub-group and classes.
C03	Use wave function as basis for determination of irreducible representations and the Great Orthogonally theorem and its consequence.
C04	Solve problem based on point group, matrix representation and character table
C05	Construct character table of various point group
C06	Justify which can take part in bonding on the basis of SALCs and point group of molecules

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M.Sc. I Semester I	
CHE-503, Organic Chemistry-I	
CO1	Understand the concepts of chemical bonding, various structural effects, acids and bases, intermediates and aromaticity.
CO2	Learn the concepts of stereochemistry
C03	Understand and identify the types of organic reactions.
C04	Advanced knowledge of various stereochemical aspects.
C05	Establish mechanistic knowledge of aliphatic and aromatic substitutions, and oxidation reduction reactions
C06	Develop problem solving ability of the students

M.Sc. I Semester I	
CHE-505, Inorganic Chemistry Practical-I	
CO1	Prepare solution of required conc. and the handle laboratory equipment properly.
CO2	Perform experiment accurately and able to perform calculation.
C03	Explain experiment and principal of experiment in detail
C04	Perform calculations and discuss results and write conclusions of the experiment.
C05	Apply knowledge to a) design experiment for given aim or modify experiment to enhance results. b) to find out lacuna in experimental procedure.
C06	Solve problem/ numerical depending on given experimental data / information.

M.Sc. I Semester I	
CHE-506, Organic Chemistry Practical I	
CO1	Understand the theoretical aspects behind separation, purification and synthesis of organic compounds.
CO2	Acquire experimental skills for separation, purification, identification, and synthesis of organic compounds.
C03	Design experimental setup for performing the organic reactions.
C04	Monitor the organic reactions.
C05	Describe the mechanistic aspects of organic reactions.
C06	Develop problem-solving ability.

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M.Sc. I Semester I	
CHE – 507(A), Chemical Mathematics	
CO1	Students will able to remember rules of differentiation, integration, vectors, matrices and determinants.
CO2	Students can understand the various rules to solve problems related to derivatives, integration, vectors, matrices and determinants.
C03	Students able to apply mathematical concepts to solve problems related to chemistry.
C04	Students can analyse the chemical problems using the knowledge of integration, differentiation, vectors, matrices and determinants.
C05	Students can analyse the chemical problems using the knowledge of integration, differentiation, vectors, matrices and determinants.
C06	Students will able to create chemical problems with methods of mathematical background

M.Sc. I Semester I	
CHE-507(B), Chemistry of Nanomaterials	
CO1	Define / memories the terms related to - applications of nanomaterials, band theory, defects in crystal structures, some properties of nanomaterials, synthesis of nanomaterials.
CO2	Discuss Applications of nanomaterials, synthesis methods of nanomaterials, some properties of nanomaterials, defects in nanomaterials
C03	Apply their knowledge to – choose synthesis method for nanomaterial, selection of nanomaterial for particular application, explain observed properties of nanomaterial, etc.
C04	Differentiate / compare – metals-semiconductors-insulators, Non-stoichiometry and point defects, different synthetic methods, properties of nanomaterials.
C05	Explain the terms related to - applications of nanomaterials, band theory, defects in crystal structures, some properties of nanomaterials, synthesis of nanomaterials.
C06	Propose scope / Applications of nanomaterials to solve real problems.

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M.Sc. I Semester I	
CHE-507(C), Analytical Chemistry	
CO1	Define/memorize GLP, Lab Safety, Quality assurance
CO2	Discuss good laboratory practices, laboratory emergencies, and mass spectrometry
C03	Apply their knowledge to prepare quality assurance reports, emergencies in the laboratory
C04	Differentiate between different ionization technique, compare hazardous and non hazardous material handling
C05	Explain the Quality Assurance, Laboratory Accreditation, Laboratory Emergencies, different ionization technique
C06	Applications of GLP, Lab Safety, mass spectrometry

M.Sc. I Semester I	
CHEOD-507(D) Organic Reactions and Reagents	
CO1	Understand the concepts of named organic reactions and reagents.
CO2	Identify the type of named organic reaction and uses of reagents.
C03	Predict the reaction conditions of organic reaction.
C04	Write the reaction mechanism.
C05	Design appropriate synthetic routes.
C06	Develop problem-solving ability of the students.

M.Sc. I Semester I	
CHE-508, Research methodology	
CO1	Develop a comprehensive understanding of different research methodologies and their applications in mathematics.
CO2	Cultivate critical thinking and analytical skills necessary for identifying research problems and formulating research questions.
C03	Provide practical experience in designing experiments, collecting and analyzing data, and interpreting research results.
C04	Foster effective communication skills for presenting research findings orally and in written form.
C05	Promote ethical research practices and awareness of responsible conduct in mathematical research
C06	Develop problem solving ability.

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M.Sc. I Semester II	
CHEOD- 551, Molecular Spectroscopy	
CO1	Remember basic concepts of molecular spectroscopy, selection rules, intensity of spectral lines and width of spectral transition.
CO2	Understand principles and applications of rotational, vibrational, Raman, electronic and Mossbauer spectroscopy.
C03	Apply various spectroscopic techniques for gaining insights into molecular structure
C04	Analyse vibrating diatomic molecule, simple harmonic and anharmonic oscillator, Scattering of light and Raman Spectrum.
C05	Evaluate bond length, vibrational frequency, force constant and dissociation energy using spectral data
C06	Create awareness about rotational fine structure, vibrational coarse structure, Quadrupole effects

M.Sc. I Semester II	
CHE-552: Inorganic Chemistry-II	
CO1	Remember basic concepts of molecular spectroscopy, selection rules, intensity of spectral lines and width of spectral transition.
CO2	Understand principles and applications of rotational, vibrational, Raman, electronic and Mossbauer spectroscopy.
C03	Apply various spectroscopic techniques for gaining insights into molecular structure
C04	Analyse vibrating diatomic molecule, simple harmonic and anharmonic oscillator, Scattering of light and Raman Spectrum.
C05	Evaluate bond length, vibrational frequency, force constant and dissociation energy using spectral data
C06	Create awareness about rotational fine structure, vibrational coarse structure, Quadrupole effects

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M.Sc. I Semester II	
CHE-553, Organic Chemistry-II	
CO1	Understand the concepts of pericyclic and photochemical reactions, and molecular rearrangements
CO2	Learn concepts of Organic Spectroscopy.
C03	Identify the type of pericyclic and photochemical reactions
C04	Solve the problems based on pericyclic and photochemical reactions and molecular rearrangements
C05	Deduce the structure from the spectral data and justify the findings.
C06	Develop problem solving ability of the students.

M.Sc. I Semester II	
CHE- 554, Physical Chemistry Practical II	
CO1	Students will grasp the fundamental principles of Conductometry, Polarography, Potentiometry and pH metry.
CO2	Students will familiar with the operation of Conductometer, Polarimeter, Potentiometer and pH meter.
C03	Students will understand the concepts of conductance, resistance and learn how to calculate and interpret these values.
C04	Students will learn to interpret polarographic waves and understand their significance in identifying electroactive species and determining their concentration.
C05	Students will explore the applications of Potentiometry in various fields such as acid- base titrations, determination of pH and analysis of ionic concentration

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M.Sc. I Semester II	
CHE-555: Inorganic Chemistry Practical-II	
CO1	Define coordination complex, cell constant, resistance, specific conductance, equilibrium constant, absorbance, Beer's law, solubility product, chromatography, etc.
CO2	Discuss photochemistry of potassium trioxalatoferrate complex, kinetics of formation of Cr(III)-EDTA, Determination of Cu(II)and Fe (II) by solvent extraction technique.
C03	Outline the flow-chart for synthesis of [Mn(acac)3], Chloropentaamminecobalt(III) chloride, Nitro pentaamminecobalt(III) chloride, Bis[TrisCu(I)thiourea complexes.
C04	Estimate purity of the [Mn(acac)3], Chloropentaamminecobalt(III) chloride, Nitro pentaamminecobalt(III) chloride, Bis[TrisCu(I)thiourea complexes
C05	Determine equilibrium constant of M – L systems Fe(III)–Sulphosalicylic acid, magnetic susceptibility (χg and χm) of mercury tetracyanato cobalt or Fe(acac) and magnetic susceptibility (χg and χm) of mercury tetracyanato cobalt or Fe(acac).
C06	Calculate the quantity from observation of the experiments and Interpret the result obtained respective experiments.

M.Sc. I Semester II	
CHE-556, Organic Chemistry Practical II	
CO1	Understand the theoretical concepts behind organic synthesis.
CO2	Acquire the experimental skills for separation, purification, identification and synthesis of organic compounds
C03	Design experimental set up for performing the organic reactions.
C04	Monitor the organic reactions and analyse the products using spectral results.
C05	Describe the mechanistic aspects of organic reactions.
C06	Develop problem solving ability.

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M.Sc. I Semester II	
CHE-557(A), Organometallic Compounds and Inorganic Reaction Mechanism	
CO1	Define various terms in organometallic chemistry and inorganic reaction mechanism etc.
CO2	Explain/Discuss various reaction mechanisms such as ligand insertion, inner and outer sphere mechanism, ligand substitution reaction.
C03	Discuss 1. Structure and bonding in carbonyl and organometallic complexes, 2: Trans effect, 3. Ligand field effects, catalytic cycles, 4. Inert and labile complexes, 5. Synthesis methods of organometallic compounds, etc.
C04	Apply 18 electron rule. Applications of organometallic compounds and mechanism of these reactions.
C05	Demonstrate IR spectra of carbonyl complexes, deduce structure of carbonyl complexes
C06	Justify structures of organometallic compounds from spectral data

M.Sc. I Semester II	
CHE-557 (B), Material Characterization Techniques	
CO1	Students are able to understand different characterization techniques of solids
CO2	Discuss Principle of XRD, instrumentation of powder XRD, Brags law, applications of XRD for crystal structure determination, numerical problems
C03	Apply their knowledge to the interpretation of SEM and TEM images
C04	Differentiate between Scanning and Transmission of electron.
C05	Explain the basics of X-rays, the Principle of XRF, types of XRF, instrumentation, qualitative and quantitative analysis, and numerical analysis.
C06	Applications of different characterization techniques

M.Sc. I Semester II	
CHE-557 (C) Green Chemistry	
CO1	Apply the principles of green chemistry to chemical processes.
CO2	Apply the principles of green chemistry to reduce the cost of chemical processes.
C03	Develop economical synthetic route involving principles of green chemistry.
C04	Analyze chemical data and choose safer and renewalbe raw materials for chemical processes.
C05	Develop processes in accordance with Sustainable Development Goals.

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M.Sc. I Semester II	
CHEOD-557 (D) Nuclear and Radiation Chemistry	
CO1	Remember basic concepts of radioactive decay, decay kinetics and Interaction of radiation with matter.
CO2	Understand concepts of nuclear and radiation Chemistry, radiolysis of water, the process of nuclear fission and fission fragments.
C03	Nuclear chemistry applications: reaction mechanism, medical treatment, isotopic labelling, and carbon dating.
C04	Study units for measuring radiation absorption, interaction of γ radiation with matter and radiation dosimetry.
C05	Use proper isotopic notation to write down and balance a nuclear reaction. State and compare the differences and similarities between a nuclear change and a chemical change.
C06	Identify and define various types of nuclear changes or processes including fission and decay reactions.

M.Sc. I Semester II	
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M.Sc. II Semester III	
CHO-601 MJ: Organic Reaction Mechanism and Stereochemistry	
CO1	Acquire familiarity with fundamental organic reaction mechanisms and stereochemistry principles.
CO2	Gain a comprehensive understanding of Theoretical Concepts to Predict Reactivity and Selectivity.
C03	Apply concepts of reaction mechanisms and stereochemistry.
C04	Design Synthetic Routes and Strategies.
C05	Analyze the products of different organic reactions.
C06	Solve Complex Organic Chemistry Problems based on Organic Reaction Mechanism and Stereochemistry.

M.Sc. II Semester III	
CHO-602 MJ: Advanced Spectroscopic Methods in Structure Determination	
CO1	Learn the fundamental knowledge of 1H NMR, 13C NMR, 19F NMR and Mass Spectral techniques.
CO2	Acquire advanced knowledge of 1H NMR, 13C NMR, 19F NMR and Mass Spectral techniques
C03	Apply the knowledge of 1H NMR, 13C NMR, 19F NMR and Mass Spectral techniques for structure determination.
C04	Discuss probable spectral signals
C05	Interpret different types of spectra
C06	Deduce the structure of the unknown compound using 1H NMR, 13C NMR and Mass Spectra.

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M.Sc. II Semester III	
CHO- 603 MJ: Heterocyclic Chemistry	
CO1	learn the structures, nomenclature rules, and classifications of heterocyclic compounds
CO2	understand advanced synthetic methodologies to design and execute the synthesis of various heterocyclic compounds.
C03	Predict the molecular properties, electronic structures, and the reactivity of heterocyclic systems.
C04	Distinguish the reactivity of heterocycles, elucidating reaction mechanisms and their pathways.
C05	Evaluate the heterocyclic compounds with other organic compounds.
C06	Summarize the significance and applications of heterocyclic chemistry.

M.Sc. II Semester III	
CHO-604 MJP: Organic Synthesis Experiments	
CO1	Recall the sequential steps involved in the preparation of target compounds from given starting materials in single-stage, and double-stage preparations
CO2	Recognize the mechanisms of organic preparations and their relevance to product formation
C03	Apply knowledge of functional group transformations to troubleshoot and optimize reaction conditions
C04	Assess the synthetic pathways for the efficient production of target compounds
C05	Examine the structure and reactivity of starting materials to propose viable synthetic routes for heterocyclic compound synthesis.
C06	Design multistep synthetic strategies for the construction of complex heterocyclic scaffolds from simple starting materials in heterocyclic compound synthesis

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M.Sc. II Semester III	
CHO-605 MJP: Ternary Mixture Separation	
CO1	Understand the concept of type determination and apply separation techniques
CO2	Create a report on ternary mixture separation.omprehend different purification techniques.
C03	Accurately record and report physical constants.
C04	Analyze microscale chemical elemental analysis.
C05	Evaluate and execute qualitative estimation of functional groups
C06	Create a report on ternary mixture separation. Course Content

M.Sc. II Semester III	
CHO-610 (A) MJ: Synthetic Methods in Organic Chemistry	
CO1	Know the concepts of ring formation mechanism and will apply in organic synthesis.
CO2	learn the synthetic applications of Organo-Boron, Organo-Tin and Organo Silicon
C03	Predict the reaction conditions of organic reactions.
C04	Analyze the products obtained from the synthetic methods.
C05	Relate the reaction mechanism and its products.
C06	Create a summary of synthetic methods in organic chemistry.

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M.Sc. II Semester III	
CHO-610 (B) MJ: Carbohydrates and Chiron Approach	
CO1	Recall monosaccharide structures and D/L forms in Fisher projections
CO2	Understand cyclic hemiacetal forms and anomeric configurations.
C03	Applying Chiron approaches, they'll design syntheses of complex chiral molecules.
C04	Analyze protective group strategies between temporary and permanent groups.
C05	Evaluate glycosylation methods, stereoselectivity, and coupling efficiency.
C06	Summarize the planning of synthesis, pathways for chiral compound synthesis.

M.Sc. II Semester III	
CHO: 610 (C) MJ: Medicinal Chemistry	
CO1	Identify drug and learn different stages of drug design and development
CO2	Know the application of computers in drug design
C03	Categorize various stages of Drug action and analyze various factors affecting drug action
C04	distinguish between infectious and non-infectious diseases
C05	Relate the infectious diseases and causative agents.
C06	Summarize the overall significance, development and applications of various drugs.

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M.Sc. II Semester III	
CHO-631 RP: Research Project	
CO1	understand key concepts and principles relevant to the research topic
CO2	learn diverse research methodologies proficiently
C03	write and communicate research findings persuasively through various mediums in the form of project report
C04	analyze and synthesize scholarly literature effectively.
C05	evaluate research findings and methodologies critically.
C06	design and execute original research projects independently.

M.Sc. II Semester III	
CHO-651 MJ: Chemistry of Natural Products	
CO1	Learn the fundamental aspects and knowledge of natural products
CO2	Know the different pathways and biogenesis of natural products
C03	Apply the gained knowledge in the synthesis of natural products.
C04	Categorize the organic functional group transformations in their synthesis.
C05	Interpret the logical retrosynthetic analysis.
C06	Interpret the logical retrosynthetic analysis.

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M.Sc. II Semester IV	
CHO-652 MJ: Advanced Synthetic Organic Chemistry	
CO1	Learn the fundamental concepts of organometallic reactions and their bonding, reactivity, and mechanism.
CO2	Understand the significance of advanced organometallic reagents in organic chemistry.
C03	Employ synthetic methodologies for cross-coupling reactions, enabling the formation of CC, C-N, and other bonds.
C04	Analyze the products of synthetic organic reactions.
C05	Relate the products of the retrosynthetic transformations with the Target Molecules.
C06	Design the summary of advanced synthetic reagents, their reactions and the product
M.Sc. II Semester IV	
CHO-653 MJP: Convergent and Divergent Organic Synthesis	
CO1	Learn new synthetic methodologies for the selective modification of starting materials.
CO2	Recognize the reactivity of starting materials towards different reagents and reaction conditions
C03	Apply multi-step synthesis strategies to construct complex molecules from simple starting materials
C04	Analyze reaction mechanisms and intermediates to understand the synthesis pathways.
C05	Evaluate the efficiency and practicality of different synthetic routes based on yield and selectivity
C06	Create novel synthesis routes based on the principles of organic chemistry and reactivity patterns

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M.Sc. II Semester IV	
CHO-654 MJP: Green Chemistry Experiments	
CO1	Know the principles of green chemistry and the importance of sustainability in chemical processes
CO2	Identify solvent-free reactions using appropriate techniques and equipment.
C03	Optimize green chemistry reactions in the laboratory
C04	Analyze the advantages and disadvantages of solvent-free reactions, green catalysts, and green solvents in comparison to traditional chemical methodologies
C05	Assess the role of green catalysts in promoting the desired reactions while minimizing waste and environmental impact
C06	Communicate experimental procedures, results, and conclusions effectively through written reports and oral presentations.

M.Sc. II Semester IV	
CHO-660 (A) MJ: Asymmetric Synthesis	
CO1	Learn the principles of asymmetric synthesis to achieve stereoselectivity, enantioselectivity, and diastereo-selectivity in cyclic compounds.
CO2	Understand resolution techniques, including Dynamic Kinetic Resolution (DKR), for racemic mixtures of cyclohexane and decalin-based molecules, quantifying enantiomeric excess (EE) values
C03	Interpret enantiomeric and diastereomeric excess in reactions,
C04	Distinguishing between R and S configurations in compounds.
C05	Evaluate total synthesis examples, integrate multiple asymmetric synthesis strategies to design efficient synthetic routes, and assess the applicability and limitations of different methods in complex synthesis challenges.
C06	Summarize the concepts such as diastereoselectivity, enantiomeric and diastereomeric excess chiral pool, chiral auxiliaries, and chiral reagents and catalysts in asymmetric synthesis

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M.Sc. II Semester IV	
CHO-660 (B) MJ: Applied Organic Chemistry	
CO1	Gain a comprehensive understanding of impurities in organic drugs, functional dyes, polymers, and metal-organic frameworks.
CO2	Demonstrate comprehension of the principles, structures, and mechanisms underlying each concept.
C03	Identify functional dyes, polymers, metal-organic frameworks and impurities present in organic drugs.
C04	Classify functional dyes, polymers, and metal-organic frameworks and impurities found in drugs according to relevant criteria.
C05	Compare functional dyes, polymers, metal-organic frameworks, and the impurities in drugs.
C06	Develop a strategic plan or workflow for the removal of impurities in organic drugs, identification of functional dyes and their properties, polymers properties and their synthesis, and metal-organic framework synthesis.
M.Sc. II Semester IV	
CHO-660 (C) MJ: Industrial Organic Chemistry	
CO1	List the key industrial processes used in the synthesis of major organic chemicals.
CO2	Explain the basic principles and mechanisms underlying the production of organic chemicals
C03	Apply knowledge of organic reaction mechanisms to optimize conditions in industrial chemical processes.
C04	Differentiate between various catalytic methods used in industrial organic synthesis and assess their efficiencies and environmental impacts.
C05	Evaluate the economic and environmental considerations in the industrial production of organic compounds, making recommendations for improvements.
C06	Design a conceptual plan for a new industrial process or product, incorporating principles of green chemistry and sustainability.

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M.Sc. II Semester IV	
CHO-660 (B) MJ: Applied Organic Chemistry	
CO1	Gain a comprehensive understanding of impurities in organic drugs, functional dyes, polymers, and metal-organic frameworks.
CO2	Demonstrate comprehension of the principles, structures, and mechanisms underlying each concept.
C03	Identify functional dyes, polymers, metal-organic frameworks and impurities present in organic drugs.
C04	Classify functional dyes, polymers, and metal-organic frameworks and impurities found in drugs according to relevant criteria.
C05	Compare functional dyes, polymers, metal-organic frameworks, and the impurities in drugs.
C06	Develop a strategic plan or workflow for the removal of impurities in organic drugs, identification of functional dyes and their properties, polymers properties and their synthesis, and metal-organic framework synthesis.

M.Sc. II Semester IV	
CHO-681 RP: Research Project	
CO1	Understand key concepts and principles relevant to the research topic.
CO2	Learn diverse research methodologies proficiently.
C03	Write and communicate research findings persuasively through various mediums in the form of project report
C04	Analyze and synthesize scholarly literature effectively.
C05	Evaluate research findings and methodologies critically.
C06	Design and execute original research projects independently.

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