Course Outcomes of Programme Offered by the Department

Name of the Programme : M.Sc. Chemistry

The main areas of Chemistry such as Organic, Inorgaic and Physical are included in the chemistry course curriculum for the undergraduate students. The purpose of the curriculum is to provide and enhance the basic knowledge platform that supports an inventive culture. The course curriculum educates future leaders of the nation about how chemistry underlies in the nature and in all natural processes.

The experiments set for laboratory work are designed such that they both instruct and inspire the students to develop a firm foundation in the fundamentals and application of principles of chemistry. The students are taught how to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments. The course is so designed that the students understand the pivotal role of chemistry in our society and become potent enough to explore new areas of research both in chemistry and in allied fields of research and technology.

Semester	Course Code/Title	Course Outcomes	
SEMESTER - I	**Paper I (Inorganic Chemistry General)**	CO1	Describe advanced symmetry concepts of chemical molecules and its applications.
		CO2	To identify the axis, plane, center and point group, polarity, dipole moment, product of symmetry operation and character table of chemical compounds.
		CO3	Describe the bonding and stereochemistry in covalent compounds, characterstics of bonding in covalent compounds viz. Bent's rule, walsh diagrams, dπ-pπ bonding.
		CO4	To discuss the substitution reactions of covalently bonded molecules boron, silicon and nitrogen.
		CO5	To know about the metal equilibria in solutions.
		CO6	To describe the factors affecting stability of metal ligand complexes.
		CO7	To use the various methods for the determination of stability constant.

		CO8	To know about the substitution reactions in square planar complexes with special reference to trans effect.
		CO9	Know about the limitations of crystal field theory and its effects in coordination complexes.
		CO10	To apply the concept of molecular orbital theory to tetrahedral square planar and octahedral complexes.
	Paper II (Physical Chemistry General)	CO1	Recapitulation of thermodynamic laws, concept of fugacity and its determination.
		CO2	Concept of activity and its determination using emf measurement, vapour pressure method and some other methods.
		CO3	To know about Partial molar quantities, chemical potential and Gibbs-Duhem equation and its variation with temperature and pressure.
		CO4	To explain thermodynamic functions of mixing (free energy, entropy, volume and enthalpy), concept of escaping tendency and chemical potential.
		CO5	To describe the concept of potential energy surfaces.
		CO6	To explain Collision theory of reaction rates, steric requirement, Arrhenius equation and activated complex theory (ACT).
		CO7	To demonstrate thermodynamic formulations of activated complex theory.
		CO8	To explain Lindemann-Christiansen and Hinshelwood mechanisms of unimolecular reactions.
		CO9	To discuss Debye-Hückel theory of ion-ion interaction and activity coefficient, its applicability, limitations and its modification for finite-sized ions, effect of

			ion-solvent interaction on activity coefficient.
		CO10	Able to derive D-H-O equation - its applicability and limitations, Pair-wise association of ions (Bjerrum treatment)and its modifications for ion-pair formation.
		CO11	To know the Concept of electrical double layer and its structure.
		CO12	To know about Helmholtz-Perrin, Gouy-Chapman, and Stern models, electrokinetic phenomena and the determination of zeta potential.
		CO13	To discuss the Langmuir adsorption isotherm and its kinetic derivation for non-dissociative and dissociative adsorption.
		CO14	To know about surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons.
		CO15	To carry out a comparison between homogeneous and heterogeneous reaction rates.
I	**Paper III (Organic Chemistry General)**	CO1	Describe reaction intermediates, energy profile diagrams and establish mechanism of organic reaction simultaneously understand effect of structure on reactivity and application of Hammett /Taft equations, Curtin-Hammett principles, Hammond postulates in theoretical treatment of organic reactions.
		CO2	Understand mechanistic details of different types of and factors affecting aliphatic nucleophilic substitution reactions and the terminology involved therein.
		CO3	Know mechanistic details of different types of elimination reactions, Saytzeff and Hoffman rules and application of these

			in prediction of product formation in various elimination reactions.
		CO4	Master stereo-chemical terms, inter-convert stereo-structural formulae of organic molecules, analyze configurations, create stereo-structures and correlate configuration by applying the concept of chemical correlation.
		CO5	Realize the concepts of prochirality, topicity related terms, asymmetric synthesis, its main categories vis-à-vis application of Cram's, Prelog and Horeaus rule.
		CO6	Describe stability of different configurations and conformations of acyclic and cyclic organic compounds, sugars, decalins.
	Paper IVA (Chemistry of Life Science)	CO1	To describe the prokaryotic and eukaryotic cell Structure, metabolic processes occurring in cell. Able to discuss the Carbohydrate metabolism-glycolysis, Kreb's cycle, glycogenolysis, glycogenesis pentose phosphate pathway and gluconeogenesis.
		CO2	To explain the Structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, structural polysaccharides - cellulose and chitin. Storage polysaccharides-starch and glycogen.
		CO3	To analyze the structure and functions of fatty acids, triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids. β-oxidation of fatty acid, Fluid mosaic mode of cell membrane.

		CO4	To know the concept of the amino acids, peptides and proteins. Able to describe the primary, secondary structure of proteins and forces responsible for holding these structures.
		CO5	To understand enzymatic and chemical cleavage of polypeptide chain, sequencing of amino acids in a polypeptide segment, Sanger method, Edman degradation method, concept of denaturation of proteins.
		CO6	To explain the Structure of nucleotides, nucleosides, DNA (Watson-Crick model) RNA and their conformation.
		CO7	Able to explain the DNA replication, translation and transcription.
	Paper IVB (Mathematics for Chemists)	CO1	To explain definitions of vectors, representation and properties of vectors.
		CO2	To perform vector mathematical operations.
		CO3	To explain scalar and vector products of vectors.
		CO4	To discuss definition and properties of matrices and determinants.
		CO5	Be able to perform matrix mathematics.
		CO6	To solve linear equations using matrices.
		CO7	To discuss need, theory and applications of logarithms.
		CO8	To execute the knowledge in solving general and chemical problems.
		CO9	Be able to represent equations graphically and perform curve fitting for least squares method.
		CO10	To perform binomial expansion.

		CO11	To prove and apply trigometric identities and explain polar coordinates in trigonometric functions.
		CO12	To explain rules of differentiation and be able to find out the derivative of a function by applying various methods of differentiation.
		CO13	To perform partial differentiation.
		CO14	To discuss exact and inexact differentials and their applications to chemistry.
		CO15	To explain rules and methods of integration.
		CO16	To perform integration between limits and its application in chemistry.
SEMESTER-II	**Paper V (Inorganic Chemistry)**	CO1	To discuss the various possible arrangements of electrons in terms of term symbols.
		CO2	Able to draw the vector diagrams of orbital coupling and spin orbital coupling in p2, p3, d2 configurations.
		CO3	To calculate the spectral terms for d2 and d8 metal ions.
		CO4	To derive the term symbol for closed subshell.
		CO5	To interpret the Orgel diagrams, Tanabe-Sugano diagrams for transition metal complexes (d1-d9 states).
		CO6	To apply the spectroscopic methods for assignment of absolute configuration in optically active metal chelates and their stereochemical information.
		CO7	To know the concept of Circular Dichroism and Optical Rotatory Dispersion and its application to determine configuration of Tris-chelated complexes.

		CO8	To discuss the synthesis, structure characterstic and chemical properties of metal carbonyls, metal nitrosyls.
		CO9	To explain the synthesis and structural characterstics and important reactions of dinitrogen and dioxygen complexes.
		CO10	To know the various classifications of metal cluster compounds.
		CO11	To categories the metal boranes carboranes, metalloboranes and metallocarboranes and their various aspects.
		CO12	To discuss the existence, stability and formation of metal-metal multiple bonds.
	Paper VI (Physical Chemistry)	CO1	To discuss the various postulates of quantum mechanics.
		CO2	To learn about operators and their properties.
		CO3	To be able to perform operator mathematics including commutation of operators.
		CO4	To discuss Heisenberg's Uncertainty Principle.
		CO5	To understand and form Schrödinger equation for various systems.
		CO6	To be able to setup and solve Schrödinger equation for a particle in a box and for a one-dimensional box with a finite barrier and its application to quantum mechanical tunnelling.
		CO7	Able to setup and solve Schrödinger equation for linear harmonic oscillator and its solution.

		CO8	To know about angular momentum operators their commutation relations and Ladder operators.
		CO9	To explain the shapes of atomic orbitals upto d-level.
		CO10	To explain the basic concepts of polymers and polymerization.
		CO11	To discuss the Mechanism and Kinetics of chain growth and step growth polymerization.
		CO12	To determine the molecular mass by osmometry and viscometry methods.
		CO13	To know the basic concept of nuclear and radiochemistry.
		CO14	To discuss the structure and functioning of various detectors use in radiochemistry.
		CO15	To explain the radiotracer technique, activation analysis and its applications in various aspects.
	Paper VII (Organic Chemistry)	CO1	To know the concept of Aromatic Electrophilic Substitution and their applications.
		CO2	To understand the mechanisms of Aromatic Nucleophilic Substitution by diazonium salts, arynes.
		CO3	To understand the concept of aliphatic electrophilic substitution reaction.
		CO4	To know the Bimolecular aliphatic electrophilic substitutions mechanisms - SE2, SE1 and SEi.
		CO5	To understand the neighbouring group participation, classical and non-classical carbocation.
		CO6	Role of non-bonding electrons, sigma and π-bonds.
		CO7	To understand the concept of carbocations rearrangements and migratory aptitudes.

		CO8	To describe the generation, structure, stability and reactivity of free radicals.
		CO9	To know the mechanisms of addition alkenes and alkynes.
		CO10	To study addition to C=O group of aldehydes, ketones and acids.
		CO11	To understand and reactivity of carbonyl compounds in various reactions.
		CO12	To learn various name reactions related to ketones and aldehydes.
	Paper VIII (Computer for Chemist)	CO10	Basic understanding about Computer Understanding the basic concept associated with C- Language and program designing.
		CO11	Students will develop different programs, Run and Retrieve results.
	Paper IX (Inorganic Chemistry Practical)	CO1	To know the concept of quantitative analysis and qualitative analysis and its application.
		CO2	To analyse the given mixture for the presence of two acidic radicals, two rare earth metal ions and one insoluble salt.
		CO3	To know the cerimetric / Iodometric titrations.
		CO4	To demonstrate the various cerimetric and iodometric titrations in laboratory.
		CO5	To separate and quantify the presence of two metal ions in a solution.
		CO6	To prepare a sample of various coordination complexes and their spectroscopic study.
		CO7	To perform experimentation and evaluate the results.
		CO8	To develop the ability to compile interpreted information in the form of lab record.
		CO9	To face viva-voce.
	Paper- X (Physical Chemistry Practical)	CO1	To know the concept of viscosity and its determination.

		CO2 To determine the viscosity averaged molar mass of a polymer. CO3 To study the pH metric titration for the determination of normality of acids. CO4 To determine the partition coefficient of an solute between two immiscible solvents by using distribution law. CO5 To study the specific and molecular rotation of sucrose or glucose by polarimetry. CO6 Study the kinetics of inversion of cane-sugar (sucrose) in presence of an acid by polarimetry. CO7 To determine the refractive index of various organic solvents and its variation with concentration. CO 8 To understand and master the fundamentals of conductometric titrations in aqueous media. CO 9 To study and conduct experiments related to chemical kinetics for the determination of the order and rate constant of the reaction. CO 10 To understand and master the fundamentals of potentiometric experiments. CO 11 To determine extent of adsorption and verify Freundlich and Langmuir adsorption isotherms. CO12 To perform experimentation and evaluate the results. CO13 To develop the ability to compile interpreted information in the form of lab record. CO14 To face viva-voce.
	Paper- XI, Organic Chemistry Practical	CO1 To introduce and demonstrate the basic principle and techniques of separation of binary organic mixture.

		CO2	To analyse qualitatively the presence of extra elements and functional groups in the binary organic mixture along with understanding of chemical reaction involved.
		CO3	To make them able to differentiate between aromatic/aliphatic, saturated/unsaturated, hydrocarbon/heterocycles.
		CO4	To understand and develop the capabilities of preparing derivatives of different organic compounds bearing various organic functionalities.
		CO5	To understand significance of melting point, mixed melting point, boiling point in identification of organic compounds.
		CO6	To develop the skill of performing experiments and analysing data to evaluate results.
		CO7	To develop the ability to compile interpreted information in the form of lab record.
		CO8	To make them mentally and academically sound to face viva-voce.
		CO9	To perform the experimentation and evaluate the results.
		CO10	To develop the ability to compile interpreted information in the form of lab record.
		CO11	To face viva-voce after completion of course.
Semester III	**Paper- XII (Inorganic Chemistry General)**	CO1	To introduce various basic concepts of bioinorganic chemistry to the students.

		CO2	To discuss the various dioxygen carriers proteins present in various organisms.
		CO3	To explain the electron transfer processes in living organisms with reference to iron sulphur proteins and cytochromes. To know the fundamentals of polarography and its applications.
		CO4	To discuss the various theories applicable in polarography.
		CO5	To apply the symmetry and group theory in elucidation of structural features with the help of vibrational spectra.
		CO6	To study the resonance Raman spectroscopy for the study of active sites of metalloproteins.
		CO7	To discuss the basic principles, spectral parameters and display in Mossbauer spectroscopy to explain the oxidation states, coordination number and nature of metal ligand bond.
		CO8	To apply the Mossbauer technique for the determination of structure and bonding in iron and tin complexes.
		CO9	To know the basic principle of Photoelectron spectroscopy and study of simple molecules.
		CO10	To study the chemical information from ESCA.
	Paper- XIII (Physical Chemistry General)	CO1	To know the basic concept of microwave spectroscopy and able to interpret the rotational spectra of rigid diatomic and polyatomic linear molecules and symmetric top molecules.
		CO2	To discuss the raman and infrared spectroscopy and its application in physical chemistry.
		CO3	To explain the NMR spectroscopy and its significance in chemistry.
		CO4	Know about NQR and ESR spectroscopy and their applications in chemistry.
		CO5	To identify symmetry elements in crystals and know the classification of crystals

			under various point groups and space groups.
		CO6	To understand the basic concept of reciprocal lattice related to X-ray crystallography and interpretation of powder X-ray diffraction patterns.
		CO7	To determine interplanar spacing for different crystal systems and structure factors for different types of lattices.
		CO8	To know about phase problem in crystallography and methods for phase determination.
		CO9	To know about various crystal structure refinement procedures.
	Paper- XIV (Organic Chemistry General)	CO1	To know the basic concept of Ultraviolet and Visible Spectroscopy.
		CO2	To discuss the Beer-Lambert law, effect of solvent on electronic transitions.
		CO3	To apply Fieser-Woodward rules for calculating **λ**max for conjugated dienes and carbonyl compounds.
		CO4	To introduce mass spectrometry and difference with spectroscopy.
		CO5	To discuss the methods of fragmentation of organic compounds - EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance.
		CO6	To apply the concept of mass spectrometry for the determination of structure of organic compounds based on fragmentation.
		CO7	To explain the basic concept behind NMR spectroscopy and its application for the structure elucidation.

		CO8	To introduce and discuss the chemical shift and coupling constant in relation to stereochemical structure of the organic compound.
		CO9	To explain the difference between First order and second order NMR spectra and Tools used for simplification of complex NMR spectrum (instrumental and chemical).
		CO10	To know the difference between 1 H-NMR and 13 C-NMR and their applications in structure determination of organic compounds.
		CO11	To introduce the concept of 2D-NMR.
		CO12	To explain the principle of IR spectroscopy and its application in determining different functional groups present in organic compounds.
		CO13	To apply various spectroscopic techniques discussed above for solving/determining the structure of organic compounds (composite problems).
	Paper- XV (Organic Chemistry Special)	CO1	To understand the principle of Organometallic Reagents and their applications in organic synthesis.
		CO2	To know about the role of various Organometallic Reagents of Li, Mg, Cd, Zn,Cu, S, Si, B, I, Pd, Ni, Fe, Co, Rh, Cr and Ti compounds in organic synthesis along with their preparations, properties and applications of these reagents with mechanistic details.
		CO3	To understand the principle of oxidation, oxidative processes related to Hydrocarbons- alkenes,aromatic rings, activated and unactivated saturated C-H groups, alcohols, diols, aldehydes,

			ketones, ketals and carboxylic acids. Amines, hydrazines, and sulphides
		CO4	To learn about applications of ruthenium tetraoxide and thallium (III) nitrate in oxidation of various types of compounds.
		CO5	To understand the general pathways of reduction reactions. Reduction of Hydrocarbons – alkanes, alkenes, alkynes, substituted and unsubstituted aromatic rings.
		CO6	To be able to understand the reduction of carbonyl compounds – aldehydes, ketones, acids and their derivatives, Epoxides. reduction of compounds containing nitro, nitroso, azo and oxime groups.
	Paper- XVI (Organic Chemistry Special)	CO1	Appreciate the role of Molecular Orbitals in analysing Pericyclic Reactions.
		CO2	Interpret the stereochemical course of a Pericyclic Reaction and identify the product.
		CO3	Predict the course of an organic photochemical reaction and identify the product with the type of functional group present on the molecule.
Semester IV	**Paper- XVII (Organic Chemistry Special)**	CO1	After completion of course the students will be able to apply the concepts of Disconnection approach and Green chemistry for the synthesis of different target molecules in organic chemistry.
		CO2	To have knowledge about various terms used in disconnection approach like synthons, synthetic equivalents, functional group interconversions and importance of order of events.

		CO3	To know about one group C-X and two group C-X disconnections, one group C-C disconnection.
		CO4	To understand the practical aspects of chemoselectivity, regioselectivity, regiospecificity, stereoselectivity and stereospecificity.
		CO5	To understand the concept of reversal of polarity and amine synthesis.
		CO6	To know the application of wittig reagents and acetylene for the synthesis of alkenes.
		CO7	To understand application of aliphatic nitro compounds in organic synthesis.
		CO8	To learn about different strategies for the synthesis of three, four, five and six membered rings.
		CO9	To explore the use of ketenes in organic synthesis.
		CO10	To explore two group C-C disconnection utilizing Diels Alder reactions, 1,3-difunctionalized compounds, unsaturated carbonyl compounds, 1,5-difunctionalized compounds, Michael addition and Robinson Annelation.
		CO11	To know the strategy about control in carbonyl condensations.
		CO12	To understand the principles of protection and deprotection approach in synthetic organic chemistry with special reference of alcoholic, amino, carbonyl and carboxylic groups.
		CO13	To apply the tools of retero-synthesis for the synthesis of natural products like Juvabione and Cortisone.
		CO14	To understand the need of green chemistry and its principles.

		CO15	To have an elementary idea of green reagent, green solvent, green catalyst, solid phase, mw and ultrasound assisted.
		CO16	To know the concept of atom economy for different types of reactions.
		CO17	To apply concepts of green chemistry for the synthesis of Adipic acid and Ibuprofen.
		CO18	To understand the concept of aromaticity and various criteria of aromaticity.
	Paper- XVIII (Organic Chemistry Special)	CO 1	After completing this course, the student will know various name reactions, aspects of heterocyclic chemistry and flavonoids.
		CO 2	Get to know mechanistic details of Arndt-Eistert synthesis Beckmann, Hofmann, Curtius, Lossen, Schmidt, Favorskii, Neber, Fritsch-Butenberg-Wiechell, Baeyer-Villiger, Benzilbenzillic acid rearrangements.
		CO 3	To understand mechanistic details of Darzens synthesis, stroke enamine synthesis, Shapiro reaction; Sharplcss asymmetric epoxidation, Prevost and Woodward hydroxylation.
		CO 4	To understand general aspects of isolation and degradative and synthetic aspects of structure elucidation of flavonoids.
		CO 5	To apply this knowledge for structure elucidation and synthesis of Cyanin, Quercetin, Diadzein and Chrysin.
		CO 6	To understand Biosynthetic Acetate and Shikimic acid pathway leading to production of Flavonoids and catechin.
		CO 7	To be familiar with systematic (Hantzsch-Widman) nomenclature for monocylic and fused ring systems.

		CO 8 To understand the method of synthesis and the chemical reactions of three and four membered heterocyclic compounds such as oxirane, azirene, oxazirane, diaziridines, Oxetane and azetidine. CO 9 To understand basic character, methods of synthesis and Reactions with mechanistic details of pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole. CO 10 To understand the general method of synthesis and chemical reactions of purines and pyrimidines.
	Paper- XIX (Organic Chemistry Special)	After completing this course the student will get to know about enzymes, coenzymes, terpenoids and cholesterol. The course outcomes are - CO1 To understand chemical and biological catalysis, nomenclature and classification, of enzymes, extraction and purification of enzymes, Fischer's lock and key and Koshland's induced fit hypothesis. CO2 To understand kinetics of Enzyme catalyzed reactions, Michaelis-Menten and Lineweaver-Burk plots and kinetics of reversible and irreversible inhibition. CO3 To be familiar with mechanisms of enzyme catalyzed reactions, Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. To understand mechanism of action of chymotrypsin, carboxypeptidase A and papain CO4 To get knowledge about Cofactors as derivatives of vitamins. knowledge of coenzymes, prosthetic groups, apoenzymes. structure and biological functions and mechanisms of reactions catalyzed by coenzyme A, thiamine

			pyrophosphate, pyridoxal phosphate, NAD^+,$NADP^+$, FMN, FAD, by the above cofactors. Nomenclature and biological roles of prostaglandins, synthesis PGE_2 and $PGF_{2\alpha}$.
		CO5	To understand definition and classification of terpenoids, isoprene and special isoprene rule, general methods of structure elucidation of terpenoids.
		CO6	To apply the acquainted knowledge for structure elucidation and synthesis of Geraniol,α-terpineol, α-pinene, camphor, farnesol and squalene, biogenetic isoprene rule and biosynthesis of terpenoids.
		CO7	To know about steroids and their classification, Isolation and nomenclature, structure elucidation, synthesis and stereochemistry of cholesterol.
		CO8	To the understand synthetic pathways of testosterone, progesterone, 5α- and 5β-cholanic acids from Cholesterol. Johnson's hydrochrysene approach for the synthesis of androsterone.
	Paper- XX (Organic Chemistry Special)	CO1	Demonstrate understanding of the basic principles of drug action, design and the terminology involved therein.
		CO2	Apply the knowledge of drug design in developing new drugs using rational approach to drug design.
		CO3	Explain synthesis, general mode of action and medicinal uses of listed classes of drugs.
		CO4	Describe synthesis, structure elucidation and medicinal uses of penicillins and cephalosporins as cell wall biosynthesis and protein synthesis inhibitors.

		CO5	Relate physiological action of alkaloids and their classification based on nitrogen heterocyclic ring.
		CO6	Appreciate general aspects of isolation and structure elucidation of alkaloids for application in structure elucidation, synthesis and biosynthesis of listed alkaloids.
	Paper-XXI (Organic Chemistry Special Practical)	CO1	To understand the methods of separations of binary (liquid-liquid, liquid-solid or solid-solid) organic mixtures.
		CO2	Identification of different functional groups using qualitative analysis.
		CO3	To understand significance of melting point and boiling point in structure elucidation of organic compounds.
		CO4	To prepare derivatives of different organic functionalities.
		CO5	To characterize given organic compounds by interpreting their ^{1}H NMR and FT-IR spectra.
		CO6	To perform experimentation and evaluation the results.
		CO7	To develop the ability to compile information in the form of lab records.
		CO8	To defend Viva-voce examination.
	Paper- XXII (Organic Chemistry Special Practical)	CO 1	To understand the concept of stepwise synthesis of a product and their purification.
		CO 2	To explore various combinations of reactions that can be exploited to form a product.
		CO 3	To have a knowledge of multistep reactions the possibilities.
		CO 4	Evaluate, compile and present and explain the results.

		CO 5	To perform experimentation and evaluate the results.
		CO 6	To develop the ability to compile interpreted information in the form of lab record.
		CO 7	To face viva-voce.
	Paper-XXIII (Organic Chemistry Special Practical)	CO 1	Understand the basics of quantitative analysis and application in analysis of functional groups in organic compounds.
		CO 2	Analyze and estimate sugars, fats, amino acids in samples.
		CO 3	Evaluate, compile and present and explain the results.
		CO 4	To face viva-voce.