Course Outcomes – Program Outcomes (COPO) Mapping

Program Outcomes (PO): B.Sc. (H) Chemistry

Learning Outcome-based Curriculum Framework (LOCF)

The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner

ABBREVIATIONS / NOMENCLATURE

Sno.	Nomenclature	Description	Aggregate Courses
1	PO	Program Outcome	PO1, PO2,PO3, PO4, PO5
2	CO	Course Outcome	CO1, CO2, CO3….CO8
3	CC	Core Courses	CC1, CC2, CC3….C14
4	DSE	Discipline Specific Electives	DSE1, DSE2, DSE3, DSE4
5	GE	General Electives	GE1 , GE2, GE3, GE4

Program Outcomes (PO): B.Sc(H) Chemistry

UGCF (NEP)

Sno.	Program Outcomes (PO): B.Sc (H) Chemistry	Statements
1.	**PO1**	Knowledge: Students acquire theoretical knowledge and understanding of the fundamental concepts, principles and processes in main branches of chemistry, namely, organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry and biochemistry. In depth understanding is the outcome of transactional effectiveness and treatment of specialized course contents. Width results from the choice of electives that students are offered.
2.	**PO2**	Laboratory Skills: A much valued learning outcome of this programme is the laboratory skills that students develop during the course. Quantitative techniques gained through hands on methods opens choice of joining the industrial laboratory work force early on. The programme also provides ample training in handling basic chemical laboratory instruments and their use in analytical and biochemical determinations. Undergraduates on completion of this programme can cross branches to join analytical, pharmaceutical, material testing and biochemical labs besides standard chemical laboratories.
3.	**PO3**	Communication: Communication is a highly desirable attribute to possess. Opportunities to enhance students' ability to write methodical, logical and precise reports are inherent to the structure of the programme. Techniques that effectively communicate scientific chemical content to large audiences are acquired through oral and poster presentations and regular laboratory report writing.
4	**PO4**	Capacity Enhancement: Modern day scientific environment requires students to possess ability to think independently as well as be able to work productively in groups. This requires some degree of balancing. The chemistry honours programme course is designed to take care of this important aspect of student development through effective teaching learning process.
5	**PO5**	Portable Skills: Besides communication skills, the programme develops a range of portable or transferable skills in students that they can carry with them to their new work environment after completion of chemistry honours programme. These are problem solving, numeracy and mathematical skills- error analysis, units

		and conversions, information retrieval skills, IT skills and organizational skills. These are valued across work environments

Course Outcomes (CO): B.Sc (H) Chemistry

SEMESTER 1: **CC1: ATOMIC STRUCTURE & CHEMICAL BONDING (INORGANIC CHEMISTRY – I)**			
Unique Paper Code	**Name of the Paper**	**Course Outcome: CO**	**Statement**
32171101	Atomic Structure & Chemical Bonding (Inorganic Chemistry-I)	CO1	The course enables the students to solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p and d orbitals, and periodicity in atomic radii, ionic radii, ionization enthalpy and electron affinity of elements.
		CO2	The students can draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).
		CO3	The students understand the concept of lattice energy using Born-Landé and Kapustinskii equation.
		CO4	Rationalize the conductivity of metals, semiconductors and insulators based on the Band theory.
		CO5	Understand the importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces and their effect on melting points, boiling points, solubility and energetics of dissolution.
CC2: STATES OF MATTER & IONIC EQUILIBRIUM (PHYSICAL CHEMISTRY - I)			
32171102	States of Matter & Ionic	CO1	By the end of this course, the students can derive mathematical expressions for

	Equilibrium (Physical Chemistry-I)		different properties of gas and liquid and understand their physical significance.
		CO2	They can apply the concepts of gas equations and liquids while studying other chemistry courses and every-day life.
		CO3	Explain the crystal structure and calculate related properties of cubic systems.
		CO4	Explain the concept of ionization of electrolytes with emphasis on weak acid and base and hydrolysis of salt.
GE 1 (FOR HONOURS): ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS			
32175901	Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	CO1	The students are able to solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, and shapes of s, p, and d orbitals and periodicity in atomic radii, ionic radii, ionization energy and electron affinity of elements.
		CO2	Draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).
		CO3	Understand and explain the differential behavior of organic compounds based on fundamental concepts learnt.
		CO4	Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
		CO5	Learn and identify many organic reaction mechanisms including free radical substitution, electrophilic addition and electrophilic aromatic substitution.

COPO MAPPING

	SEMESTER I : COPO MAPPING					
Papers	Program Outcome : PO					
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5
CC1	CO1	✓				✓
	CO2					✓
	CO3	✓				
	CO4					✓
	CO5	✓				
CC2	CO1	✓				
	CO2	✓				✓
	CO3					✓
	CO4	✓				
GE1	CO1	✓				✓
	CO2					✓
	CO3	✓				
	CO4				✓	
	CO5	✓				

SEMESTER 2:

CC3: BASICS AND HYDROCARBONS
(ORGANIC CHEMISTRY – I)

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
32171201	Basics and Hydrocarbons (Organic Chemistry – I)	CO1	The students understand and explain the different nature and behavior of organic compounds based on fundamental concepts learnt.
		CO2	Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
		CO3	Learn and identify many organic reaction mechanisms including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution.

		CO4	Understand the fundamental concepts of stereochemistry.
CC4: CHEMICAL THERMODYNAMICS AND ITS APPLICATIONS (PHYSICAL CHEMISTRY – II)			
32171202	Chemical Thermodynamics and its Applications (Physical Chemistry – II)	CO1	The students understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties.
		CO2	They are able to derive the expressions of ΔU, ΔH, ΔS, ΔG, ΔA for an ideal gas under different conditions.
		CO3	They can explain the concept of partial molar properties.
		CO4	Explain the thermodynamic basis of colligative properties and applications in surroundings
GE 2 (FOR HONOURS): CHEMISTRY OF S- AND P-BLOCK ELEMENTS, STATES OF MATTER AND CHEMICAL KINETICS			
32175917	Chemistry of s- and p-Block Elements, States of Matter and Chemical Kinetics	CO1	The students understand the chemistry and applications of s- and p-block elements.
		CO2	Derive ideal gas law from kinetic theory of gases and explain why the real gases deviate from ideal behaviour.
		CO3	Explain Maxwell-Boltzmann distribution, critical constants and viscosity of gases.
		CO4	Explain the properties of liquids especially surface tension and viscosity.
		CO5	Explain symmetry elements, crystal structure specially NaCl, KCl and CsCl
		CO6	Define rate of reactions and the factors that affect the rates of reaction.
		CO7	Understand the concept of rate laws e.g., order, molecularity, half-life and their determination.
		CO8	Learn about various theories of reaction rates and how these account for experimental observations.

COPO MAPPING

	SEMESTER II : COPO MAPPING					
Papers	Program Outcome : PO					
CC3	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5
	CO1	✓				
	CO2				✓	
	CO3					✓
	CO4	✓				
CC4	CO1	✓				
	CO2	✓				
	CO3			✓		
	CO4	✓				
GE2	CO1	✓				
	CO2	✓				✓
	CO3	✓				
	CO4	✓				
	CO5	✓				
	CO6	✓				
	CO7					✓
	CO8	✓				

SEMESTER 3:

CC5: S- AND P-BLOCK ELEMENTS
(INORGANIC CHEMISTRY – II)

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
32171301	s- and p- Block Elements (Inorganic Chemistry – II)	CO1	The students learn the fundamental principles of metallurgy and understand the importance of recovery of byproducts during extraction.
		CO2	Understand the basic and practical applications in various fields of metals and alloy behavior and their manufacturing processes.
		CO3	Apply the thermodynamic concepts like that of Gibbs energy and entropy to the principles of extraction of metals.

		CO4	Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table.
		CO5	Understand oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides.
		CO6	Understand vital role of sodium, potassium, calcium and magnesium ions in biological systems and the use of caesium in devising photoelectric cells.
CC6: HALOGENATED HYDROCARBONS AND OXYGEN CONTAINING FUNCTIONAL GROUPS (ORGANIC CHEMISTRY – II)			
32171302	Halogenated Hydrocarbons and Oxygen Containing Functional Groups (Organic Chemistry – II)	CO1	The students understand preparation, properties and reactions of haloalkanes, haloarenes and oxygen containing functional groups.
		CO2	Use the synthetic chemistry learnt in this course to do functional group transformations.
		CO3	To propose plausible mechanisms for any relevant reaction.
CC7: PHASE EQUILIBRIA AND ELECTROCHEMICAL CELLS (PHYSICAL CHEMISTRY – III)			
32171303	Phase Equilibria and Electrochemical Cells (Physical Chemistry)	CO1	Understand phase equilibrium, criteria, CST, Gibbs-Duhem-Margules equation.
		CO2	Learn the working of electrochemical cells, galvanic cell, corrosion and happenings in surroundings related to electrochemistry.
GE 3 (FOR HONOURS): **CHEMICAL ENERGETICS, EQUILIBRIA AND FUNCTIONAL GROUP ORGANIC CHEMISTRY-I**			
32175902	Chemical Energetics, Equilibria and Functional Group Organic	CO1	The students understand the laws of thermodynamics, thermochemistry and equilibria.
		CO2	Understand concept of pH and its effect on the various physical and chemical properties of the compounds.

	Chemistry-I	CO3	Use the concepts learnt to predict feasibility of chemical reactions and to study the behaviour of reactions in equilibrium.
		CO4	Understand the fundamentals of functional group chemistry through the study of methods of preparation, properties and chemical reactions with underlying mechanism.
		CO5	Use concepts learnt to understand stereochemistry of a reaction and predict the reaction outcome.
		CO6	Design newer synthetic routes for various organic compounds.

COPO MAPPING

	SEMESTER III : COPO MAPPING					
Papers	Program Outcome : PO					
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5
CC5	CO1	✓				
	CO2	✓				
	CO3					✓
	CO4	✓				
	CO5	✓				
	CO6	✓				
CC6	CO1	✓				
	CO2					✓
	CO3				✓	
CC7	CO1	✓				
	CO2	✓	✓			
GE3	CO1	✓				
	CO2	✓				
	CO3					✓
	CO4	✓				
	CO5				✓	✓
	CO6			✓		✓

SEMESTER 4:

CC8: COORDINATION CHEMISTRY (INORGANIC CHEMISTRY – III)

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
32171401	Coordination Chemistry (Inorganic Chemistry – III)	CO1	The course enables the students to understand the terms, ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds.
		CO2	Discuss the various types of isomerism possible in such compounds and understand the types of isomerism possible in a metal complex.
		CO3	Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes
		CO4	Explain the meaning of the terms $\Delta o.$, Δt, pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy
		CO5	Explain magnetic properties and colour of complexes on basis of Crystal Field Theory
		CO6	Understand the important properties of transition metals like variable oxidation states, colour, magnetic and catalytic properties and use Latimer diagrams to predict and identify species which are reducing, oxidizing and tend to disproportionate and calculate skip step potentials
		CO7	Understand reaction mechanisms of coordination compounds and differentiate between kinetic and thermodynamic stability.

CC9: NITROGEN CONTAINING FUNCTIONAL GROUPS, POLYNUCLEAR HYDROCARBONS, HETEROCYCLIC CHEMISTRY, ALKALOIDS AND TERPENES (ORGANIC CHEMISTRY – III)

32171402	Nitrogen containing functional groups, Polynuclear Hydrocarbons, Heterocyclic Chemistry, Alkaloids and Terpenes (Organic Chemistry – III)	CO1	The students gain theoretical understanding of chemistry of compounds having nitrogen containing functional groups, heterocyclics, polynuclear hydrocarbons, alkaloids and terpenes which includes various methods for synthesis through application of the synthetic organic chemistry concepts learnt so far.
		CO2	Become familiar with their particular properties, chemical reactions, criterion of aromaticity with reference to polynuclear hydrocarbons and heterocyclic compounds, trends in basicity of amines and heterocyclic compounds and their behaviour at different pH.
		CO3	Learn practical approach to structural elucidation of organic compounds with specific examples of terpenes and alkaloids.
		CO4	Predict the carbon skeleton of amines and heterocyclic compounds via use of Hoffmann's exhaustive methylation and Emde's modification methods.
		CO5	Understand the applications of these compounds including their medicinal applications through their reaction chemistry.
CC10: CONDUCTANCE & CHEMICAL KINETICS (PHYSICAL CHEMISTRY IV)			
32171403	Conductance & Chemical Kinetics (Physical Chemistry - IV)	CO1	The students can explain the chemistry of conductance and its variation with dilution, migration of ions in solutions.
		CO2	Learn the applications of conductance measurements.
		CO3	Have understanding of rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic.
		CO4	Have knowledge of the laws of absorption of light energy by molecules and the subsequent photochemical reactions.
GE 4 (FOR HONOURS): ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLYNUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY			
32175917	Organometallics, Bioinorganic	CO1	The students understand the chemistry and applications of 3d elements including their

	Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy		oxidation states and important properties of the familiar compounds potassium dichromate, potassium permanganate and potassium ferrocyanide.
		CO2	Use IR data to explain the extent of back bonding in carbonyl complexes.
		CO3	Get a general idea of toxicity of metal ions through the study of Hg2+ and Cd2+ in the physiological system..
		CO4	Understand the fundamentals of functional group chemistry, polynuclear hydrocarbons and heterocyclic compounds through the study of methods of preparation, properties and chemical reactions with underlying mechanism.
		CO5	Gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques.
		CO6	Use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules

COPO MAPPING

	SEMESTER IV : COPO MAPPING					
Papers	Program Outcome : PO					
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5
CC8	CO1	✓				
	CO2	✓				
	CO3	✓				✓
	CO4	✓				
	CO5	✓				
	CO6	✓			✓	
	CO7	✓				
CC9	CO1	✓				
	CO2	✓				
	CO3	✓				
	CO4					✓
	CO5	✓				

CC10	CO1	✓				
	CO2	✓				
	CO3	✓				
	CO4	✓			✓	
GE4	CO1	✓				
	CO2				✓	
	CO3	✓				
	CO4	✓				
	CO5	✓				
	CO6					✓

SEMESTER 5: **CC11: BIOMOLECULES (ORGANIC CHEMISTRY – IV)**			
Unique Paper Code	**Name of the Paper**	**Course Outcome: CO**	**Statement**
32171501	Biomolecules (Organic Chemistry – IV)	CO1	The students understand and demonstrate how structure of biomolecules determines their reactivity and biological functions.
		CO2	Gain insight into concepts of heredity through the study of genetic code, replication, transcription and translation.
		CO3	Demonstrate understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes.
CC12: QUANTUM CHEMISTRY & SPECTROSCOPY (PHYSICAL CHEMISTRY – V)			
32171502	Quantum Chemistry & Spectroscopy (Physical Chemistry – V)	CO1	The students learn about limitations of classical mechanics and solution in terms of quantum mechanics for atomic/molecular systems.
		CO2	Develop an understanding of quantum mechanical operators, quantization, probability distribution, uncertainty principle and application of quantization to spectroscopy.

		CO3	Interpret various types of spectra and know about their application in structure elucidation.
DSE1: NOVEL INORGANIC SOLIDS			
32177901	Novel Inorganic Solids	CO1	The students understand the mechanism of solid-state synthesis.
		CO2	Explain about the different characterization techniques and their principle.
		CO3	Understand the concept of nanomaterials, their synthesis and properties.
		CO4	Explain the mechanism of growth of self-assembled nanostructures.
		CO5	Appreciate the existence of bioinorganic nanomaterials.
		CO6	Explain the importance of composites, conducting polymers and their applications.
		CO7	Understand the usage of solid materials in various instruments, batteries, etc. which would help them to appreciate the real life importance of these materials
DSE2: GREEN CHEMISTRY			
32177908	Green Chemistry	CO1	The students understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances.
		CO2	Understand stoichiometric calculations and relate them to green chemistry metrics. They will learn about atom economy and how it is different from percentage yield.
		CO3	Learn to design safer chemicals, products and processes that are less toxic than current alternatives. Hence they will understand the meaning of inherently safer design for accident prevention and the principle "what you don't have can't harm you"
		CO4	Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources, importance led reactions in various green solvents.
		CO5	Appreciate the use of green chemistry in problem solving skills, critical thinking and

			valuable skills to innovate and find out solution to environmental problems. Thus the students are able to realise that chemistry can be used to solve rather than cause environmental problems.
		CO6	Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Success stories and real world cases also motivate them to practice green chemistry. These days. customers are demanding to know about a product: Is it green? Does it contribute to global warming? Was it made from non depletable resources? Students have many career opportunities as " green" is the path to success.

COPO MAPPING

	SEMESTER V : COPO MAPPING					
Papers	Program Outcome : PO					
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5
CC11	CO1	✓				
	CO2	✓				
	CO3			✓		
CC12	CO1	✓				
	CO2	✓				
	CO3	✓				✓
DSE1	CO1	✓				
	CO2	✓				
	CO3	✓				
	CO4	✓				
	CO5				✓	
	CO6			✓		
	CO7					✓
DSE2	CO1	✓				
	CO2					✓
	CO3				✓	
	CO4	✓				
	CO5					✓
	CO6				✓	

SEMESTER 6:

CC13: ORGANOMETALLIC CHEMISTRY & BIO-INORGANIC CHEMISTRY (INORGANIC CHEMISTRY – IV)

Unique Paper Code	Name of the Paper	Course Outcome: CO	Statement
32171601	Organometallic Chemistry & Bio-inorganic Chemistry (Inorganic Chemistry – IV)	CO1	Understand and explain the basic principles of qualitative inorganic analysis.
		CO2	Apply 18-electron rule to rationalize the stability of metal carbonyls and related species.
		CO3	Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
		CO4	Identify important structural features of the metal alkyls tetrameric methyl lithium and dimeric trialkyl aluminium and explain the concept of multicenter bonding in these compounds
		CO5	Diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting it and understand and describe the active sites and action cycles of the metalloenzymes carbonic anhydrase and carboxypeptidase.
		CO6	Explain the sources and consequences of excess and deficiency of trace metals and learn about the toxicity of certain metal ions, the reasons for toxicity and antidotes.
		CO7	Explain the use of chelating agents in medicine and, specifically, the role of cisplatin in cancer therapy and explain the applications of iron in biological systems with particular reference to haemoglobin, myoglobin, ferritin and transferrin.
		CO8	Get a general idea of catalysis and describe in detail the mechanism of Wilkinson's catalyst, Zeigler- Natta catalyst and synthetic gasoline manufacture by Fischer-Tropsch process.

CC14: SPECTROSCOPY AND APPLIED ORGANIC CHEMISTRY (ORGANIC CHEMISTRY – V)			
32171602	Spectroscopy and Applied Organic Chemistry (Organic Chemistry – V)	CO1	Gain insight into the basic principles of UV, IR and NMR spectroscopic techniques.
		CO2	Use spectroscopic techniques to determine structure and stereochemistry of known and unknown compounds.
		CO3	Develop a sound understanding of the structure of Pharmaceutical Compounds. They will also understand the importance of different classes of drugs and their applications for treatment of various diseases.
		CO4	Learn about the chemistry of natural and synthetic polymers including fabrics and rubbers.
		CO5	Understand the chemistry of biodegradable and conducting polymers and appreciate the need of biodegradable polymers with emphasis on basic principles.
		CO6	Learn about the theory of colour and constitution as well as the chemistry of dyeing.
		CO7	Know applications of various types of dyes including those in foods and textiles
DSE3: APPLICATIONS OF COMPUTERS IN CHEMISTRY			
32177903	Applications of Computers in Chemistry	CO1	Have knowledge of most commonly used commands and library functions used in QBASIC programming.
		CO2	Develop algorithm to solve problems and write corresponding programs in BASIC for performing calculations involved in laboratory experiments and research work.
		CO3	Use various spreadsheet software to perform theoretical calculations and plot graphs.
DSE4: INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS			
32177910	Instrumental Methods of	CO1	The students will be able to handle analytical data.
		CO2	Understand basic components of IR, FTIR, UV-Visible and Mass spectrometer.

	Chemical Analysis	CO3	Interpret of IR, FTIR, UV-visible spectra and their applications.
		CO4	Understand the use of single and double beam instruments.
		CO5	Learn separations techniques like Chromatography.
		CO6	Learn elemental analysis, NMR spectroscopy, Electroanalytical Methods, Radiochemical Methods, X-ray analysis and electron spectroscopy.

COPO MAPPING

	SEMESTER IV : COPO MAPPING					
Papers	Program Outcome : PO					
	Course Outcome: CO	PO1	PO2	PO3	PO4	PO5
CC13	CO1	✓				
	CO2					✓
	CO3	✓				
	CO4					
	CO5				✓	
	CO6			✓		
	CO7			✓		
	CO8	✓				
CC14	CO1	✓				
	CO2					✓
	CO3	✓				
	CO4	✓				
	CO5				✓	
	CO6	✓				
	CO7	✓				
DSE3	CO1					✓
	CO2					✓
	CO3					✓
DSE4	CO1		✓			
	CO2	✓				
	CO3					✓
	CO4	✓				
	CO5		✓			
	CO6		✓			✓