MATHABHANGA COLLEGE
DEPARTMENT OF CHEMISTRY
COURSES OUTCOME

Program	Year	Paper(Code)	Course Name	Outcome
B.Sc Honours in Chemistry	2023-24	UG/CHEM/101/C-1	ORGANIC CHEMISTRY – I (Credits : Theory – 4, Practical – 2) SEM-1(CBCS Curriculum)	**1. Hybridization and Molecular Geometry:** **Learning Outcome:** ● Understand the concept of hybridization in organic compounds. ● Determine the shapes of molecules using the VSEPR theory. ● Explore how hybridization influences bond properties. **2. Calculation of Double Bond Equivalent (DBE):** **Learning Outcome:** ● Learn how to calculate DBE and its application in determining the degree of unsaturation in organic compounds. **3. Electronic Displacements:** **Learning Outcome:** ● Understand inductive, electromeric, resonance, and mesomeric effects on electron distribution in molecules. ● Explore hyperconjugation and its applications. ● Learn about bond polarization, bond polarizability, steric effects, and steric inhibition of resonance. **4. Dipole Moment and Acid-Base Strength:** **Learning Outcome:** ● Comprehend the concept of dipole moment. ● Compare and analyze the relative strengths of organic acids and bases. **5. Molecular Orbital (MO) Theory:** **Learning Outcome:** ● Gain a qualitative understanding of molecular orbital theory. ● Learn about bonding and antibonding interactions, σ, σ^*, π, π^*, and n–MOs. ● Understand the significance of HOMO, LUMO, and SOMO. **6. Sketch and Energy Levels of π MOs:** **Learning Outcome:** ● Sketch and analyze π MOs in acyclic and cyclic p-orbital systems. **7. Aromaticity and Hückel's Rules:** **Learning Outcome:**

				● Understand Hückel's rules for aromaticity. ● Explore aromaticity in different systems and understand the concept of antiaromaticity and homoaromaticity. **8. Reaction Thermodynamics:** **Learning Outcome:** ● Learn about free energy and its role in equilibrium. ● Understand enthalpy and entropy factors in reactions. ● Calculate enthalpy change via bond dissociation energy (BDE). ● Explore intermolecular and intramolecular reactions. **9. Tautomerism:** **Learning Outcome:** ● Understand the concept of tautomerism and prototropy. ● Analyze the composition of equilibrium in different systems. ● Explore factors affecting keto-enol tautomerism. ● Apply thermodynamic principles in tautomeric equilibria. By the end of this course, a student should have a solid understanding of fundamental organic chemistry principles, including molecular structure, electronic effects, molecular orbitals, reaction thermodynamics, and tautomerism. They will also develop problem-solving skills and the ability to apply these concepts to various organic compounds and reactions.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/102/C-2	PHYSICAL CHEMISTRY – I (Credits : Theory – 4, Practical – 2)SEM-1, (CBCS Curriculum)	**Kinetic Molecular Model of a Gas:** **1. Postulates and Derivation of the Kinetic Gas Equation:** **Learning Outcome:** ● Understand the postulates of the kinetic molecular model. ● Derive the kinetic gas equation from basic principles. ● Relate macroscopic properties of gases (pressure, volume, temperature) to molecular behavior. **2. Collision Frequency, Collision Diameter, and Mean Free Path:** **Learning Outcome:** ● Understand the factors influencing collision frequency. ● Define and calculate collision diameter. ● Define and calculate mean free path. ● Explore the relationship between collision frequency, collision diameter, and mean free path. **3. Viscosity of Gases:** **Learning Outcome:** ● Understand the concept of viscosity in gases. ● Explore temperature and pressure dependence of viscosity.

- Establish the relationship between mean free path and coefficient of viscosity.
- Calculate collision diameter (σ) from viscosity (η).

4. Variation of Viscosity with Temperature and Pressure:
Learning Outcome:
- Analyze how viscosity changes with temperature and pressure.
- Understand the molecular basis of viscosity variations.

5. Maxwell Distribution:
Learning Outcome:
- Comprehend the Maxwell distribution of molecular speeds.
- Use Maxwell distribution to evaluate average, root mean square, and most probable molecular velocities.

6. Average Kinetic Energy, Law of Equipartition of Energy, and Degrees of Freedom:
Learning Outcome:
- Understand the concept of average kinetic energy in gases.
- Explore the law of equipartition of energy and its molecular implications.
- Define and calculate degrees of freedom in molecular systems.
- Explain the molecular basis of heat capacities.

7. Barometric Distribution Law:
Learning Outcome:
- Understand the barometric distribution law.
- Explore the relationship between pressure and altitude.
- Analyze the factors influencing atmospheric pressure.

By the end of this course, students should have a comprehensive understanding of the kinetic molecular model and its applications to various properties of gases, providing a solid foundation for further studies in thermodynamics and statistical mechanics.

8. Deviations from Ideal Gas Behavior:
Learning Outcome:
- Understand the concept of ideal gases and the assumptions behind their behavior.
- Identify and explain deviations from ideal gas behavior in real gases.
- Explore the compressibility factor (Z) and its significance in describing deviations.

9. Compressibility Factor (Z) and Its Variation with Pressure:
Learning Outcome:
- Define the compressibility factor (Z) and understand its role in characterizing real gas behavior.

- Analyze how Z varies with pressure for different gases.
- Recognize the significance of Z in describing the departure from ideal gas behavior.

10. Causes of Deviation from Ideal Behavior:
Learning Outcome:

- Identify and explain the various factors that contribute to deviations from ideal gas behavior.
- Understand the molecular interactions and conditions under which deviations become prominent.

11. van der Waals' Equation of State:
Learning Outcome:

- Derive the van der Waals equation of state for real gases.
- Understand the physical significance of van der Waals constants (a and b) in the equation.
- Apply the van der Waals equation to explain real gas behavior.

Liquid State:
Learning Outcome:

- Develop a comprehensive understanding of the structure and properties of the liquid state.
- Analyze the concepts of vapor pressure, surface tension, and viscosity.
- Understand the experimental methods used to measure surface tension and viscosity.
- Explore the temperature dependence of surface tension and viscosity.
- Apply principles of surface tension and viscosity to phenomena like capillary rise and fluid flow.

By the end of this course, students should be able to apply their knowledge to explain and predict the behavior of liquids under different conditions. They should also be equipped with the skills to perform experimental measurements related to surface tension and viscosity.

Ionic Equilibrium:
Learning Outcome:

- Develop a comprehensive understanding of the classification of electrolytes.
- Analyze factors influencing the degree of ionization of electrolytes.
- Understand the ionization constant and ionic product of water.
- Apply the concept of pH and common ion effect in weak acid and base ionization.
- Calculate dissociation constants of acids and hydrolysis constants of salts.
- Derive and apply the Henderson equation for buffer solutions.
- Understand the principles of solubility and solubility product.
- Analyze acid–base titration curves and understand the theory of indicators.

By the end of this course, students should have a strong foundation in the principles of ionic equilibria, allowing them to analyze and predict the behavior of electrolytes in different solutions. They should also

				be able to apply these concepts to practical scenarios such as buffer solutions and titrations.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/201/C-3	INORGANIC CHEMISTRY – I (Credits : Theory – 4, Practical – 2) SEM-2, (CBCS Curriculum)	**1. Atomic Structure:** **Learning Outcome:** ● Develop a deep understanding of Bohr's theory and its limitations. ● Analyze the atomic spectrum of hydrogen. ● Comprehend wave mechanics, including the de Broglie equation and Heisenberg's Uncertainty Principle. ● Understand Schrödinger's wave equation and the significance of wave functions. ● Define and apply quantum numbers to describe electron states. ● Explore normalized and orthogonal wave functions. ● Visualize the shapes of orbitals using radial and angular distribution curves. ● Apply Pauli's Exclusion Principle, Hund's Rule, and Aufbau's Principle to electron configurations. ● Analyze the variation of orbital energy with atomic number. By the end of this course, students should have a strong foundation in the principles of atomic structure, enabling them to understand and predict the behavior of electrons in atoms and apply these concepts to explain the properties of elements in the periodic table. **2. Periodic Table:** **Learning Outcome:** ● Develop a deep understanding of the organization of elements into s, p, d, and f blocks in the periodic table. ● Analyze the structure of the long form of the periodic table. ● Calculate effective nuclear charge using Slater's rules. ● Analyze trends in atomic, ionic, crystal, and covalent radii. ● Understand ionization enthalpy, successive ionization enthalpies, and factors affecting ionization energy. ● Analyze trends in electron gain enthalpy. ● Explore electronegativity and its scales, including trends with bond order, partial charge, and hybridization. By the end of this course, students should be able to apply these concepts to explain the trends observed in the properties of elements across the periodic table. They should also understand the theoretical basis for these trends and their practical applications. **3. Chemical Bonding:** **Learning Outcome:** ● Develop a comprehensive understanding of ionic, covalent, and metallic bonding.

				● Analyze the energetics and principles of hybridization in covalent bonds. ● Apply molecular orbital theory and predict molecular shapes using VSEPR theory. ● Understand the factors influencing covalent and ionic character in compounds. ● Analyze weak chemical forces and their effects on physical properties. By the end of this course, students should be equipped with the knowledge to explain and predict the bonding characteristics of various types of compounds. They should also understand the effects of different forces on the properties of substances. **4. Oxidation and Reduction:** **Learning Outcome:** ● Develop a solid understanding of oxidation-reduction reactions. ● Balance and write redox equations. ● Apply standard electrode potential to predict the feasibility of inorganic reactions. ● Understand the electrochemical series and its applications. ● Analyze the principles and techniques involved in volumetric analysis. ● Recognize the concept of titration and understand different types of titrations. ● Apply indicators in titrations and understand the concept of equivalence point and end point. By the end of this course, students should have a strong foundation in the principles of oxidation-reduction reactions, electrochemistry, and volumetric analysis. They should be able to apply these concepts to analyze and predict chemical reactions and perform quantitative analysis using titration techniques.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/202/C-4	ORGANIC CHEMISTRY – II, SEM-2(Credits : Theory – 4, Practical – 2) (CBCS)	**1. Stereochemistry II:** **Learning Outcome:** ● Develop a deep understanding of chirality arising from stereoaxis. ● Analyze stereoisomerism in substituted cumulenes with even and odd numbers of double bonds. ● Recognize chiral axes in various compounds, including allenes, spiro compounds, alkylidenecycloalkanes, and biphenyls. ● Apply configurational descriptors (R/S and P/M) to characterize stereochemistry. ● Understand atropisomerism and its impact on stereochemistry. ● Explore the concept of prostereoisomerism and prostereogenic centers. ● Recognize (pro)n-chirality and the topicity of ligands and faces. ● Analyze descriptors such as pro-R/pro-S, pro-E/pro-Z, and Re/Si in the context of prostereoisomerism. ● Understand pro-r and pro-s descriptors of ligands on pro-pseudoasymmetric centers. By the end of this course, students should have a thorough understanding of advanced concepts in stereochemistry, enabling them to analyze and predict the stereochemical outcomes of complex molecules and reactions. They should also be able to apply configurational descriptors and recognize the significance of prostereoisomerism in various chemical systems.

				2. Conformation: **Learning Outcome:** ● Develop a thorough understanding of conformational nomenclature and terminology. ● Analyze energy barriers of rotation and the concept of torsional and steric strains. ● Evaluate the relative stability of conformers based on steric effects, dipole-dipole interactions, and hydrogen bonding. ● Understand the butane gauche interaction. ● Perform conformational analysis of hydrocarbons, haloalkanes, and dihaloalkanes. ● Recognize the conformation of conjugated systems, including s-cis and s-trans configurations. By the end of this course, students should be able to apply conformational analysis principles to predict and analyze the different conformations of organic molecules and understand their stability based on various factors such as steric effects and intermolecular interactions. **3. Chemistry of Aliphatic Hydrocarbons:** **Learning Outcome:** ● Develop a comprehensive understanding of the chemistry of aliphatic hydrocarbons. ● Analyze the formation, reactions, and mechanisms involving carbon-carbon sigma and pi bonds. ● Understand the chemistry of alkyl halides, aryl halides, alcohols, phenols, ethers, epoxides, and aromatic hydrocarbons. ● Apply the principles learned to predict and analyze reactions and understand the stereochemistry involved. ● Explore the relative reactivity of different functional groups in nucleophilic substitution reactions. ● Understand the directing effects of groups in electrophilic aromatic substitution reactions. By the end of this course, students should be well-equipped to understand and apply the principles of aliphatic hydrocarbon chemistry in predicting and analyzing organic reactions. They should also have a solid foundation in stereochemistry and be able to predict the outcomes of various reactions based on the principles learned.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/301/C-5	PHYSICAL CHEMISTRY – II (Credits : Theory – 4, Practical – 2)-SEM-3(CBCS)	**1. Chemical thermodynamics:** **Learning Outcome:** ● Develop a solid understanding of fundamental concepts in thermodynamics. ● Apply the laws of thermodynamics to various systems and processes. ● Calculate heat and work for different thermodynamic processes. ● Understand the principles of thermochemistry, including heats of reactions and adiabatic flame temperature. ● Analyze the second law of thermodynamics and its implications. ● Comprehend free energy functions and their variations with temperature, volume, and pressure.

- Apply thermodynamic principles to predict spontaneity and study thermodynamic processes.

By the end of this course, students should have a thorough understanding of the fundamental principles of thermodynamics and be able to apply these principles to solve problems related to heat, work, and energy changes in different systems. They should also be equipped to analyze and predict the spontaneity of various processes.

2. Systems of Variable Composition:
Learning Outcome:

- Develop a thorough understanding of partial molar quantities and their role in thermodynamics.
- Apply the Gibbs-Duhem equation to analyze the relationships between thermodynamic parameters in a system.
- Understand the chemical potential of ideal mixtures and the changes in thermodynamic functions during the mixing of ideal gases.
- Comprehend the physical significance of the fugacity function in real gases.
- Apply the concept of activity and activity coefficient in the context of solutions.
- Analyze how thermodynamic properties change with composition in systems of variable composition.

By the end of this course, students should have a solid foundation in the principles of thermodynamics as applied to systems with variable composition. They should be able to apply these principles to analyze and predict the behavior of mixtures and solutions, considering the changes in thermodynamic parameters with varying composition.

3. Chemical Equilibrium:
Learning Outcome:

- Understand the criteria for achieving thermodynamic equilibrium in chemical systems.
- Analyze chemical equilibria in ideal gases, considering the concept of fugacity.
- Comprehend the thermodynamic derivation of the relationship between Gibbs free energy and the reaction quotient.
- Understand the coupling of exoergic and endoergic reactions in the context of chemical equilibrium.
- Define and analyze equilibrium constants, considering their dependence on temperature, pressure, and concentration.
- Apply Le Chatelier's principle quantitatively to predict the effects of changes on chemical equilibria.
- Analyze equilibrium between ideal gases and a pure condensed phase.

By the end of this course, students should have a solid understanding of the principles governing chemical equilibrium, including the thermodynamics involved and the factors influencing equilibrium constants. They should be able to apply these principles to predict and analyze the behavior of chemical systems at equilibrium.

4. Solutions and Colligative Properties:

				Learning Outcome: ● Understand the behavior of dilute solutions, especially in terms of vapor pressure. ● Apply Raoult's and Henry's Laws to analyze the vapor pressure changes in dilute solutions. ● Define and comprehend excess thermodynamic functions in solutions. ● Use chemical potential to derive relations between colligative properties and the amount of solute in a solution. ● Apply the concepts of colligative properties to calculate molar masses of solutes in different types of solutions. By the end of this course, students should have a solid understanding of the principles underlying solutions and colligative properties. They should be able to apply these principles to predict and analyze the behavior of solutions, especially in terms of changes in vapor pressure, boiling point, freezing point, and osmotic pressure.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/302/C-6	INORGANIC CHEMISTRY – II (Credits : Theory – 4, Practical – 2), SEM-3 (CBCS)	**1. General Principles of Metallurgy:** **Learning outcome:** ● Understand the different modes of occurrence of metals based on their standard electrode potentials. ● Analyze Ellingham diagrams to predict the feasibility of reduction reactions using carbon and carbon monoxide. ● Understand the principles of electrolytic reduction and hydrometallurgical methods in metallurgy. ● Comprehend various purification methods, including the electrolytic Kroll process, parting process, van Arkel-de Boer process, and Mond's process. ● Analyze the principles and applications of zone refining in the purification of metals. By the end of this course, students should have a solid understanding of the general principles of metallurgy, including the modes of occurrence of metals, reduction methods, purification processes, and zone refining. They should be able to apply these principles to predict and analyze the extraction and purification of metals in various industrial processes. **2. Acid and Base:** **Learning Outcome:** ● Understand the Brönsted-Lowry concept of acid-base reactions and the solvated proton. ● Analyze the relative strength of acids within the Brönsted-Lowry framework. ● Identify and classify different types of acid-base reactions, including leveling solvents. ● Define the Lewis acid-base concept and classify Lewis acids. ● Understand the principles of Hard and Soft Acids and Bases (HSAB). ● Apply HSAB principles to analyze acid-base reactions and their outcomes. By the end of this course, students should have a comprehensive understanding of the different concepts of acids and bases, including Brönsted-Lowry, Lewis, and HSAB concepts. They should be able to apply

these principles to analyze and predict the behavior of acids and bases in various chemical reactions.

3. Chemistry of s and p Block Elements:
Learning Outcome:

- Understand the inert pair effect and its impact on the stability of oxidation states.
- Analyze diagonal relationships and anomalous behavior in the periodic table.
- Comprehend the concepts of allotropy and catenation.
- Analyze the complex formation tendency of s and p block elements.
- Classify hydrides and understand the properties of basic beryllium acetate and nitrate.
- Study specific compounds with emphasis on structure, bonding, preparation, properties, and uses.

By the end of this course, students should have a comprehensive understanding of the chemistry of s and p block elements, including the inert pair effect, diagonal relationships, allotropy, catenation, complex formation, hydrides, and the properties of specific compounds. They should be able to apply this knowledge to analyze and predict the behavior of elements and compounds in various chemical contexts.

4. Noble Gases:
Learning Outcome:

- Understand the occurrence and practical applications of noble gases.
- Rationalize the inertness of noble gases and analyze their chemical properties.
- Define and comprehend the concept of clathrates and their involvement with noble gases.
- Study the preparation and properties of specific noble gas compounds, including XeF_2, XeF_4, and XeF_6.
- Analyze the nature of bonding in noble gas compounds using Valence Bond and Molecular Orbital treatments.
- Understand the molecular shapes of noble gas compounds using the VSEPR theory.

By the end of this course, students should have a comprehensive understanding of the properties, occurrences, and applications of noble gases, as well as the unique characteristics of noble gas compounds and their bonding. They should be able to apply this knowledge to analyze and predict the behavior of noble gases in various chemical contexts.

5. Inorganic Polymers:
Learning Outcome:

- Identify and differentiate between different types of inorganic polymers.
- Compare the characteristics of inorganic polymers with organic polymers.
- Understand the synthesis methods for silicones and siloxanes.
- Analyze the structural aspects of silicones and siloxanes.
- Comprehend the practical applications of silicones and siloxanes.
- Understand the structure, synthesis, and properties of borazines, silicates, and phosphazenes.

				● Analyze the applications of borazines, silicates, and phosphazenes. ● Understand the synthesis, structure, and properties of polysulphates. ● Analyze the applications of polysulphates in various fields. By the end of this course, students should have a comprehensive understanding of the synthesis, structure, properties, and applications of various inorganic polymers, including silicones, siloxanes, borazines, silicates, phosphazenes, and polysulphates. They should be able to apply this knowledge to assess the suitability of these polymers for specific industrial and technological applications.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/303/C-7	ORGANIC CHEMISTRY – III (Credits : Theory – 4, Practical – 2), SEM-3(CBCS)	**1. Carbonyl Compounds:** **Learning Outcome:** ● Understand the structure and reactivity of carbonyl compounds. ● Recognize various methods used in the preparation of carbonyl compounds. ● Study nucleophilic additions and addition-elimination reactions with ammonia derivatives, including their mechanisms. ● Understand the mechanisms of condensation reactions such as Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro, and Wittig reactions. ● Analyze rearrangement reactions such as Beckmann and Benzil-Benzilic acid rearrangements. ● Understand additional reactions like haloform reaction and Baeyer-Villiger oxidation. ● Study α-substitution reactions and various oxidation/reduction methods (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC, and PGC). ● Comprehend Michael addition reactions involving unsaturated carbonyl compounds. ● Understand keto-enol tautomerism and the preparation of diethyl malonate and ethyl acetoacetate. By the end of this course, students should have a solid understanding of the reactivity, mechanisms, and synthetic applications of carbonyl compounds and their derivatives. They should be able to apply this knowledge to predict and analyze the outcomes of various reactions involving carbonyl compounds in different chemical contexts. **2. Organometallics** **Learning Outcome:** ● Understand the preparation and properties of Grignard reagents. ● Comprehend the properties and reactivity of organolithium compounds. ● Understand the preparation and reactions of Gilman cuprates, including conjugate addition reactions. ● Analyze the addition reactions of Grignard and organolithium reagents to carbonyl compounds. ● Understand substitution reactions on -COX using organometallic reagents. ● Compare the reactivity among Grignard, organolithiums, and organocopper reagents. ● Understand the Reformatsky reaction and Blaise reaction. ● Comprehend the concept of umpolung in the context of organometallic reagents.

- Understand the base-nucleophile dichotomy in the reactions of organometallic reagents.
- Analyze the abnormal behavior of Grignard reagents in specific reactions.
- Understand the Corey-House synthesis.

By the end of this course, students should have a thorough understanding of the properties and reactions of various organometallic reagents and their applications in synthetic organic chemistry. They should be able to apply this knowledge to design and predict the outcomes of organometallic reactions in different chemical contexts.

3. Carboxylic Acids and their Derivatives:
Learning Outcome:

- Understand the methods of preparation and physical properties of monocarboxylic acids.
- Analyze the typical reactions of monocarboxylic acids.
- Study the typical reactions of dicarboxylic acids, hydroxy acids, and unsaturated acids.
- Analyze the properties and reactivity of specific dicarboxylic acids such as succinic/phthalic, lactic, malic, tartaric, citric, maleic, and fumaric acids.
- Understand the methods of preparation and reactions of acid chlorides, anhydrides, esters, and amides.
- Perform a comparative study of nucleophilic substitution at the acyl group.
- Analyze the mechanisms of acidic and alkaline hydrolysis of esters.
- Understand the mechanisms of reactions such as Claisen condensation, Dieckmann, and Reformatsky reactions.
- Comprehend the Hofmann-Bromamide degradation and Curtius rearrangement.

By the end of this course, students should have a comprehensive understanding of the preparation, properties, and reactions of carboxylic acids and their derivatives. They should be able to apply this knowledge to predict and analyze the outcomes of various reactions involving these compounds in different chemical contexts.

4. Nitrogen Containing Functional Groups:
Learning Outcome:

- Understand the methods of preparation and important reactions of nitro compounds.
- Comprehend the methods of preparation and significant reactions of nitriles and isonitriles.
- Analyze the effect of substituents and solvent on the basicity of amines.
- Understand the methods of preparation and properties of amines.
- Study the Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, and Hofmann-elimination reaction.
- Distinguish between 1°, 2°, and 3° amines using Hinsberg reagent and nitrous acid.

				- Understand the methods of preparation of diazonium salts. - Analyze the synthetic applications of diazonium salts. By the end of this course, students should have a solid understanding of the preparation, properties, and reactions of nitrogen-containing functional groups. They should be able to apply this knowledge to predict and analyze the outcomes of various reactions involving these functional groups in different chemical contexts. **5. Polynuclear Hydrocarbons:** **Learning Outcome:** - Understand the reactions of naphthalene, phenanthrene, and anthracene. - Analyze the chemical transformations and modifications of these compounds. - Comprehend the structure of naphthalene and anthracene. - Understand the methods of preparation for naphthalene and anthracene. - Learn techniques for structure elucidation using spectroscopic methods. - Study the important derivatives of naphthalene and anthracene. - Analyze the properties and reactivity of these derivatives. - Understand the concept of polynuclear hydrocarbons. - Analyze the properties, structures, and occurrences of polynuclear hydrocarbons. By the end of this course, students should have a comprehensive understanding of the structures, properties, and reactions of naphthalene, phenanthrene, anthracene, and other polynuclear hydrocarbons. They should be able to apply this knowledge to predict and analyze the outcomes of various reactions involving these compounds in different chemical contexts. **6. Sulphur containing compounds:** **Learning Outcome:** - Understand the methods of preparation of thiols. - Analyze the reactions involving thiols, including their chemical transformations and modifications. - Comprehend the methods of preparation of thioethers. - Study the reactions of thioethers, including their properties and reactivity. - Understand the preparation methods for sulphonic acids. - Analyze the reactions and properties of sulphonic acids. By the end of this course, students should have a solid understanding of the preparation, properties, and reactions of sulphur-containing compounds, particularly thiols, thioethers, and sulphonic acids. They should be able to apply this knowledge to predict and analyze the outcomes of various reactions involving these compounds in different chemical contexts.

B.Sc Honours in Chemistry	2023-24	UG/CHEM/401/C-8	PHYSICAL CHEMISTRY – III (Credits : Theory – 4, Practical – 2), SEM-4	**1. Phase Equilibria:** **Learning Outcome:** ● Understand the fundamental concepts of phases, components, and degrees of freedom. ● Apply the Gibbs Phase Rule to nonreactive and reactive systems. ● Comprehend the Clausius-Clapeyron equation and its applications to various phase equilibria. ● Analyze phase diagrams for one-component systems and understand their applications. ● Understand phase diagrams for binary systems involving solid-liquid equilibria and solid solutions. ● Interpret three-component systems and triangular plots. ● Derive and understand the Gibbs-Duhem-Margules equation and apply it to binary solutions. ● Apply the Nernst distribution law to various systems. By the end of this course, students should have a comprehensive understanding of phase equilibria concepts, including phase diagrams, binary solutions, and distribution laws, and be able to apply these principles to analyze and predict equilibria in different systems. **2. Solid state:** **Learning Outcome:** ● Understand the characteristics and properties of the solid state. ● Comprehend the principles of the law of constancy of interfacial angles and the law of rational indices. ● Understand Miller indices as a system of notation for planes and directions in crystal lattices. ● Gain elementary ideas of symmetry, symmetry elements, and symmetry operations in crystals. ● Acquire a qualitative idea of point and space groups in crystal symmetry. ● Understand the seven crystal systems and fourteen Bravais lattices as fundamental aspects of crystal structures. ● Comprehend the principles of X-ray diffraction and Bragg's law in the analysis of crystal structures. ● Gain a simple account of the rotating crystal method and powder pattern method in X-ray diffraction. ● Analyze powder diffraction patterns of specific crystal structures such as NaCl, CsCl, and KCl. By the end of this course, students should have a solid understanding of the principles and techniques used in the study of solid-state structures, including crystal symmetry, X-ray diffraction, and the analysis of powder diffraction patterns. They should be able to apply these concepts to analyze and interpret crystal structures. **3. Chemical Kinetics:** **Learning Outcome:** ● Understand the concepts of reaction order and molecularity.

- Derive rate laws and expressions in terms of the advancement of a reaction.
- Analyze the differential and integrated forms of rate expressions for up to second-order reactions.
- Learn methods for the experimental determination of reaction order.
- Comprehend simple reaction mechanisms and kinetics of complex reactions.
- Analyze the kinetics of chain reactions, ionic reactions, and the salt effect.
- Understand the temperature dependence of reaction rates and apply the Arrhenius equation.
- Gain insights into collision theory and the Lindemann mechanism.
- Provide a qualitative treatment of the theory of absolute reaction rates.

By the end of this course, students should have a solid understanding of the principles of chemical kinetics, including reaction order, rate laws, temperature dependence, and reaction mechanisms. They should be able to apply these concepts to analyze and predict the behavior of chemical reactions over time.

4. Catalysis:
Learning outcome:

- Understand the different types of catalysts, including homogeneous and heterogeneous catalysts.
- Differentiate between catalytic and non-catalytic reactions.
- Comprehend the concepts of specificity and selectivity in catalysis.
- Analyze how catalysts can influence the selectivity of a reaction.
- Understand the mechanisms involved in catalyzed reactions at solid surfaces, particularly in heterogeneous catalysis.
- Analyze the role of adsorption and desorption in catalytic reactions.
- Gain insights into enzyme catalysis and its importance in biological systems.
- Understand the Michaelis-Menten mechanism as a model for enzyme-substrate interactions.
- Comprehend the principles of acid-base catalysis in chemical reactions.
- Analyze the role of acids and bases as catalysts in various reactions.

By the end of this course, students should have a comprehensive understanding of catalysis, including the types of catalysts, specificity, selectivity, and the mechanisms involved in various catalytic reactions, both at solid surfaces and in biological systems. They should be able to apply these concepts to analyze and design catalytic processes.

5. Surface chemistry:
Learning Outcome:

- Understand the differences between physical adsorption and chemisorption.
- Comprehend the factors influencing each type of adsorption.
- Analyze adsorption isotherms, including Freundlich and Langmuir isotherms.
- Interpret the behavior of adsorption in relation to these isotherms.

				● Understand the BET adsorption equation and its application. ● Analyze the specific surface area of adsorbents using the BET equation. ● Comprehend the Gibbs adsorption equation and its application in determining surface excess. ● Analyze the behavior of surfactants and micelles in the context of surface excess. ● Understand the properties and behavior of surfactants. ● Analyze the formation and properties of micelles. ● Gain insights into the cleansing action of detergents. ● Understand how surfactants contribute to the removal of dirt and oil. ● Comprehend the concept of the electrical double layer. ● Analyze the significance of Zeta potential in colloidal stability. ● Understand the mechanism of coagulation in colloidal systems. ● Apply Schulze-Hardy rule to predict the coagulating power of an electrolyte. By the end of this course, students should have a thorough understanding of surface chemistry, including adsorption phenomena, isotherms, surfactants, micelles, and the principles governing colloidal stability. They should be able to apply these concepts to real-world scenarios and industrial processes.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/402/C-9	INORGANIC CHEMISTRY – III (Credits : Theory – 4, Practical – 2), SEM-4(CBCS)	**1. Coordination Chemistry:** **Learning Outcome:** ● Understand Alfred Werner's coordination theory. ● Comprehend the concept of coordination numbers and primary and secondary valencies. ● Analyze the valence bond theory in the context of inner and outer orbital complexes. ● Understand the principle of electroneutrality and back bonding. ● Comprehend Crystal Field Theory and its application in explaining the electronic structure of coordination complexes. ● Understand the measurement of Δo (10 Dq), Crystal Field Stabilization Energy (CFSE), and factors affecting them. ● Compare and contrast octahedral and tetrahedral coordination geometries. ● Understand tetragonal distortions from octahedral geometry and the Jahn-Teller theorem. ● Analyze the concept of square planar coordination geometry. ● Understand the qualitative aspects of ligand field theory and molecular orbital theory. ● Analyze the electronic structure and bonding in coordination compounds. ● Apply IUPAC rules for naming coordination compounds. ● Understand different types of isomerism in coordination compounds. ● Analyze the stereochemistry of complexes with 4 and 6 coordination numbers. ● Understand the chelate effect and its significance. ● Comprehend the formation and properties of polynuclear complexes. ● Analyze the concepts of labile and inert complexes.

				By the end of this course, students should have a comprehensive understanding of coordination chemistry, including various theories, geometries, and isomerism in coordination compounds. They should be able to apply these concepts to predict and explain the properties of coordination complexes. **2. Transition Elements:** **Learning Outcome:** ● Understand the electronic configurations of transition elements. ● Analyze the group trends in terms of color, variable valency, magnetic properties, catalytic properties, and ability to form complexes. ● Comprehend the origin of color in transition metal compounds. ● Understand the concept of variable valency in transition elements. ● Analyze the magnetic properties of transition elements. ● Understand the factors influencing magnetic behavior in these elements. ● Understand the catalytic properties exhibited by transition elements. ● Analyze the role of transition metals as catalysts in various reactions. ● Comprehend the ability of transition elements to form coordination complexes. ● Analyze the factors influencing complex formation. ● Understand the stability of different oxidation states in transition elements. ● Analyze the factors determining the stability of oxidation states. ● Understand the concept of e.m.f in the context of transition elements. ● Interpret Latimer and Bsworth diagrams to represent the stability of oxidation states. ● Analyze the differences between the first, second, and third transition series. ● Understand the variations in electronic configurations, properties, and trends across different transition series. By the end of this course, students should have a solid understanding of the properties and behavior of transition elements, including their electronic configurations, color, variable valency, magnetic and catalytic properties, ability to form complexes, stability of oxidation states, and differences between various transition series. **3. Lanthanoids and Actinoids:** **Learning Outcome:** ● Understand the electronic configurations of lanthanoids and actinoids. ● Recognize the unique electronic structure of these elements. ● Analyze the oxidation states exhibited by lanthanoids and actinoids. ● Understand the factors influencing the stability of different oxidation states. ● Comprehend the color, spectral, and magnetic properties displayed by lanthanoids and actinoids. ● Analyze the relationship between electronic transitions and observed properties.

				● Understand the concept of lanthanide contraction. ● Analyze the consequences of lanthanide contraction on atomic and ionic sizes. ● Comprehend the ion-exchange method for the separation of lanthanides. ● Understand the principles and techniques involved in the separation process. By the end of this course, students should have a comprehensive understanding of the electronic configurations, oxidation states, color, spectral, and magnetic properties of lanthanoids and actinoids. They should also be familiar with the concept of lanthanide contraction and the separation methods used for lanthanides. **4. Bioinorganic Chemistry:** **Learning outcome:** ● Understand the role of metal ions in biological systems. ● Recognize the significance of metal ions in various biological processes. ● Analyze the classification of elements based on their action in biological systems. ● Understand the role of different elements in biological functions. ● Comprehend the influence of geochemical factors on the distribution of metals in biological systems. ● Analyze how environmental factors affect metal availability. ● Understand the mechanisms and significance of biological processes involving metal ions. ● Analyze specific examples such as the Sodium/Potassium pump, carbonic anhydrase, and carboxypeptidase. ● Understand the consequences of excess and deficiency of trace metals in biological systems. ● Analyze the impact of imbalances on health and physiological processes. ● Understand the toxicity of specific metal ions (Hg, Pb, Cd, As). ● Analyze the reasons for the toxicity of these metal ions. ● Comprehend the use of chelating agents in medical applications. ● Understand how chelation therapy is employed to mitigate the effects of metal toxicity. ● Understand the role of iron in biological systems. ● Analyze the structure and function of hemoglobin in oxygen transport. ● Comprehend the mechanisms involved in the storage and transfer of iron in biological systems. ● Analyze the significance of iron regulation for cellular functions. By the end of this course, students should have a thorough understanding of the role of metal ions in biological systems, the classification of elements in biological processes, the effects of geochemical factors, and the significance of various metal-related biological processes and their regulation. They should also be familiar with the impact of metal imbalances and the use of chelating agents in medicine.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/403/C-10	ORGANIC CHEMISTRY – IV (Credits :	**1. Cycloalkanes and Conformational Analysis:** **Learning Outcome:**

			Theory – 4, Practical – 2), SEM-4(CBCS)	● Identify different types of cycloalkanes. ● Understand the structural characteristics and properties of cycloalkanes. ● Analyze the factors influencing the relative stability of cycloalkanes. ● Understand the concept of strain in cycloalkanes. ● Comprehend Baeyer strain theory and its application to cycloalkanes. ● Analyze how strain affects the stability of cyclic structures. ● Understand the principles of conformational analysis. ● Analyze the different conformations of alkanes. ● Interpret energy diagrams for cyclohexane conformations. ● Understand the energy differences between chair, boat, and twist boat forms. ● Analyze energy diagrams to determine the relative stability of different conformations. ● Understand the factors influencing the stability of cyclohexane conformations. ● Understand the dynamic aspects of stereochemistry in cyclohexane rings. ● Analyze the interconversion of different conformations. By the end of this course, students should have a solid understanding of the types of cycloalkanes, factors influencing their stability, conformational analysis, and the dynamic stereochemistry involved in cyclohexane rings. They should be able to interpret energy diagrams and make informed decisions about the relative stability of different conformations. **2. Nucleic Acids:** **Learning Outcome:** ● Identify and describe the components of nucleic acids. ● Understand the role of nucleic acids in biological systems. ● Define and differentiate between nucleosides and nucleotides. ● Understand the structural components of nucleosides and nucleotides. ● Describe the structural features of adenine, guanine, cytosine, uracil, and thymine. ● Understand the nomenclature conventions for nucleic acid bases. ● Analyze the structure of polynucleotides. ● Understand the linkage and arrangement of nucleotides in polynucleotide chains. By the end of this course, students should have a comprehensive understanding of the components of nucleic acids, the structure and nomenclature of individual nucleic acid bases, and the overall structure of polynucleotides. This knowledge is fundamental for understanding the role of nucleic acids in genetic information storage and transmission in living organisms. **3. Amino Acids, Peptides and Proteins:** **Learning Outcome:**

- Classify amino acids and peptides based on their structural and chemical characteristics.
- Describe the synthesis methods of α-amino acids.
- Understand the ionic properties and chemical reactions of α-amino acids.
- Recognize the importance of α-amino acids in protein structure.
- Explain the concept of zwitterions in amino acids.
- Understand the significance of pKa values and isoelectric point in amino acid behavior.
- Explain the use of electrophoresis in studying amino acids and peptides.
- Explore methods for the determination of primary structures of peptides.
- Understand end-group analysis techniques.
- Describe the synthesis of peptides using N-protecting, C-protecting, and C-activating groups.
- Understand the principles of solid-phase peptide synthesis.
- Explain the concept of solid-phase synthesis in peptide chemistry.
- Understand the advantages and applications of solid-phase peptide synthesis.

By the end of this course, students should have a comprehensive understanding of the structure, properties, and synthesis of amino acids, peptides, and proteins. This knowledge is crucial for understanding the molecular basis of biological processes and the role of proteins in living organisms.

4. Heterocyclic Compounds:
Learning outcome:

- Classify heterocyclic compounds based on their structures and properties.
- Understand nomenclature rules specific to heterocyclic compounds.
- Analyze the structural features of 5-numbered and 6-membered heterocyclic rings.
- Understand the concept of aromaticity in heterocyclic compounds.
- Explain the synthesis methods of Furan, Pyrrole, Thiophene, Pyridine, Pyrimidine, Indole, Quinoline, and Isoquinoline.
- Describe the mechanism of substitution reactions in heterocyclic compounds.
- Understand the Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis, and other synthesis methods.
- Explore the reactions and mechanisms involved in the synthesis of heterocyclic compounds.
- Interpret the structural features of indole, quinoline, and isoquinoline.
- Understand the methods used for the structure elucidation of these heterocyclic compounds.
- Describe the Fischer indole synthesis and Madelung synthesis methods.
- Understand the principles behind these synthetic approaches.
- Explain the Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller reaction, Pictet-Spengler reaction, and Pomeranz-Fritsch reaction.
- Understand the mechanisms and applications of these synthesis methods.

By the end of this course, students should have a comprehensive understanding of the classification,

				nomenclature, structures, aromaticity, synthesis, and reactions of heterocyclic compounds, including specific examples such as Furan, Pyrrole, Thiophene, Pyridine, Pyrimidine, Indole, Quinoline, and Isoquinoline. **5. Carbohydrates:** **Learning Outcome:** ● Classify carbohydrates based on their occurrence and structures. ● Understand the biological significance of carbohydrates in living organisms. ● Analyze the constitution and absolute configuration of glucose and fructose. ● Explain the concepts of epimers and anomers in monosaccharides. ● Understand the phenomenon of mutarotation and its implications. ● Determine the ring size of glucose and fructose. ● Represent monosaccharides using Haworth projections. ● Explore the conformational structures of monosaccharides. ● Describe the interconversions of aldoses and ketoses. ● Understand the Killiani-Fischer synthesis and Ruff degradation. ● Elucidate the structures of maltose, lactose, and sucrose. ● Understand the methods used for the structure determination of disaccharides. ● Provide an elementary treatment of starch, cellulose, and glycogen. ● Understand the structures and functions of these polysaccharides. ● Explore the role of polysaccharides in biological systems. By the end of this course, students should have a comprehensive understanding of the occurrence, classification, structures, and biological importance of carbohydrates, including monosaccharides, disaccharides, and polysaccharides.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/501/C-11	PHYSICAL CHEMISTRY – IV (Credits : Theory – 4,	**1. Conductance:** **Learning Outcome:** ● Understand the Arrhenius theory of electrolytic dissociation.

				Practical – 2), SEM-5(CBCS)	● Differentiate between electrical conductivity, equivalent, and molar conductivity. ● Analyze the variation of conductivity with dilution for weak and strong electrolytes. ● Understand the concept of molar conductivity at infinite dilution. ● Explain Kohlrausch's law and its application. ● Understand the Debye-Hückel-Onsager equation. ● Explain the Wien effect, Debye-Falkenhagen effect, and Walden's rules. ● Understand the quantitative aspects of Faraday's laws of electrolysis. ● Define and calculate ionic velocities, mobilities, and transference numbers. ● Apply conductance measurement in various scenarios, such as determining degree of dissociation, ionic product of water, solubility and solubility product, conductometric titrations, and hydrolysis constants of salts. By the end of this course, students should be proficient in understanding the principles of conductance, electrolytic dissociation, and the various applications of conductance measurements in different chemical scenarios. **2. Electrochemistry:** **Learning Outcome:** ● Grasp the rules governing oxidation and reduction in half-cell reactions. ● Understand the practical applications of electrolysis in metallurgy and industry. ● Differentiate between reversible and irreversible cells. ● Define and calculate the electromotive force (EMF) of a cell. ● Apply the Nernst equation to predict cell potentials under non-standard conditions. ● Understand the concept of standard electrode potential. ● Apply standard electrode potentials to different types of half-cells. ● Utilize EMF measurements to determine thermodynamic parameters and equilibrium constants. ● Understand concentration cells, liquid junction potential, and transference numbers. ● Discuss potentiometric titrations and their applications in various chemical analyses. By the end of this course, students should be proficient in understanding the principles of electrochemistry, cell potentials, and the applications of electromotive force measurements in various chemical scenarios. **3. Statistical Thermodynamics :** **Learning Outcome:** ● Develop a conceptual understanding of macrostates and microstates. ● Explore the relationship between probability, thermodynamic probability, and entropy. ● Derive and apply the Boltzmann distribution to describe the statistical behavior of particles.

				- Understand the concept of the partition function and its significance. - Express thermodynamic functions and equilibrium constants in terms of the partition function. - Calculate translational, rotational, and vibrational partition functions for molecular motion. - Explain the Nernst heat theorem and Planck's formulation of the third law of thermodynamics. - Understand the concept of residual entropy and its role in certain systems. - Learn methods for calculating the absolute entropy of molecules. By the end of this course, students should be proficient in applying statistical thermodynamics to describe the behavior of systems, including the distribution of energy and particles at the molecular level. **4. Electrical & Magnetic Properties of Atoms and Molecules:** **Learning outcome:** - Develop a solid understanding of electrostatics and its application to dielectric media. - Grasp the Clausius-Mosotti equation and Lorenz-Laurentz equation and apply them in relevant contexts. - Understand the concepts of dipole moment and molecular polarizabilities and explore their measurement techniques. - Explore the diamagnetic and paramagnetic behavior of atoms and molecules. - Understand the principles of magnetic susceptibility and its experimental determination. - Gain insights into the molecular interpretation of electrical and magnetic properties. By the end of this course, students should be proficient in applying electrostatic and magnetic principles to describe the behavior of atoms and molecules, including their response to electric and magnetic fields.
B.Sc Honours in	2023-24	UG/CHEM/502/C-12	ORGANIC CHEMISTRY –	**1. Pericyclic reactions:** **Learning Outcome:**

Chemistry			V (Credits : Theory – 4, Practical – 2), SEM-5(CBCS)	● Develop a comprehensive understanding of pericyclic reactions. ● Grasp the mechanisms, stereochemistry, and regioselectivity in electrocyclic reactions. ● Apply the FMO approach to analyze 4π- and 6π-electron electrocyclic reactions. ● Understand cycloreversion reactions and the factors influencing them. ● Gain proficiency in the FMO approach for studying cycloaddition reactions, with a focus on Diels-Alder reactions and [2+2] cycloadditions. ● Master the concept of sigmatropic reactions, including sigmatropic shifts and their order, [1,3]- and [1,5]-H shifts, and [3,3]-shifts in Claisen and Cope rearrangements. By the end of this course, students should have a deep understanding of pericyclic reactions, enabling them to analyze and predict the outcomes of various electrocyclic, cycloreversion, cycloaddition, and sigmatropic reactions. **2. Organic Spectroscopy:** **Learning Outcome:** ● Comprehensive Understanding: Develop a comprehensive understanding of UV, IR, and NMR spectroscopy principles. ● Application Skills: Apply Woodward Rules for predicting λmax in various systems. ● Use IR spectroscopy for functional group analysis. ● Interpret NMR spectra, considering chemical shift, spin-spin coupling, and anisotropic effects. ● Analytical Skills: Analyze the impact of molecular factors on spectroscopic data. ● Gain proficiency in identifying functional groups based on spectroscopic information. Upon completion of this course, students should be equipped with the knowledge and skills to analyze and interpret UV, IR, and NMR spectra, making them proficient in the application of spectroscopic techniques in organic chemistry. **3. Dyes:** **Learning Outcome:** ● General Knowledge: Classification of Dyes: Understand the different classes of dyes and their unique characteristics. ● Differentiate between various types of dyes based on their chemical structures. ● Color and Constitution: Chemical Basis of Color: Explore the relationship between the chemical structure of dyes and their color. ● Understand how different chromophores contribute to the color of dyes. ● Dyeing Chemistry: Mordant and Vat Dyes: Comprehend the concepts of mordant and vat dyes. ● Analyze the chemistry involved in the dyeing process. ● Synthesis and Applications: Azo Dyes: Study the synthesis and mechanism of diazo coupling in azo

dyes.

- Examine the applications of azo dyes, with a focus on examples like Methyl Orange and Congo Red.
- Triphenyl Methane Dyes: Explore the synthesis and properties of triphenyl methane dyes.
- Investigate the applications of triphenyl methane dyes, including Malachite Green, Rosaniline, and Crystal Violet.
- Phthalein Dyes: Understand the synthesis and characteristics of phthalein dyes.
- Explore applications, focusing on examples like Phenolphthalein and Fluorescein.
- Natural Dyes: Elucidate the structures of natural dyes. Study the synthesis and applications of natural dyes such as Alizarin and Indigotin.
- Edible Dyes: Gain knowledge about edible dyes used in the food industry. Understand the significance and examples of edible dyes.
- Comprehensive Understanding: Develop a comprehensive understanding of the chemistry and classification of dyes.
- Application Skills: Apply knowledge of dyeing chemistry to understand the processes of mordant and vat dyeing.
- Demonstrate proficiency in synthesizing and understanding the mechanisms of different dye classes.
- Analytical Skills: Analyze the chemical basis of color in dyes. Evaluate the applications and significance of various dyes in different contexts.
- Synthesis and Structure Elucidation: Synthesize selected dyes and interpret their chemical structures. Elucidate the structures of natural dyes through analytical techniques.

Upon completion of this course, students should possess a solid foundation in dye chemistry, enabling them to understand the coloration process, synthesize dyes, and appreciate their applications in various industries.

4. Pharmaceutical Compounds: Structure and Importance:
Learning Outcome:

- Classification and Structure: Antipyretics: Paracetamol: Understand the classification of antipyretics.
- Examine the chemical structure of Paracetamol.
- Explore the synthesis process of Paracetamol.
- Analgesics: Ibuprofen: Learn the classification of analgesics.
- Analyze the chemical structure of Ibuprofen.
- Study the synthesis process of Ibuprofen.
- Antimalarials: Chloroquine: Explore the classification of antimalarials. Investigate the chemical structure of Chloroquine.
- Understand the synthesis process of Chloroquine.
- Antibiotics and Medicinal Values: Antibiotics: Chloramphenicol: Gain an elementary understanding of antibiotics.
- Conduct a detailed study of Chloramphenicol, including its structure, mechanism, and applications.

				● Medicinal Values: Curcumin (Haldi): Explore the medicinal values and applications of Curcumin (found in turmeric). ● Azadirachtin (Neem): Understand the medicinal properties and applications of Azadirachtin (found in neem). ● Vitamin C: Study the medicinal importance of Vitamin C. ● Antacid: Ranitidine: Examine the medicinal applications and structure of Ranitidine (an antacid). ● Overall Learning Outcome: Pharmaceutical Classification: Develop a strong understanding of the classification of pharmaceutical compounds. ● Chemical Structures: Analyze the chemical structures of various pharmaceutical compounds. ● Synthesis Processes: Understand the synthesis processes involved in the production of pharmaceutical compounds. ● Mechanisms and Applications: Gain insights into the mechanisms of action and therapeutic applications of pharmaceutical compounds. ● Medicinal Values: Appreciate the medicinal values and importance of pharmaceutical compounds such as Curcumin, Azadirachtin, Vitamin C, and Ranitidine. Upon completion of this course, students should possess a comprehensive knowledge of the classification, structure, synthesis, and medicinal importance of various pharmaceutical compounds. This knowledge is crucial for understanding their therapeutic applications in the field of medicine.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/601/C-13	INORGANIC CHEMISTRY – IV (Credits : Theory – 4, Practical – 2), SEM-6(CBCS)	**1. Organometallic Compounds:** **Learning outcome:** ● Definition and Classification: Understand the definition of organometallic compounds. Classify organometallic compounds based on bond type. ● Hapticity of Organic Ligands: Conceptualize the hapticity of organic ligands in organometallic compounds. ● Metal Carbonyls: Comprehend the 18-electron rule in metal carbonyls. Determine the electron count of mononuclear, polynuclear, and substituted metal carbonyls of the 3d series. Explore general methods of preparation for mono and binuclear carbonyls of the 3d series. ● Analyze the structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co, and Ni using Valence Bond Theory (VBT). Understand the -acceptor behavior of CO, including the MO diagram of CO. Discuss the synergic effect and use IR data to explain the extent of back bonding. ● Zeise's Salt: Explore the preparation and structure of Zeise's salt. Provide evidence for the synergic effect and compare it with that in carbonyls. ● Metal Alkyls: Identify important structural features of methyl lithium (tetramer) and trialkyl aluminum (dimer). Understand the concept of multicenter bonding in these compounds. Investigate the role of triethylaluminum in the polymerization of ethene (Ziegler–Natta Catalyst). Examine the species present in the ether solution of Grignard reagent and their structures. Discuss the Schlenk equilibrium. ● Ferrocene: Learn the preparation and reactions of ferrocene, including acetylation, alkylation,

metallation, and Mannich Condensation. Understand the structure and aromaticity of ferrocene. Compare the aromaticity and reactivity of ferrocene with that of benzene.

- Learning Outcome:Upon completion of this section, students should have a comprehensive understanding of organometallic compounds, including their classification, hapticity, metal carbonyls, Zeise's salt, metal alkyls, and the specific case of ferrocene. Students will be equipped to analyze the structures, reactions, and applications of these compounds in various contexts.

2. Reaction Kinetics and Mechanism:
Learning outcome:

- Introduction to Inorganic Reaction Mechanisms: Gain an understanding of the fundamental principles of inorganic reaction mechanisms.
- Substitution Reactions in Square Planar Complexes: Explore substitution reactions in square planar complexes.
- Understand the concept of the Trans-effect in square planar complexes.
- Theories of Trans Effect: Learn about different theories explaining the Trans-effect phenomenon.
- Mechanism of Nucleophilic Substitution in Square Planar Complexes: Understand the detailed mechanism of nucleophilic substitution in square planar complexes.
- Thermodynamic and Kinetic Stability: Differentiate between thermodynamic and kinetic stability in the context of inorganic reactions.
- Kinetics of Octahedral Substitution: Explore the kinetics of substitution reactions in octahedral complexes.
- Ligand Field Effects and Reaction Rates: Understand how ligand field effects influence reaction rates in coordination compounds.
- Mechanism of Substitution in Octahedral Complexes: Gain insights into the detailed mechanism of substitution reactions in octahedral complexes.
- Learning Outcome: Upon completion of this section, students should have a solid understanding of inorganic reaction mechanisms, with a focus on substitution reactions in square planar and octahedral complexes. They will be familiar with concepts such as the Trans-effect, thermodynamic and kinetic stability, and ligand field effects that influence the reaction rates in coordination compounds. Students will be equipped to analyze and interpret the mechanisms of substitution reactions in different coordination geometries.

3. Catalysis by Organometallic Compounds:
Learning outcome:

- Alkene Hydrogenation (Wilkinson's Catalyst): Explore the mechanism of alkene hydrogenation using Wilkinson's Catalyst. Understand the role of organometallic compounds in catalyzing this industrial process.
- Hydroformylation (Co Salts): Study the industrial process of hydroformylation catalyzed by cobalt

				salts. Gain insights into the mechanism of hydroformylation and the role of organometallic compounds. ● Wacker Process: Examine the Wacker process for the oxidation of ethylene to acetaldehyde. Understand the catalytic role of organometallic compounds in this process. ● Synthetic Gasoline (Fischer Tropsch Reaction): Explore the Fischer-Tropsch reaction for the synthesis of gasoline. Learn about the catalytic role of organometallic compounds in the conversion of synthesis gas to hydrocarbons. ● Synthesis Gas by Metal Carbonyl Complexes: Understand the generation of synthesis gas using metal carbonyl complexes. Explore the catalytic aspects of organometallic compounds in the production of synthesis gas. ● Learning Outcome: Upon completion of this section, students should have a comprehensive understanding of the catalytic processes involving organometallic compounds in industrial settings. They will be able to analyze the mechanisms of alkene hydrogenation, hydroformylation, the Wacker process, Fischer-Tropsch reaction, and the generation of synthesis gas. Students will also appreciate the importance of organometallic catalysis in these key industrial reactions.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/602/C-14	PHYSICAL CHEMISTRY – V (Credits : Theory – 4, Practical – 2), SEM-6(CBCS)	**1. Quantum Chemistry:** **Learning Outcome:** ● Fundamental Concepts: Understand the concept of black body radiation and Planck's quantum theory. Explore the phenomena of photoelectric effect and Compton effect. ● Grasp the wave-particle duality and de-Broglie hypothesis. ● Quantum Mechanics Postulates: Familiarize with elementary concepts of operators, eigenfunctions, and eigenvalues. Understand linear and Hermitian operators. Comprehend the postulates of quantum mechanics. ● Schrödinger Equation: Learn the Schrödinger equation and its application to a free particle. ● Explore the "particle-in-a-box" model with a rigorous treatment. Understand the quantization of energy levels, zero-point energy, and Heisenberg Uncertainty principle. ● Vibrational Motion: Qualitatively treat the simple harmonic oscillator model of vibrational motion. ● Discuss the setup of Schrödinger equation and the solution for vibrational motion. ● Understand vibrational energy of diatomic molecules and zero-point energy. ● Angular Momentum and Rotational Motion: ● Understand commutation rules for angular momentum. ● Quantization of the square of total angular momentum and its components. ● Explore the rigid rotator model for the rotation of diatomic molecules.

- Hydrogen Atom and Many-Electron Atoms: Qualitatively treat the hydrogen atom and hydrogen-like ions.
- Explore the Schrödinger equation for many-electron atoms (He, Li).
- Recognize the need for approximation methods and discuss the variation theorem.

Upon completion of this section, students should have a solid understanding of the foundational concepts of quantum chemistry, including the postulates of quantum mechanics, the Schrödinger equation, and its applications to various physical systems such as vibrational and rotational motion, hydrogen atom, and many-electron atoms. They should also be able to grasp the key principles behind quantization, operators, and eigenfunctions in quantum mechanics.

2. Molecular Spectroscopy:
Learning Outcome:

- Basics of Molecular Spectroscopy: Understand the interaction of electromagnetic radiation with molecules. Explore various types of spectra and the Born-Oppenheimer approximation.
- Rotational Spectroscopy: Grasp selection rules and intensities of spectral lines in rotational spectroscopy. Determine bond lengths of diatomic molecules and understand the impact of isotopic substitution.
- Vibrational Spectroscopy: Derive the classical equation of vibration. Compute force constants, amplitude, and anharmonicity in diatomic molecular vibrations.
- Understand Morse potential, dissociation energies, and fundamental frequencies. Explore polyatomic molecules, modes of vibration, and group frequencies.
- Vibration-Rotation Spectroscopy and Raman Spectroscopy: Understand diatomic vibrating rotator and the P, Q, R branches.
- Qualitatively treat Rotational Raman effect and vibrational Raman spectra. Recognize Stokes and anti-Stokes lines and their intensity difference.
- Electronic Spectroscopy: Grasp the Franck-Condon principle and electronic transitions. Understand singlet and triplet states, fluorescence, phosphorescence, dissociation, and predissociation. Perform calculations of electronic transitions using the free electron model.
- Nuclear Magnetic Resonance (NMR) and Electron Spin Resonance (ESR) Spectroscopy: Understand the principles of NMR and ESR spectroscopy. Interpret low and high-resolution spectra in NMR, considering chemical shift and spin-spin coupling. Explore the principles and hyperfine structure in ESR spectroscopy.

Upon completion of this section, students should have a comprehensive understanding of molecular spectroscopy, covering rotational, vibrational, electronic, and magnetic resonance spectroscopy. They should be able to interpret spectra, determine molecular properties, and apply these techniques to analyze various types of molecules.

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<td>3. Photochemistry:
Learning Outcome:

● Characteristics of Electromagnetic Radiation: Understand the properties and characteristics of electromagnetic radiation. Explore the electromagnetic spectrum and the significance of different regions.
● Lambert-Beer's Law: Comprehend Lambert-Beer's law and its application in the context of photochemistry. Recognize the limitations of Lambert-Beer's law.
● Absorption Coefficients: Understand the physical significance of absorption coefficients in the context of photochemical processes.
● Laws of Photochemistry: Learn the fundamental laws governing photochemical reactions. Explore the quantum yield and actinometry in the context of photochemistry.
● Photochemical Reactions: Understand the differential rate of photochemical reactions. Explore examples of both low and high quantum yields in photochemical reactions.
● Photochemical Equilibrium: Grasp the concept of photochemical equilibrium. Understand the factors influencing the establishment of photostationary states.
● Photosensitized Reactions and Quenching: Learn about photosensitized reactions and their mechanisms. Understand the concept of quenching in the context of photochemistry.
● Role in Biochemical Processes: Explore the role of photochemical reactions in biochemical processes. Understand the impact of light-induced processes in biological systems.
● Chemiluminescence: Grasp the concept and characteristics of chemiluminescence. Learn about examples and applications of chemiluminescent reactions.

Upon completion of this section, students should have a solid understanding of the principles of photochemistry, including laws, quantum yields, and the role of electromagnetic radiation in chemical processes. They should be able to analyze and interpret photochemical reactions and understand their significance in various applications, including biochemical processes.</td>
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<td>B.Sc
Honours in</td>
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<td>1. Optical methods of analysis:
Learning Outcome:</td>
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Chemistry			ANALYTICAL METHODS IN CHEMISTRY (Credits: Theory-04, Practical-02)	● Origin of Spectra: Understand the origin of spectra in the context of optical methods of analysis. Explore the interaction of radiation with matter leading to the generation of spectra. ● Fundamental Laws of Spectroscopy: Learn the fundamental laws governing spectroscopy and their significance. Explore selection rules and their application in different spectroscopic techniques. ● Validity of Beer-Lambert's Law: Comprehend the principles and conditions under which Beer-Lambert's law is valid. Understand the limitations and factors affecting the validity of Beer-Lambert's law. ● UV-Visible Spectrometry: Grasp the basic principles of instrumentation for UV-Visible spectrometry. Understand the components of a single and double-beam instrument. ● Quantitative Analysis: Learn the basic principles of quantitative analysis using UV-Visible spectrometry. Practice the estimation of metal ions, geometrical isomers, and keto-enol tautomers. ● Infrared Spectrometry: Understand the basic principles of instrumentation for Infrared spectrometry. Explore sampling techniques and the interpretation of structural data. ● Structural Illustration: Interpret structural features through the analysis of Infrared spectra. Recognize the effects and importance of isotope substitution in Infrared spectrometry. ● Flame Atomic Absorption and Emission Spectrometry: Learn the basic principles of instrumentation for flame atomic absorption and emission spectrometry. Understand techniques for quantitative estimation of trace levels of metal ions in water samples. ● Background Correction and Chemical Interferences: Understand methods of background correction in flame atomic absorption and emission spectrometry. Recognize sources of chemical interferences and strategies for their removal. Upon completion of this section, students should have a solid understanding of optical methods of analysis, including UV-Visible spectrometry, Infrared spectrometry, and flame atomic absorption/emission spectrometry. They should be able to **2. Thermal methods of analysis:** **Learning Outcome:** ● Theory of Thermogravimetry (TG): Understand the theoretical basis of thermogravimetry (TG) and its applications. Explore the principles underlying the measurement of mass changes with temperature. ● Basic Principle of Instrumentation: Learn the basic principles of the instrumentation used in thermogravimetry. Understand the components of a thermogravimetric analysis (TGA) instrument. ● Techniques for Quantitative Estimation: Acquire skills in using thermogravimetric techniques for quantitative estimation. Explore specific techniques for the quantitative estimation of calcium (Ca) and magnesium (Mg). ● Quantitative Estimation of Ca and Mg from Their Mixture: Learn step-by-step procedures for the quantitative estimation of Ca and Mg from a mixture. Understand the applications and limitations of thermogravimetric analysis in quantitative determinations.

				Upon completing this section, students should have a comprehensive understanding of the theory behind thermogravimetry, the basic principles of instrumentation, and the practical techniques for quantitative estimation. They should be able to apply these methods to analyze mixtures containing calcium and magnesium, gaining valuable skills in thermal methods of analysis. **3. Electroanalytical methods:** **Learning Outcome:** ● Classification of Electroanalytical Methods: Understand the various electroanalytical methods and their classifications. Explore the applications and significance of electroanalytical techniques in analytical chemistry. ● Basic Principles of pH Metric, Potentiometric, and Conductometric Titrations: Gain insights into the basic principles underlying pH metric titrations. Explore the principles of potentiometric titrations and understand their applications. Understand the basics of conductometric titrations and their relevance in analytical chemistry. ● Techniques for the Determination of Equivalence Points: Learn the techniques employed to determine equivalence points in electroanalytical methods. Understand the importance of accurate determination of equivalence points for precise analysis. ● Techniques for the Determination of pKa Values: Explore the methods used for the determination of pKa values in electroanalytical chemistry. Understand the significance of pKa values in the characterization of acidic or basic substances. Upon completing this section, students should have a solid understanding of the classification of electroanalytical methods. They should be familiar with the basic principles of pH metric, potentiometric, and conductometric titrations, as well as techniques for determining equivalence points and pKa values. This knowledge equips them with essential skills for conducting electroanalytical analyses in various contexts. **4. Separation techniques:** **Learning Outcome:** ● Solvent Extraction: Classification, Principle, and Efficiency: Understand the different types of solvent extraction techniques. Grasp the fundamental principles underlying solvent extraction and its efficiency. ● Mechanism of Extraction: Explore the mechanisms involving solvation and chelation in solvent extraction. ● Techniques of Extraction: Gain knowledge about batch, continuous, and counter-current extraction methods. Qualitative and Quantitative Aspects of Solvent Extraction: ● Metal Ion Extraction: Understand the qualitative and quantitative aspects of extracting metal ions from aqueous solutions.

				● Extraction of Organic Species: Explore the solvent extraction techniques for organic species from aqueous and non-aqueous media. ● Chromatography: Classification, Principle, and Efficiency: Understand the classification of chromatographic techniques and their efficiency. ● Mechanism of Separation: Explore the separation mechanisms involving adsorption, partition, and ion exchange. ● Development of Chromatograms: Learn about frontal, elution, and displacement methods for developing chromatograms. ● Qualitative and Quantitative Aspects of Chromatographic Methods: Various Chromatographic Techniques: Understand qualitative and quantitative aspects of chromatographic methods such as IC, GLC, GPC, TLC, and HPLC. ● Stereoisomeric Separation and Analysis: Explore methods for stereochemical analysis, including measurement of optical rotation and determination of enantiomeric composition. Understand the role of computers in instrumental methods of analysis. Upon completing this section, students should have a comprehensive understanding of solvent extraction and chromatography. They should be able to apply these separation techniques qualitatively and quantitatively for the extraction of metal ions and organic species. Additionally, students should comprehend the stereoisomeric separation and analysis methods, as well as the role of computers in instrumental analysis.
B.Sc Honours in Chemistry	2023-24	UG/CHEM/DSE2	CHEMISTRY-DSE: INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE (Credits: Theory-04, Practicals-02)	**1. Silicate Industries:** **Learning Outcome**: ● Glass: Glassy State and Properties: Understand the characteristics of the glassy state and its unique properties. Classification of Glasses: Differentiate between silicate and non-silicate glasses. ● Manufacture and Processing: Explore the methods involved in the manufacturing and processing of glass. ● Composition and Properties of Various Glasses: Examine the composition and properties of different types of glasses, including: Soda lime glass, Lead glass, Armoured glass, Safety glass, Borosilicate glass, Fluorosilicate glass, Coloured glass, Photosensitive glass ● Ceramics: Important Clays and Feldspar: Identify significant clays and feldspar used in ceramics. Types and Manufacture of Ceramics: Explore the various types of ceramics and the processes involved

				in their manufacture. ● High Technology Ceramics: Understand the applications of high technology ceramics. Superconducting and Semiconducting Oxides: Explore oxides with superconducting and semiconducting properties. Fullerenes, Carbon Nanotubes, and Carbon Fibre: Learn about the applications and properties of fullerenes, carbon nanotubes, and carbon fibre. ● Cements: Classification of Cement: Understand the classification of cements based on their properties. Ingredients and Their Role: Identify the ingredients used in cement and their respective roles. Manufacture and Setting Process: Learn about the manufacturing process of cement and the mechanisms involved in the setting process. Quick Setting Cements: Explore the characteristics and applications of quick-setting cements. Upon completion of this section, students should have a comprehensive understanding of the glass, ceramics, and cement industries. They should be able to differentiate between various types of glasses, ceramics, and cements, and comprehend the manufacturing processes involved. Additionally, students should understand the properties and applications of high-technology ceramics and advanced carbon materials. **2. Fertilizers:** **Learning Outcome:** ● Types of Fertilizers: Overview of Fertilizers: Understand the role of fertilizers in enhancing soil fertility. Classification of Fertilizers: Differentiate between various types of fertilizers based on their composition and nutrients. ● Fertilizer Manufacture: Urea: Learn the manufacturing process of urea. Ammonium Nitrate: Understand the production method for ammonium nitrate. Calcium Ammonium Nitrate: Explore the manufacturing process of calcium ammonium nitrate. Ammonium Phosphates: Examine the methods involved in producing ammonium phosphates. ● Polyphosphate and Superphosphate: Understand the manufacturing processes for polyphosphate and superphosphate fertilizers. ● Compound and Mixed Fertilizers: Explore the methods used in the production of compound and mixed fertilizers. ● Potassium Chloride: Learn about the manufacturing process of potassium chloride. ● Potassium Sulphate: Understand the production method for potassium sulphate. Upon completion of this section, students should be able to recognize and classify various types of fertilizers. They should also have a comprehensive understanding of the manufacturing processes involved in producing specific fertilizers such as urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, and potassium sulphate. This knowledge will enable students to appreciate the role of fertilizers in modern agriculture.

				3. Surface Coatings: **Learning outcome:** ● Objectives of Coating Surfaces: Understanding Coating Objectives: Comprehend the primary objectives of coating surfaces. Preliminary Treatment: Explore the methods and processes involved in the preliminary treatment of surfaces. ● Classification of Surface Coatings: Types of Surface Coatings: Learn about the classification of surface coatings based on different criteria. ● Paints and Pigments: Formulation of Paints: Understand the components and formulation of paints. ● Composition and Properties: Explore the composition and related properties of paints. ● Oil Paint: Examine the characteristics of oil paint. ● Vehicle: Learn about the role and types of vehicles in paint formulations. ● Modified Oils: Understand the modification processes of oils used in paints. ● Pigments, Toners, and Lakes: Explore the significance and properties of pigments, toners, and lakes. ● Fillers: Understand the role of fillers in paint formulations. ● Thinners: Learn about the use of thinners in paint applications. ● Enamels: Examine the composition and characteristics of enamel paints. ● Emulsifying Agents: Understand the role of emulsifying agents in paint formulations. ● Special Paints: Explore specific types of paints, including heat retardant, fire retardant, eco-friendly, and plastic paints. ● Dyes: Learn about the use of dyes in surface coatings. ● Wax Polishing: Understand the process and benefits of wax polishing. ● Water and Oil Paints: Differentiate between water-based and oil-based paints. ● Additives: Explore the various additives used in paint formulations. ● Metallic Coatings: Electrolytic and Electroless Coatings: Understand the processes involved in electrolytic and electroless metallic coatings. ● Metal Spraying: Explore the technique of metal spraying. ● Anodizing: Learn about the anodizing process. Upon completion of this section, students should have a comprehensive understanding of the objectives of coating surfaces, the preliminary treatment of surfaces, the classification of surface coatings, and the formulation and properties of paints and pigments. Additionally, students should be familiar with the various types of paints, additives, and metallic coatings, including electrolytic and electroless coatings, metal spraying, and anodizing. This knowledge will equip students to make informed decisions in selecting and applying coatings in different scenarios. **4. Batteries:** **Learning Outcome:**

- Primary and Secondary Batteries: Definition: Understand the distinctions between primary and secondary batteries. Characteristics: Explore the unique characteristics of primary and secondary batteries.
- Battery Components and Their Role: Anode, Cathode, and Electrolyte: Understand the roles of anode, cathode, and electrolyte in a battery.
- Separator: Learn about the function of the separator in battery design.
- Characteristics of Batteries Voltage, Capacity, and Energy Density: Explore the characteristics such as voltage, capacity, and energy density in batteries.
- Cycle Life: Understand the concept of cycle life in battery performance.
- Working of Batteries.
- Pb Acid Battery: Learn about the working principles and applications of lead-acid batteries.
- Li-Battery: Understand the working mechanism and applications of lithium-ion batteries.
- Solid State Electrolyte Battery: Explore the working principles of batteries with solid-state electrolytes.
- Fuel Cells: Definition and Types: Understand the concept of fuel cells and explore different types. Working Principles: Learn about the working principles of fuel cells.
- Solar Cells: Photovoltaic Conversion: Understand the conversion of solar energy into electrical energy. Types and Applications: Explore different types of solar cells and their applications.
- Polymer Cells: Definition and Composition: Understand the characteristics and composition of polymer cells. Working Mechanism: Explore the working mechanism of polymer cells.

Upon completion of this section, students should have a comprehensive understanding of primary and secondary batteries, the roles of battery components, characteristics of batteries, and the working principles of specific batteries such as lead-acid, lithium-ion, and solid-state electrolyte batteries. Additionally, students should be familiar with fuel cells, solar cells, and polymer cells, including their definitions, types, and working mechanisms. This knowledge will enable students to comprehend the applications and functionalities of various energy storage and conversion technologies.

5. Alloys:
Learning Outcome:

- Classification of Alloys: Definition: Understand what alloys are and how they differ from pure metals. Classification: Explore the various ways alloys can be classified, such as by composition or structure.
- Ferrous and Non-Ferrous Alloys: Ferrous Alloys: Learn about alloys that primarily contain iron and their significance. Non-Ferrous Alloys: Explore alloys that do not contain iron as a major component.
- Specific Properties of Elements in Alloys: Elemental Contributions: Understand how specific elements contribute to the properties of alloys. Effects on Properties: Explore the impact of alloying elements on properties such as strength, hardness, and corrosion resistance.
- Manufacture of Steel: Decarbonization: Learn the process of removing excess carbon from steel.

Demanganization, Desulphurization, Dephosphorisation: Understand processes to reduce impurities in steel.

- Surface Treatment: Explore surface treatment methods like argon treatment, heat treatment, nitriding, and carburizing.
- Composition and Properties of Different Types of Steels
- Carbon Steels: Explore the composition and properties of carbon steels.
- Alloy Steels: Understand the characteristics of alloy steels, including specific alloying elements.
- Stainless Steels: Learn about the composition and properties of stainless steels.

Upon completing this section, students should have a comprehensive understanding of alloys, their classification, and the specific properties imparted by different elements in alloys. They should be familiar with the manufacture of steel, including processes such as decarbonization, demanganization, desulphurization, and dephosphorisation. Additionally, students should gain knowledge about surface treatment methods and the composition and properties of various types of steels, including carbon steels, alloy steels, and stainless steels. This knowledge will equip students with insights into the diverse world of alloys and their applications.

6. Catalysis:
Learning outcome:

- General Principles and Properties of Catalysts: Definition: Understand the role of catalysts in chemical reactions. Properties: Explore the key characteristics and requirements for a substance to act as a catalyst.
- Homogeneous Catalysis: Catalytic Steps: Learn about the steps involved in homogeneous catalysis. Examples: Explore specific examples of homogeneous catalysis in various chemical reactions.
- Heterogeneous Catalysis: Catalytic Steps: Understand the mechanism and steps involved in heterogeneous catalysis. Examples: Explore instances of heterogeneous catalysis in different industrial processes.
- Industrial Applications: Homogeneous Catalysis in Industry: Examine how homogeneous catalysis is applied in industrial processes. Heterogeneous Catalysis in Industry: Explore the industrial applications of heterogeneous catalysis.
- Deactivation or Regeneration of Catalysts: Deactivation Mechanisms: Understand the factors leading to the deactivation of catalysts. Regeneration Techniques: Learn methods employed to regenerate catalysts for extended use.

				• Phase Transfer Catalysts: Definition and Applications: Understand the concept of phase transfer catalysts and their applications. • Application of Zeolites as Catalysts: Properties of Zeolites: Explore the unique properties of zeolites. Catalytic Applications: Understand how zeolites are used as catalysts in various reactions. Upon completing this section, students should have a solid understanding of catalysis, encompassing both homogeneous and heterogeneous catalytic processes. They should be familiar with the general principles and properties of catalysts, as well as their applications in industrial settings. Students should also grasp the mechanisms of catalyst deactivation and the techniques for catalyst regeneration. Additionally, they should comprehend the role of phase transfer catalysts and the application of zeolites as catalysts in various chemical reactions. This knowledge will enable students to appreciate the importance of catalysis

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