MATHABHANGA COLLEGE
DEPARTMENT OF CHEMISTRY
COURSES OUTCOME

Program	Year	Paper(Code)	Course Name	Outcome
B.Sc program in Chemistry	2023-24	UG/CHEM/DSC 1A	CHEMISTRY-DSC 1A: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS (Credits: Theory-04, Practical-02) SEM-1(CBCS Curriculum)	**1. Inorganic Chemistry-1** **Atomic Structure:** **Learning Outcome** ● Review of Bohr's Theory and Its Limitations: Bohr's Model: Recapitulate the key features of Bohr's atomic model. Limitations: Understand the shortcomings and limitations of Bohr's model. ● Dual Behaviour of Matter and Radiation: Wave-Particle Duality: Explore the concept of dual behavior exhibited by matter and radiation. ● de Broglie's Relation: Wave Nature of Particles:Understand de Broglie's relation and its implications for particles. ● Heisenberg Uncertainty Principle: Principle Explanation: Comprehend the Heisenberg Uncertainty Principle and its significance. ● Hydrogen Atom Spectra: Emission Spectra: Review the spectra observed in hydrogen atoms. ● Need for a New Approach to Atomic Structure: Limitations of Previous Models: Understand why a new approach was needed for atomic structure. ● Quantum Mechanics: Introduction: Define quantum mechanics and its importance in atomic theory. ● Time Independent Schrödinger Equation: Equation Components: Understand the terms and components of the Schrödinger equation. Significance of ψ_1 and ψ_2: Explore the meaning and significance of the wavefunction. ● Schrödinger Equation for Hydrogen Atom: Application to Hydrogen Atom: Apply the Schrödinger equation to describe the hydrogen atom. ● Radial and Angular Parts of Hydogenic Wavefunctions. Atomic Orbitals: Define atomic orbitals and their components. Graphical Representation: Visually represent the variations in wavefunctions for different orbitals. ● Radial and Angular Nodes: Significance: Understand the significance of radial and angular nodes. ● Radial Distribution Functions: Concept and Application: Explore radial distribution functions and the concept of the most probable distance. ● Quantum Numbers and Orbital Angular Momentum: Quantum Number Significance: Understand the role and significance of quantum numbers. Discuss orbital angular momentum and its quantum numbers ml and ms. ● Shapes of Atomic Orbitals: s, p, d Orbitals: Define and visualize the shapes of s, p, and d atomic orbitals. Explore nodal planes. Discovery of Spin and Electronic Configurations Spin Quantum Number: Introduce the discovery of spin and its quantum number (s). Discuss rules for filling electrons in various orbitals. ● Electronic Configurations and Stability Configurations:

				Detail electronic configurations of atoms. Explore the stability of half-filled and completely filled orbitals. Discuss the concept of exchange energy. ● Relative Energies of Atomic Orbitals: Comparisons: Understand the relative energies of different atomic orbitals. ● Anomalous Electronic Configurations. Special Cases: Explore instances of anomalous electronic configurations. Upon completing this section, students should have a comprehensive understanding of atomic structure, encompassing the historical models, wave-particle duality, quantum mechanics, and the application of the Schrödinger equation to describe the hydrogen atom. They should be familiar with the shapes of different atomic orbitals, quantum numbers, and electronic configurations, including anomalous cases. This knowledge will provide a solid foundation for further studies in quantum chemistry and atomic theory. **2. Ionic Bonding:** **Learning Outcomes:** ● General Characteristics of Ionic Bonding: Define and discuss the fundamental features of ionic bonding. Energy Considerations in Ionic Bonding. Explore the energy aspects associated with ionic bonding. Discuss lattice energy and solvation energy. ● Born-Landé Equation: State the Born-Landé equation and its significance. Explain its use in calculating lattice energy. ● Born-Haber Cycle: Describe the Born-Haber cycle and its applications. Polarizing Power and Polarizability. ● Define polarizing power and polarizability in the context of ionic compounds.Fajan's Rules. Understand Fajan's rules and their application. Explore the ionic character in covalent compounds. Bond Moment, Dipole Moment, and Percentage Ionic Character ● Define and discuss bond moment, dipole moment, and the concept of percentage ionic character. ● Covalent Bonding: VB Approach: Discuss the Valence Bond (VB) approach. Explore the shapes of inorganic molecules using VSEPR and hybridization. Provide examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal, and octahedral arrangements. Concept of Resonance Define resonance and discuss resonating structures in various inorganic and organic compounds. ● MO Approach: Explain the Molecular Orbital (MO) approach. Discuss rules for the Linear Combination of Atomic Orbitals (LCAO) method. Explore bonding and antibonding MOs and their characteristics. Provide examples of s-s, s-p, and p-p combinations of atomic orbitals. Discuss nonbonding combinations of orbitals. ● MO Treatment of Diatomic Molecules: Apply MO theory to homonuclear diatomic molecules of the 1st and 2nd periods. Include the idea of s-p mixing. Discuss MO treatment for heteronuclear diatomic molecules such as CO, NO, and NO+. Comparison of VB and MO Approaches. Contrast the Valence Bond and Molecular Orbital approaches.

				Upon completion of this section, students should have a thorough understanding of ionic bonding, including energy considerations and Fajan's rules. They should be familiar with the Valence Bond and Molecular Orbital approaches, understanding shapes based on VSEPR and hybridization, and the concept of resonance in various compounds. The comparison between VB and MO approaches should provide insights into the different perspectives on chemical bonding. This knowledge lays the groundwork for an in-depth understanding of molecular structure and bonding in diverse compounds.**Organic Chemistry-1** **3. Fundamentals of Organic Chemistry** **Learning Outcome:** ● Physical Effects, Electronic Displacements: Inductive Effect: Define and explain the inductive effect. Discuss how inductive effects influence electron distribution in molecules. Electromeric Effect ● Define and discuss the electromeric effect. Illustrate examples of molecules influenced by the electromeric effect. ● Resonance: Explain the concept of resonance in organic molecules. Discuss the significance of resonance structures in stabilizing molecules. ● Hyperconjugation: Define hyperconjugation and its role in stabilizing molecules. Provide examples illustrating the impact of hyperconjugation. ● Cleavage of Bonds: Homolysis and Heterolysis: Define and differentiate between homolysis and heterolysis. Explain the outcomes and implications of each type of bond cleavage. ● Structure, Shape, and Reactivity of Organic Molecules: Nucleophiles and Electrophiles. Define nucleophiles and electrophiles. Discuss their role in organic reactions. ● Reactive Intermediates: Carbocations, Carbanions, and Free Radicals. ● Define and discuss carbocations, carbanions, and free radicals. Explore their stability and reactivity. Strength of Organic Acids and Bases Comparative Study of pK Values Discuss the concept of pK values for organic acids and bases. Compare the strengths of various organic acids and bases. Emphasize factors influencing pK values. ● Aromaticity: Benzenoids and Hückel's Rule. Define benzenoids and discuss their characteristics. Explain Hückel's rule and its application to aromatic compounds. Upon completing this section, students should have a clear understanding of the inductive effect, electromeric effect, resonance, and hyperconjugation. They should be able to differentiate between homolysis and heterolysis and comprehend the role of nucleophiles and electrophiles in organic reactions. Knowledge of reactive intermediates like carbocations, carbanions, and free radicals, along with a comparative study of organic acids and bases, will enhance their understanding of organic chemistry **4. Stereochemistry** **Learning Outcome**: ● Ethane, Butane, and Cyclohexane: Explore the different conformations of ethane, butane, and

cyclohexane. Discuss the energy changes associated with these conformations.

- Interconversion of Representations: Demonstrate the interconversion of representations: Wedge Formula, Newman Projection, Sawhorse Projection, and Fischer Projection. Highlight the advantages and limitations of each representation.
- Chirality: Concept of Chirality, Define chirality and discuss its significance in stereochemistry. Explore chirality in molecules with up to two carbon atoms.
- Configuration: Geometrical and Optical Isomerism, Differentiate between geometrical and optical isomerism. Explain the conditions leading to the formation of each type of isomer.
- Enantiomerism, Diastereomerism, and Meso Compounds. Define and provide examples of enantiomers, diastereomers, and meso compounds. Discuss their stereoisomeric relationships.
- Threo and Erythro: Define and differentiate between threo and erythro isomers. Provide examples illustrating threo and erythro configurations.
- D and L Configuration: Explain the D and L configurations in the context of optical activity. Discuss their application to simple sugars.
- Cis-Trans Nomenclature: Introduce cis-trans nomenclature for stereoisomers. Apply cis-trans nomenclature to molecules with multiple double bonds.
- CIP Rules and E/Z Nomenclature: CIP Rules: R/S Configuration. Explain the Cahn-Ingold-Prelog (CIP) rules for assigning R/S configuration. Apply the rules to molecules with up to two chiral carbon atoms.
- E/Z Nomenclature: Define E/Z nomenclature for molecules with double bonds. Apply E/Z nomenclature to molecules with up to two C=C systems.

Learning Outcome

Students should gain a comprehensive understanding of different conformations in ethane, butane, and cyclohexane. They should be proficient in interconverting representations and applying the concepts of chirality, including D/L configuration and cis-trans nomenclature. Additionally, students should master the application of CIP rules for R/S configuration and E/Z nomenclature in molecules with chiral centers and double bonds.

5. Aliphatic Hydrocarbons:
Learning Outcome:

- Alkanes: Preparation: Halogenation of Alkanes: Understand the free radical mechanism. Discuss the selectivity of hydrogen abstraction. Reactions. Combustion. Analyze the complete combustion of alkanes. Understand the products formed.
- Alkenes: Preparation. Dehydration of Alcohols. Explore the mechanism of dehydration. Discuss the conditions required for the reaction. Reactions. Hydrogenation. Explore the addition of hydrogen to alkenes. Understand the catalysts used.Halogenation and Hydrohalogenation. Discuss the anti-addition mechanism. Understand the regioselectivity in halogenation.
- Alkynes: Preparation. Elimination Reactions. Explore the elimination of halides to form alkynes. Understand the E2 mechanism.Reactions. Hydrogenation. Contrast hydrogenation of alkenes and

				alkynes. Discuss the syn addition of hydrogen. Halogenation and Hydrohalogenation. Understand the addition reactions. Explore the formation of halohydrins. Learning Outcome Students should gain a profound understanding of the functional group approach to the preparation and reactions of aliphatic hydrocarbons. This includes comprehending reaction mechanisms, stereochemistry, and the influence of reaction conditions on outcomes. Additionally, students should be able to predict products and propose reaction mechanisms based on the knowledge acquired.
B.Sc Program in Chemistry	2023-24	UG/CHEM/DSC 1B	CHEMISTRY-DSC 1B: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY (Credits: Theory-04, Practicals-02)SEM-2, (CBCS Curriculum)	**1. Physical Chemistry-1** **Chemical Energetics** **Learning Outcome:** ● Thermodynamics: Laws of Thermodynamics: Zeroth Law: Understand the concept of temperature. Discuss thermal equilibrium and the transitive property. First Law (Law of Energy Conservation): Statement and mathematical expression. Concept of internal energy and heat. ● Second Law (Law of Entropy): Definition of entropy. Direction of natural processes. Reversible and irreversible processes. ● Third Law (Law of Absolute Zero): Statement and significance. Introduction to absolute entropy. ● Thermochemistry:Principles and Definitions: Enthalpy (H) and Internal Energy (U): Definitions and mathematical relationships. Heat at constant pressure and volume. Heat Capacity and Specific Heat: ● Definitions and relation to temperature changes. ● Work (W) in Thermodynamics: Expansion work and compression work. P-V work and its calculation. Standard State and Standard Enthalpies: Standard State: Definition and conditions. Role in thermochemical calculations. ● Bond Energy and Dissociation Energy: Bond Energy:Definition and significance. Calculation from thermochemical data. Bond Dissociation Energy: Definition and comparison with bond energy. Application in reaction mechanisms. Variation of Enthalpy with Temperature: ● Kirchhoff's Equation: Derivation and application. Prediction of temperature dependence. ● Third Law of Thermodynamics: Statement and Significance: Understanding the unattainability of absolute zero. Application in entropy calculations. ● Absolute Entropies: Calculation of Absolute Entropies: Use of Third Law. Factors influencing absolute entropy. Upon completing this review, students should have a strong foundation in the principles and laws of thermodynamics, thermochemistry, and the calculation of enthalpies and entropies under different conditions. Students should be able to apply these concepts to solve problems and make predictions about the thermodynamic behavior of chemical systems. **2. Chemical Equilibrium:**

				Learning Outcome: ● Understand the concept of free energy change and its role in determining the spontaneity of reactions. ● Comprehend the thermodynamic derivation of the law of chemical equilibrium. ● Apply Le Chatelier's principle to predict the effects of changes on a system at equilibrium. ● Differentiate between ΔG and ΔG^0 and appreciate their significance. ● Relate equilibrium constants (K_p, K_c, and K_x) and understand their mathematical relationships in reactions involving ideal gases. This knowledge will enable students to analyze and predict the behavior of chemical systems at equilibrium and make informed decisions about reaction conditions. **3. Ionic Equilibria:** **Learning Outcome:** Upon completing this section, students should be able to: ● Differentiate between strong, moderate, and weak electrolytes. ● Calculate the degree of ionization and understand the factors influencing it. ● Relate ionization constants to the ionization of weak acids and bases. ● Apply the pH scale to quantify the acidity or basicity of solutions. ● Analyze the common ion effect and its impact on equilibrium. ● Calculate hydrolysis constants, degree of hydrolysis, and pH for salts. ● Understand the principles behind buffer solutions and their applications. ● Apply solubility product principles to predict the solubility and precipitation of salts. ● This knowledge will equip students to analyze and manipulate ionic equilibria, contributing to a deeper understanding of solution behavior and acid-base concepts. **4. Organic Chemistry-2** **Learning Outcome:** Students completing this section should: ● Understand the synthesis methods for aromatic hydrocarbons, alkyl, and aryl halides. ● Grasp the mechanisms and conditions involved in each preparation and reaction. ● Analyze the key steps and significance of each synthetic pathway. ● Apply the functional group approach to predict reactions and synthesize compounds. ● Gain practical insights into the reactivity of different functional groups. ● Develop problem-solving skills for various organic transformations.
B.Sc Program in	2023-24	UG/CHEM/DSC 1C	CHEMISTRY-DSC 1C: SOLUTIONS,	**1. Physical Chemistry-2** **Solutions:** **Learning Outcome:**

Chemistry			PHASE EQUILIBRIUM, CONDUCTANCE, ELECTROCHEMISTRY & FUNCTIONAL GROUP ORGANIC CHEMISTRY-II (Credits: Theory-04, Practical-02) SEM-3	Upon completing this section, students should be able to: ● Understand the behavior of ideal and non-ideal solutions. ● Analyze vapor pressure-composition and temperature-composition curves. ● Apply the lever rule to determine phase compositions. ● Recognize and interpret azeotropes and their distillation patterns. ● Explain partial miscibility, critical solution temperature, and immiscibility of liquids. ● Understand the principle of steam distillation and its applications. ● Apply the Nernst distribution law for solute distribution. ● Comprehend the principles and applications of solvent extraction techniques. **2. Phase Equilibrium:** **Learning Outcome:** Upon completing this section, students should be able to: ● Understand the concepts of phases, components, and degrees of freedom. ● Apply criteria for achieving phase equilibrium in different systems. ● Utilize the Gibbs Phase Rule to predict the number of phases in a system. ● Derive and apply the Clausius–Clapeyron equation for phase transitions. ● Interpret phase diagrams for one-component systems (water and sulfur). ● Analyze and interpret phase diagrams for two-component systems involving eutectics and melting points. ● Understand the practical implications of phase equilibria in various fields. **3. Conductance:** **Learning Outcome:** Upon completing this section, students should be able to: ● Understand and calculate conductivity, equivalent conductance, and molar conductivity. ● Explain and apply Kohlrausch Law of Independent Migration of Ions. ● Determine transference numbers experimentally using Hittorf and Moving Boundary methods. ● Understand the concept of ionic mobility and its relevance. ● Apply conductance measurements to determine the degree of ionization, solubility products, and hydrolysis constants. ● Perform and interpret conductometric titrations in acid-base reactions. **4. Electrochemistry:**

Learning Outcome:

Upon completing this section, students should be able to:

- Differentiate between reversible and irreversible cells.
- Understand the concept of EMF and its measurement.
- Apply the Nernst equation for predicting cell potential.
- Recognize different types of electrodes and their roles.
- Interpret standard electrode potential and electrochemical series.
- Calculate thermodynamic properties (ΔG, ΔH, ΔS) from EMF data.
- Derive equilibrium constants from EMF data.
- Understand concentration cells and the role of the salt bridge.Perform pH determination using electrodes.
- Apply potentiometric titrations qualitatively.

5. Organic Chemistry-3: Carboxylic acids and their derivatives:
Learning Outcome:

Upon completing this section, students should be able to:

- Identify and classify aliphatic and aromatic carboxylic acids.
- Understand the mechanisms and conditions for the hydrolysis of esters.
- Analyze the Hell – Vohlard - Zelinsky Reaction and its applications.
- Demonstrate knowledge of preparing acid chlorides, anhydrides, esters, and amides.
- Compare nucleophilicity among different acyl derivatives.
- Explain the Reformatsky Reaction and its significance.
- Understand the mechanism and applications of Perkin Condensation.

6. Amines and Diazonium Salts:
Learning Outcome:

Upon completing this section, students should be able to:

- Understand the classification and synthesis of aliphatic and aromatic amines.
- Recognize the reactions of aliphatic and aromatic amines, including elimination reactions and specific tests.
- Explain the electrophilic substitution reactions of aromatic amines.
- Define diazonium salts and their preparation from aromatic amines.
- Comprehend the various conversion reactions involving diazonium salts, leading to the formation of

				benzene, phenol, and dyes. **7. Amino Acids, Peptides and Proteins:** **Learning Outcome:** Upon completing this section, students should be able to: ● Understand the preparation methods of amino acids. ● Describe the properties of zwitterions and explain the concept of isoelectric point. ● Identify and perform reactions involving amino acids. ● Explain the structural hierarchy of proteins. ● Discuss methods for determining the primary structure of peptides. ● Understand the synthesis of peptides, including protecting groups and solid-phase synthesis. **8. Carbohydrates:** **Learning Outcome:** Upon completing this section, students should be able to: ● Classify carbohydrates and describe their general properties. ● Understand the open chain and cyclic structures of glucose and fructose. ● Determine the configuration of monosaccharides and explain mutarotation. ● Identify and describe the structures of common disaccharides. ● Recognize the structures and functions of starch and cellulose.
B.Sc Program in Chemistry	2023-24	UG/CHEM/DSC 1D	CHEMISTRY-DSC 1D: TRANSITION METAL & COORDINATION CHEMISTRY, STATES OF MATTER & CHEMICAL KINETICS (Credits: Theory-04, Practical-02) SEM-4 (CBCS)	**1. Inorganic Chemistry** **Transition Elements (3d series):** **Learning Outcome:** Upon completing this section, students should be able to: ● Describe the electronic configuration and general trends of the 3d series. ● Understand the concept of variable valency and its trends. ● Explain the color, magnetic, and catalytic properties of transition elements. ● Illustrate the ability of transition elements to form complexes. ● Analyze the stability of various oxidation states using Latimer diagrams. ● Understand the electronic configurations, oxidation states, and properties of lanthanoids and actinoids.

				2. Coordination Chemistry: **Learning Outcome:** Upon completing this section, students should be able to: ● Explain the application of Valence Bond Theory to inner and outer orbital complexes. ● Identify structural and stereoisomerism in coordination compounds. ● Understand the limitations and drawbacks of Valence Bond Theory. ● Apply the IUPAC system for the nomenclature of coordination compounds. **3. Crystal Field Theory:** **Learning Outcome:** Upon completing this section, students should be able to: ● Understand how the arrangement of ligands affects the d-orbital energies in Crystal Field Theory. ● Calculate Crystal Field Stabilization Energy for octahedral complexes. ● Analyze the crystal field effects in tetrahedral coordination. ● Comprehend the spectrochemical series and its implications. ● Compare CFSE for octahedral and tetrahedral complexes. ● Discuss tetragonal distortion, the Jahn-Teller effect, and square planar coordination. **4. Physical Chemistry-3 (30 Lectures)** **Kinetic Theory of Gases** **Learning Outcome:** Upon completing this section, students should be able to: ● Understand the postulates of the kinetic theory of gases. ● Derive the kinetic gas equation and explain its components. ● Explain the deviation of real gases from ideal behavior. ● Understand the van der Waals equation and critical phenomena. ● Interpret Maxwell-Boltzmann distribution laws and their temperature dependence. ● Grasp concepts related to collisions in gases. ● Gain insight into the viscosity of gases and its dependence on temperature and pressure. **5. Solids** **Learning Outcome:** Upon completing this section, students should be able to:

				● Differentiate between various forms of solids. ● Understand symmetry elements in crystals. ● Identify unit cells and crystal systems. ● Apply laws of crystallography, including Miller Indices. ● Explain X-ray diffraction by crystals using Bragg's law. ● Comprehend the crystal structures of NaCl, KCl, and CsCl. ● Understand defects in crystals and their implications. ● Gain an overview of glasses and liquid crystals. **6. Chemical Kinetics** **Learning Outcome:** Upon completing this section, students should be able to: ● Understand the concept of reaction rates and factors influencing them. ● Differentiate between order and molecularity of reactions. ● Derive integrated rate equations for various reaction orders. ● Calculate the half-life of a reaction. ● Apply methods for determining the order of a reaction. ● Comprehend the concept of activation energy and its calculation. ● Understand the collision theory and activated complex theory. ● Make qualitative comparisons between these theories.

Content Prepared by

Approved by

Dr. Manoj Majumder
HOD
Dept. Of Chemistry

Dr. Chanchal Mondal
Assistant Professor
Dept. Of Chemistry

Dr. Santanu Chakravorty
Assistant Professor
Dept. Of Chemistry

Mrs. Aparna Biswas
IQAC Convenor
Mathabhanga College

Dr. Debasish Datta
Principal
Mathabhanga College