Semester	**4**
Programme	**CHEMISTRY**
Course	**MINOR (GENERAL CHEMISTRY 4)**
Paper Code	**B2CH230412T/ B2CH230412P**
Credits	**4 (THEORY: 3 PRACTICAL: 1)**
Hours/week	**5 (THEORY: 3 PRACTICAL: 2)**
Category: Core/MDC/SEC/VEC	**CORE**
Theory / Practical / Composite	**COMPOSITE**
Number of Modules	**4 (THEORY: 3; PRACTICAL: 1)**
Syllabus	**Theory:** **Group A:** **Module I: Introduction to Biomolecules: Carbohydrates, Amino acids, Protein and Peptides (12 Lectures)** Classification of carbohydrates, reactions of carbohydrates, mutarotation, osazone formation, Kiliyani-Fischer and Ruff's degradation. Synthesis of amino acids, concept of isoelectric point, peptides: N-terminal and C-terminal amino acid determination, primary, secondary, tertiary and quaternary structures of proteins. **Group B:** **Module II: Covalent Bonding (12 Lectures)** Covalent bond: Polarizing power and polarizability, ionic potential, Fazan's rules. Lewis structures, formal charge. Valence Bond Theory. The hydrogen molecule (Heitler-London approach), directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, Dipole moments, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main groups chemistry) and multiple bonding (σ and π bond approach). Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO)) (elementary pictorial approach): sigma and pi-bonds and delta interaction, multiple bonding. Orbital designations: gerade, ungerade, HOMO, LUMO. Orbital mixing, MO diagrams of H2, Li2, Be2, B2, C2, N2, O2, F2, and their ions wherever possible. Bond properties: bond orders, bond lengths. **Module III: Coordination Chemistry (12 Lectures)** Double and complex salts. Werner's theory of coordination complexes, Classification of ligands, Ambidentate ligands, chelates, Coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism,

	Geometrical and optical isomerism in square planar and octahedral complexes **Practical:** **Identification of Pure Organic Compound** Solid compounds: oxalic acid, tartaric acid, citric acid, succinic acid, resorcinol, urea, glucose, cane sugar, benzoic acid and salicylic acid. Liquid compounds: Aniline, N,N-dimethylaniline, ethanol, methanol, acetone, benzaldehyde etc. Detection of melting and boiling points of the compounds.
Course Overview	Theory: It is a composite course that bridges the gap between biological systems and inorganic structural principles. 1. Students will explore the synthesis, reactions, and structural determination of essential biomolecules like carbohydrates and proteins. 2. The students are introduced to various methods of synthesis, reactions and structural determinations of several biomolecules. 3. The curriculum delves into advanced bonding theories, including Valence Bond Theory (VBT) and Molecular Orbital Theory (MOT), to understand the electronic structure of diatomic molecules. 4. To have a grasp of the MOT of simple hetero and homo-nuclear diatomic (non-mathematical approach). 5. Additionally, the course provides a comprehensive look at coordination chemistry, covering nomenclature and isomerism. 6. To realize the nature of ligands and the coordination complexes, their IUPAC names and isomeric forms. Practical: 1. The practical component focuses on the systematic identification of pure organic compounds through chemical tests and physical constant determination. 2. Identification of pure solid and liquid organic compounds and determination of boiling point of solid and melting point of liquid organic compounds
Course Outcomes (COs)	**CO1 [Carbohydrate Classification & Transformations]**: Classify carbohydrates structurally (monosaccharides, disaccharides, polysaccharides) and analyze their characteristic chemical pathways, including the mechanisms of mutarotation, osazone formation, Kiliani-Fischer chain elongation, and Ruff's degradation. **CO2 [Amino Acid Synthesis & Protein Architecture]**: Outline synthetic strategies for amino acids, determine isoelectric points, describe chemical methods for N-terminal and C-terminal sequencing in peptides, and distinguish between primary, secondary, tertiary, and quaternary protein structural configurations. **CO3 [Fajan's Rules & Valence Bond Theory]**: Apply Fajan's

	rules to evaluate the covalent character of ionic lattices using polarizing power, polarizability, and ionic potential; utilize Valence Bond Theory (VBT) and Bent's rule to explain directional hybridization and non-equivalent orbital arrays; understand Heitler-London approach for H_2 molecule. **CO4 [Molecular Geometry, VSEPR & Dipole Moments]**: Predict the structural shapes, bond angles, and dipole moments of main-group molecules and polyatomic ions by analyzing lone pair-bond pair repulsions and multiple bonding (σ and π) via VSEPR theory; draw Lewis structures and assign formal charges. **CO5 [Molecular Orbital Theory & LCAO Approach]**: Construct molecular orbital (MO) energy level diagrams for homonuclear (H_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2) and heteronuclear (CO, NO, HCl) diatomic molecules using the LCAO approximation; evaluate bond orders, bond lengths, and magnetic properties; identify gerade/ungerade, HOMO/LUMO, and orbital mixing. **CO6 [Werner's Theory & Coordination Frameworks]**: Apply Werner's coordination theory and systematic IUPAC nomenclature (up to two metal centers) to transition metal complexes; classify ligands (including ambidentate ligands) and understand chelate effect; utilize Valence Bond Theory to determine hybridization, geometry, and spin-state configurations (inner- and outer-orbital complexes). **CO7 [Isomerism in Coordination Compounds]**: Analyze structural and stereoisomerism in coordination compounds, distinguishing between constitutional isomerism (ionization, linkage, hydrate, coordination) and stereoisomerism (geometrical and optical) within 4-coordinate (tetrahedral and square planar) and 6-coordinate (octahedral) geometries. **CO8 [Qualitative Analysis of Pure Organic Compounds]:** Execute systematic laboratory workflows to identify unknown pure solid and liquid organic compounds through physical constant determination (melting point for solids, boiling point for liquids), Lassaigne's element tests (N, S, Cl, Br), solubility classifications, and diagnostic functional group tests.
Program Outcomes (POs)	**PO1: Fundamental Knowledge:** Demonstrate a comprehensive understanding of core concepts in chemistry, including organic, inorganic, physical, analytical, and biochemistry. **PO2: Laboratory Skills:** Acquire hands-on experience in laboratory techniques and instrumentation, applying safety protocols and proper methodologies to conduct experiments and analyse results. **PO3: Problem Solving:** Develop critical thinking and problem-solving skills by applying chemical principles to real-world scenarios, including the ability to design experiments and interpret data. **PO4: Research Competency:** Engage in independent and collaborative research projects, employing scientific methods to formulate hypotheses, conduct experiments, and communicate findings effectively.

	PO5: Interdisciplinary Applications: Understand the interdisciplinary nature of chemistry, exploring its applications in fields such as medicine, environmental science, materials science, and nanotechnology. **PO6: Communication Skills:** Effectively communicate scientific information, both verbally and in written form, to diverse audiences, demonstrating the ability to present complex ideas clearly and concisely. **PO7: Ethics and Sustainability:** Recognize the ethical implications and responsibilities of scientific research and practice in chemistry, emphasizing the importance of sustainability and environmental stewardship in chemical practices.

CO #	**Core Curriculum Domain**	**Bloom's Taxonomy K-Level**	**Mapped POs**	**Pedagogical Justification for K-Level & PO Selection**
CO1	Carbohydrate Transformations	**K2 (Understand)** **K4** (Analyze)	PO1, PO3, PO5	Students classify carbohydrates and deconstruct multi-step chemical rearrangements (mutarotation, osazone, Kiliani-Fischer, Ruff's degradation); requires fundamental knowledge, problem-solving, and interdisciplinary applications in biochemistry.
CO2	Amino Acids & Protein Architecture	**K3** (Apply) **K4** (Analyze)	PO1, PO3, PO5, PO6, PO7	Students apply sequencing protocols to deduce primary codes and analyze higher-tier folding patterns; bridges chemistry with biology/medicine (PO5) and emphasizes ethical dimensions of protein research (PO7).
CO3	Fajan's Rules & VBT	**K3** (Apply)	PO1, PO3	Students apply electrostatics (ionic potential) and orbital theory (Bent's rule) to track covalent properties; develops fundamental knowledge and problem-solving skills.
CO4	VSEPR & Dipole Moments	**K3** (Apply) **K4** (Analyze)	PO1, PO2, PO3	Students analyze lone pair distributions to map asymmetric polyatomic spaces and compute resultant dipoles; requires spatial reasoning and problem-solving.
C	Molecular	**K4**	PO1,	Students analyze how

O5	Orbital Theory	(Analyze)	PO3	overlapping atomic orbitals assemble into discrete molecular fields; evaluate bond orders, bond lengths, and magnetic properties; demonstrates high-level analytical reasoning.
C O6	Werner's Theory & Complexes	**K3** (Apply) **K4** (Analyze)	PO1, PO3	Students apply ligand field rules and VBT limits to predict coordination cluster configurations (high-spin/low-spin); fundamental knowledge and problem-solving.
C O7	Coordination Isomerism Matrices	**K4** (Analyze)	PO1, PO3	Students analyze stereochemical symmetries to predict optical activity or geometrical configurations in 4- and 6-coordinate systems; high-level spatial reasoning.
C O8	Qualitative Organic Analysis	**K3** (Apply) **K4** (Analyze)	PO2, PO4, PO6	Students execute laboratory workflows, perform physical constant determinations, compile analytical clues from solubility tests, and systematically identify unknown compounds; demonstrates laboratory skills, research competency, and communication.

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<tr>
<td>Reading/Reference Lists</td>
<td colspan="2">1. 4. Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.
2. 5. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. 6. Finar, I. L. Organic Chemistry (Volume 1 & Volume 2) Pearson Education.
4. 7. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
5. Huheey, J. E.; Keiter, E.A. &Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson.
6. Mingos, D.M.P., Essential trends in inorganic chemistry. Oxford University Press.
7. Winter, M. J., The Orbitron, http://winter.group.shef.ac.uk/orbitron/. An illustrated gallery of atomic and molecular orbitals.
8. General and Inorganic Chemistry, Volume 1, R. P. Sarkar, New Central Book Agency; 3rd Revised edition.
Practical:
1. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N., University of Calcutta
2. Nad, Mahapatra, Ghosal-Practical Chemistry</td>
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<tr>
<td>Evaluation</td>
<td>Theory: 60
Internal: 15 (CIA: 10; Other form of Assessment: 2; Attendance: 3)
Semester Exam:45 (Gr. A: 15; Gr. B:30)</td>
<td>Practical: 40
CA:38; Attendance: 2</td>
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<td>Paper Structure for Theory Semester Exam</td>
<td colspan="2">Gr. A: Attempt ONE out of TWO questions of 15 Marks each Gr. B: Attempt TWO out of THREE questions of 15 marks each</td>
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