Semester	**3**
Programme	**CHEMISTRY**
Course	**MAJOR (ORGANIC CHEMISTRY 2)**
Paper Code	**C2CH230321T**
Credits	**4 (THEORY: 4)**
Hours/week	**4 (THEORY 4)**
Category: Core/MDC/SEC/VEC	**CORE**
Theory/Practical/Composite	**THEORY**
Number of Modules	**4**
Syllabus	**Module I: General Treatment of Reaction Mechanism 12L** ***Reaction thermodynamics:*** free energy and equilibrium, enthalpy and entropy factor, calculation of enthalpy change via BDE, intermolecular & intramolecular reactions. ***Reaction kinetics:*** rate constant and free energy of activation; concept of order and molecularity; free energy profiles for one-step, two-step and three-step reactions; catalyzed reactions: electrophilic and nucleophilic catalysis; kinetic control and thermodynamic control of reactions; isotope effect: primary and secondary kinetic isotopic effect (k_H /k_D); principle of microscopic reversibility; Hammond's postulate. ***Free-radical substitution reaction:*** halogentaion of alkanes, mechanism (with evidence) and stereochemical features; reactivity-selectivity principle in the light of Hammond's postulate. ***Tautomerism:*** prototropy (keto-enol, nitro - *aci*-nitro, nitroso-oximino, diazo-amino and enamine-imine systems); valence tautomerism and ring-chain tautomerism; composition of the equilibrium in different systems (simple carbonyl; 1,2- and 1,3- dicarbonyl systems, phenols and related systems), factors affecting keto-enol tautomerism; application of thermodynamic principles in tautomeric equilibria. **Module II: Addition to carbon-carbon multiple bonds 12L** Halogenation reaction: Reaction, mechanism, stereoselectivity. Hydrohalogenation: Reaction, mechanism (with evidence wherever applicable), regioselectivity (Markownikoff and anti- Markownikoff additions).Iodolactonisation, Hydration: Oxymercuration-demercuration, hydroboration-oxidation, epoxidation, *syn* and *anti*-hydroxylation, ozonolysis, addition of singlet and triplet carbenes; electrophilic addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination in competition with brominations across C=C; use of NBS; Birch reductions. Isomerisation of alkenes. Nucleophilic addition to C=C. **Module III: Carbonyl compounds-I 12L**

	Addition to C=O: structure, reactivity and preparation of carbonyl compounds; mechanism (with evidence), reactivity, equilibrium and kinetic control; Burgi-Dunitz trajectory in nucleophilic additions; formation of hydrates, cyano hydrins and bisulphite adduct; nucleophilic addition-elimination reactions with alcohols, thiols and nitrogen- based nucleophiles; reactions: benzoin condensation, Cannizzaro and Tischenko reactions, reactions with ylides: Wittig and Corey-Chaykovsky reaction; Rupe rearrangement, oxidations and reductions: Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, Oppenauer, Bouveault-Blanc, acyloin condensation; oxidation of alcohols with PDC and PCC; periodic acid and lead tetraacetate oxidation of 1,2-diols. **Module IV: Stereochemistry-II 12L** ***Stereoaxis and chirality:*** Stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, alkylidenecycloalkanes and biphenyls (Atropisomerism, racemisation of chiral biphenyls; *buttressing* effect). Configurational nomenclature (R/S) for axially chiral molecules. ***Prostereoisomerism***: Topicity of ligands and faces (elementary idea); descriptors for stereoheterotopic ligands and faces: *Pro-R/Pro-S, Re/Si* descriptors ***Conformation analysis:*** Dihedral angle, torsion angle; Klyne-Prelog terminology; relative stability of conformers based on steric and electronic effects. Conformational analysis of n-butane, 2-methylbutane and halo alkanes, 1,2-dihaloalkanes and 1,2-diols, 1,2-halohydrin.
Course Overview	To have knowledge about- i) General treatment of reaction mechanisms ii) Addition to C-C multiple bonds iii) Reaction and synthesis of Carbonyl and Related Compounds iv) Stereochemistry of Organic molecules
Course Outcomes	Upon successful completion of this course, students will be able to: CO1: Evaluate reaction thermodynamics, kinetics, and energy profiles (e.g., Hammond's postulate, isotope effects) to predict reaction paths and control mechanisms. CO2: Compare and differentiate free-radical substitution mechanisms and tautomeric equilibria (prototropy, valence tautomerism) using thermodynamic and kinetic principles. CO3: Predict regioselectivity and stereoselectivity in alkene addition reactions (electrophilic, hydrohalogenation, hydration) using mechanistic evidence. CO4: Analyze the utility of specific reagents in additions (carbenes, NBS, Birch reduction, ozonolysis) to design selective transformation pathways for alkenes and dienes. CO5: Apply mechanisms of nucleophilic addition to carbonyls, considering transition state trajectories (Bürgi-Dunitz), to predict product formation and equilibrium control.

	CO6: Formulate reaction strategies for carbonyl transformations (Reductions, Oxidations, Wittig, Benzoin, Cannizzaro) to synthesize complex target molecules. CO7: Characterize axially chiral molecules (allenes, biphenyls) and apply R/S nomenclature; distinguish between stereotopic ligands and faces (pro-stereoisomerism). CO8: Perform conformational analysis of acyclic systems, evaluating the relative stability of conformers based on steric, electronic effects, and torsional strain.
Program Outcomes	**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.

Module	**Course Outcome (CO)**	**Cognitive Domain (Bloom's K-Values)**	**Mapped Program Outcomes (POs)**
Module I: General Reaction Mechanism	**CO1:** Evaluate reaction thermodynamics, kinetics, and energy profiles (e.g., Hammond's postulate, isotope effects) to predict reaction paths and control	**K4** (Analyzing) **K5** (Evaluating)	**PO1:** Core Knowledge **PO3:** Problem Solving

	mechanisms.		
	CO2: Compare and differentiate free-radical substitution mechanisms and tautomeric equilibria (prototropy, valence tautomerism) using thermodynamic and kinetic principles.	**K2** (Understanding) **K4** (Analyzing)	**PO1:** Core Knowledge **PO3:** Problem Solving
Module II: Addition to C=C	**CO3:** Predict regioselectivity and stereoselectivity in alkene addition reactions (electrophilic, hydrohalogenation, hydration) using mechanistic evidence.	**K3** (Applying) **K4** (Analyzing)	**PO1:** Core Knowledge **PO3:** Problem Solving
	CO4: Analyze the utility of specific reagents in additions (carbenes, NBS, Birch reduction, ozonolysis) to design selective transformation pathways for alkenes and dienes.	**K4** (Analyzing) **K6** (Creating)	**PO3:** Problem Solving **PO4:** Research Competency
Module III: Carbonyl Compounds-I	**CO5:** Apply mechanisms of nucleophilic addition to carbonyls, considering transition state trajectories (Bürgi-Dunitz), to predict product formation and equilibrium control.	**K3** (Applying)	**PO1:** Core Knowledge **PO3:** Problem Solving
	CO6: Formulate reaction strategies for carbonyl transformations (Reductions, Oxidations, Wittig, Benzoin, Cannizzaro) to synthesize complex target molecules.	**K4** (Analyzing) **K6** (Creating)	**PO3:** Problem Solving **PO5:** Modern Tool Usage
Module IV: Stereochemistry-II	**CO7:** Characterize axially chiral molecules (allenes, biphenyls) and apply R/S	**K2** (Understanding)	**PO1:** Core Knowledge

	nomenclature; distinguish between stereotopic ligands and faces (pro-stereoisomerism).	**K3** (Applying)	
	CO8: Perform conformational analysis of acyclic systems, evaluating the relative stability of conformers based on steric, electronic effects, and torsional strain.	**K3** (Applying) **K4** (Analyzing)	**PO1:** Core Knowledge **PO3:** Problem Solving

Reading/Reference Lists	1. Clayden, J., Greeves, N., Warren, S. Organic Chemistry, Second edition, Oxford University Press 2012. 2. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003. 3. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited. 4. Carey, F. A. & Guiliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012. 5. Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008. 6. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994. 7. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited. 8. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 9. Finar, I. L. Organic Chemistry (Volume 1) Pearson Education. 10. Graham Solomons, T.W., Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc. 11. James, J., Peach, J. M. Stereochemistry at a Glance, Blackwell Publishing, 2003. 12. Robinson, M. J. T., Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005. 13. Maskill, H., Mechanisms of Organic Reactions, Oxford Chemistry Primer, Oxford University Press. March, J., Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Wiley; 4th edition, 2006.	
Evaluation	Theory: 100 Internal: 30 (CIA:20, Other mode of Assesment:5, Attendance: 5) Semester Exam:70	
Paper Structure for Theory Semester Exam	Answer SEVEN out of NINE questions, of 10 marks each.	