Semester	**8**
Programme	**CHEMISTRY**
Course	**MAJOR (ORGANIC CHEMISTRY 8)**
Paper Code	
Credits	**4 (THEORY: 3; PRACTICAL: 1)**
Hours/week	**6 (THEORY: 3; PRACTICAL: 3)**
Category: Core/MDC/SEC/VEC	**CORE**
Theory/Practical/Composite	**COMPOSITE**
Number of Modules	**4**
Syllabus	**Theory:** **Module I: Reagent Chemistry – III 12L** **Organo-boron, Organo-selenium and organo-phosphorus compounds** Chemistry of organoboron compounds: Carbonylation, cyanidation, hydroboration, reactions of organoboranes, stereospecificity of allyl and crotyl boranes. Organo-Selenium Compounds: Synthesis and Reactivity, selenides, selenoxides Organophosphorus - Chemistry of organophosphorus compounds, phosphonium ylides and chiral phosphines. **Module II: Supramolecular Chemistry and Advanced heterocyclic chemistry 12L** **Supramolecular Chemistry** From molecular to supramolecular chemistry: nature and factors leading to strong non-covalent interactions. New molecular receptors: crown ethers, cryptands and spherands, cyclophanes, siderophores, cyclodextrins, calixarenes and their application in specific recognition processes. Cation, anion and neutral guest binding. Crystal engineering. Self-assembly of supramolecular aggregates, catenanes and rotaxanes, helicates and helical assemblies, molecular knots. Supramolecular reactivity and catalysis. Fullarenes, carbon nanotubes and graphenes.

Advanced heterocyclic chemistry

Reactions and synthesis of 1,2- and 1,3-azoles: imidazoles, thiazoles, oxazoles, pyrazoles, isoxazoles; Heterocyclic compounds containing a ring-junction nitrogen: Indolizines, aza-indolizines.

Module III: Photochemistry 12L

Basic principles of Photochemistry: Fate of the excited state molecule- physical processes: Jablonski diagram. Photochemistry of carbonyl compounds: Norrish Type-I processes for acyclic cyclic saturated ketones, β-cleavage reactions, Photocycloaddition reaction (Patterno Buchi reaction), Photo rearrangements: Lumiketone rearrangements, Di-π-methane rearrangements. Photooxidation and photo reductions, Barton's reaction, fluorescence spectroscopy and its applications.

Practical:

Group A

- Polymers identification by FTIR techniques.
- A study on protein phosphorescence – structural biological aspects.
- Fluorescence probes and their sensing applications in nanomaterials system.

Group B

- UV-vis spectra, IR, electrochemical and theoretical analysis of suitable transition metal complexes with redox non-innocent ligands having conjugated azo function.
- Investigation of redox behaviour and electronic structures of certain transition metal complexes of imino-quinone type ligands using spectroscopic, electrochemical, and theoretical methods.
- UV–Vis, electrochemical, and theoretical studies of their transition metal complexes of ligands possessing pyridyl/ benzothiazole framework.

Group C

- Study of intramolecular click reactions leading to cyclic and heterocyclic products.
- Ring-closing metathesis (RCM) reactions for the synthesis of cyclic olefins using suitable catalysts.
- Optimization of reaction conditions for click and RCM

	reactions with respect to catalyst, solvent, temperature, and time. Group D • Study of phase diagram in microemulsion. • Determination of droplet size distribution in microemulsion. • Viscosity study of microemulsion. Group E • Interfacing Neural Network and Global Optimization algorithms. • Development of advanced scripts for automated batch job submission, error handling, and file management. • Implementation of array operations or parallelization strategies. Group F • Synthesis of Rhodamine 6g based fluorophores - i) Isolation and. Purification. • Synthesis of Rhodamine 6g based fluorophores - ii) Characterization. • Synthesis of Rhodamine 6g based fluorophores - iii) Photo physical studies. Group G • Preparation of supramolecular gels and metallogels using synthesized organic molecules and suitable metal ions. • Physicochemical and morphological characterization of gels and metallogels employing spectroscopic, thermal, and microscopic methods. • Evaluation of catalytic performance in oxidation–reduction reactions using gel- and metallogel-based catalytic systems. Group H • Spectral and theoretical analysis of different metal oxide/nitride/sulphide compounds to evaluate efficiency as electrodic materials. • Development of different immobilization strategies to anchor electro catalysts on electrode surfaces. • Digital simulation of surface confined electro active species and evaluation of different factors involved therein.
Course Overview	**Theory:**
Course Outcomes	Upon successful completion of this course, students will be able to: CO1: Explain the synthesis, reactivity, and mechanisms of organoboron (including carbonylation, cyanidation, hydroboration), organoselenium (selenides/selenoxides), and organophosphorus (phosphonium ylides) reagents. CO2: Apply the stereospecificity of allyl and crotyl boranes,

	alongside chiral phosphines, to predict stereochemical outcomes in asymmetric C-C bond formations. CO3: Analyze the nature, energetics, and factors governing non-covalent interactions that direct host-guest chemistry and molecular recognition (cation, anion, and neutral binding). CO4: Categorize structural configurations and synthetic applications of specialized molecular receptors (crown ethers, cryptands, cyclodextrins, calixarenes) and carbon nanomaterials (fullerenes, CNTs, graphenes). CO5: Explain the principles of crystal engineering and self-assembly driving the formation of complex topologies like catenanes, rotaxanes, and molecular knots. CO6: Design synthetic pathways and analyze reaction mechanisms for 1,2-azoles, 1,3-azoles (imidazoles, thiazoles, oxazoles), and ring-junction nitrogen heterocycles (indolizines). CO7: Illustrate the photophysical fates of excited-state molecules using the Jablonski diagram and apply fluorescence spectroscopy to solve analytical and structural problems. CO8: Predict the products and delineate mechanisms of complex photochemical transformations, including Norrish Type-I/II, Paterno-Büchi, Lumiketone, Di-pi-methane, and Barton reactions. CO9: Communicate advanced mechanistic ideas clearly and evaluate the experimental hazards and sustainability metrics associated with light-driven (photochemical) or atom-economical (supramolecular) processes.
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: Reagent Chemistry – III	**CO1:** Explain the synthesis, reactivity, and mechanisms of organoboron (including carbonylation, cyanidation, hydroboration), organoselenium (selenides/selenoxides), and organophosphorus (phosphonium ylides) reagents.	**K2** (Understanding) **K4** (Analyzing)	**PO1:** Fundamental Knowledge **PO3:** Problem Solving
	CO2: Apply the stereospecificity of allyl and crotyl boranes, alongside chiral phosphines, to predict stereochemical outcomes	**K3** (Applying)	**PO1:** Fundamental Knowledge **PO3:** Problem Solving

	in asymmetric C-C bond formations.		
Module II: Supramolecular & Advanced Heterocyclic Chemistry	**CO3:** Analyze the nature, energetics, and factors governing non-covalent interactions that direct host-guest chemistry and molecular recognition (cation, anion, and neutral binding).	**K4** (Analyzing)	**PO1:** Fundamental Knowledge **PO3:** Problem Solving
	CO4: Categorize structural configurations and synthetic applications of specialized molecular receptors (crown ethers, cryptands, cyclodextrins, calixarenes) and carbon nanomaterials (fullerenes, CNTs, graphenes).	**K2** (Understanding)	**PO1:** Fundamental Knowledge **PO5:** Interdisciplinary Applications
	CO5: Explain the principles of crystal engineering and self-assembly driving the formation of complex topologies like catenanes, rotaxanes, and molecular knots.	**K2** (Understanding) **K3** (Applying)	**PO1:** Fundamental Knowledge **PO4:** Research Competency

	CO6: Design synthetic pathways and analyze reaction mechanisms for 1,2-azoles, 1,3-azoles (imidazoles, thiazoles, oxazoles), and ring-junction nitrogen heterocycles (indolizines).	**K4** (Analyzing) **K6** (Creating)	**PO1:** Fundamental Knowledge **PO3:** Problem Solving
Module III: Photochemistry	**CO7:** Illustrate the photophysical fates of excited-state molecules using the Jablonski diagram and apply fluorescence spectroscopy to solve analytical and structural problems.	**K2** (Understanding) **K3** (Applying)	**PO1:** Fundamental Knowledge **PO2:** Laboratory Skills
	CO8: Predict the products and delineate mechanisms of complex photochemical transformations, including Norrish Type-I/II, Paterno-Büchi, Lumiketone, Di-pi-methane, and Barton reactions.	**K3** (Applying) **K4** (Analyzing)	**PO1:** Fundamental Knowledge **PO3:** Problem Solving
Cross-Cutting / Experimental	**CO9:** Communicate advanced mechanistic ideas clearly and evaluate	**K5** (Evaluating)	**PO2:** Laboratory Skills

	the experimental hazards and sustainability metrics associated with light-driven (photochemical) or atom-economical (supramolecular) processes.		**PO6:** Communication Skills **PO7:** Ethics and Sustainability

Reading/Reference Lists	**Theory:** 1. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, Second edition, Oxford University Press, 2012. 2. Keeler, J., Wothers, P. *Chemical Structure and Reactivity – An Integrated approach*, Oxford University Press. 3. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003. 4. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited. 5. Carey, F. A., Guiliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012. 6. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 7. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education) 8. Fleming, I. *Molecular Orbitals and Organic Chemical Reactions*, Reference/Student Edition, Wiley, 2009. 9. Steed, J. W.; Atwood, J. L. *Supramolecular Chemistry*, *Wiley, 2009.* 10. Joule, J. A., Mills, K. *Heterocyclic Chemistry*, Wiley, 2010.

	11. Wardle, B. *Principles and Applications of Photochemistry*, Wiley, 2009. 12. Zweifel, G. S., Nantz, M. H., Somfai, P. *Modern Organic Synthesis: An Introduction*, Wiley, 2017. 13. Carruthers, W., Coldham, I. *Modern Methods of Organic Synthesis*, Cambridge University Press, 2015.	
Evaluation	Theory: 60 Internal: 15 (CIA: 10; Other form of Assessment: 2; Attendance: 3) Semester Exam: 45	Practical: 40 CA: 38; Attendance:2
Paper Structure for Theory Semester Exam	Answer THREE out of FOUR questions, of 15 marks each.	