CH-462 Organometallic Chemistry

Credit Hours: 3-0

Prerequisite: Nil

Course Objectives

By the end of this course, students will:

1. Understand the bonding, structure, and classification of organometallic compounds.
2. Learn the principles and mechanisms of common organometallic reactions.
3. Apply organometallic concepts to catalysis and synthetic transformations.
4. Analyze the role of organometallic complexes in industrial and pharmaceutical processes.
5. Explore the reactivity and applications of transition metal complexes in organic synthesis..

Course Contents

6. Introduction and Fundamentals of Organometallic Chemistry: Definition, history, and significance of organometallic compounds. Types of metal–carbon bonds: ionic, covalent, dative. Classification based on metal-carbon interaction (σ-bonded, π-bonded, etc.).
7. Bonding and Structure in Organometallic Compounds: 18-electron rule, hapticity, oxidation states of metals, metal–ligand bonding. Ligands: alkyl, aryl, carbonyl, phosphines, olefins, cyclopentadienyl, etc.
8. Organometallic Reaction Types and Mechanisms: Oxidative addition, reductive elimination, insertion and elimination reactions. Transmetalation, migratory insertion, β-hydride elimination.
9. Transition Metal-Catalyzed Reactions: Hydrogenation, Hydroformylation, Cross-coupling reactions (Suzuki, Heck, Stille, Sonogashira), Olefin metathesis (Grubbs catalyst), C–H activation strategies.
10. Organometallic Compounds in Organic Synthesis: Use of organolithium, Grignard reagents, organozinc, organocuprates. Synthesis of carbon–carbon and carbon–heteroatom bonds. Selectivity and control in synthesis using organometallic intermediates.

11. Applications in Industry and Catalysis: Role in polymerization (e.g., Ziegler–Natta and metallocene catalysts), Catalysts in pharmaceutical and fine chemical manufacturing, Green chemistry and sustainable catalysis.
12. Stability, Toxicity, and Safety Considerations: Handling of air-sensitive and moisture-sensitive compounds. Toxicity of organotin, organomercury, and related compounds. Safe lab practices and deactivation strategies.

Course Outcomes

After completing this course, students will be able to:

13. Explain the nature and types of metal–carbon bonds in organometallic compounds.
14. Predict and interpret the structure, reactivity, and electronic configuration of organometallic complexes.
15. Apply mechanistic concepts to organometallic-mediated transformations.
16. Solve synthetic problems involving the use of organometallic reagents and catalysts.
17. Analyze industrial and pharmaceutical processes that utilize organometallic chemistry.

Recommended Books:

18. Organometallic Chemistry — Gary O. Spessard & Gary L. Miessler, Oxford University Press, 2016 (3rd Edition)
19. Organometallics: A Concise Introduction — Christoph Elschenbroich, Wiley-VCH, 2006 (2nd Edition)
20. The Organometallic Chemistry of the Transition Metals — Robert H. Crabtree, Wiley, 2009 (5th Edition)
21. Organometallic Chemistry — R. C. Mehrotra & A. Singh, New Age International, 2011
22. Advanced Organic Chemistry: Part B – Reactions and Synthesis — Francis A. Carey & Richard J. Sundberg, Springer, 2007 (5th Edition) (Supplementary Reading)).