Teaching Plan 2024

B.Sc. Chemistry (H) NEP, V Sem

Subject: Discipline Specific Core Course -(DSC- 13): Basics of Organometallic Chemistry

Teacher: Prof. Ashu Gupta

SEMESTER-V

BSC. (HONS.) CHEMISTRY

DISCIPLINE SPECIFIC CORE COURSE -13 (DSC-13): Basics of Organometallic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basics of Organometallic Chemistry (DSC-13)-Inorganic Chemistry-V	04	03	--	01	Class 12th with Physics, Chemistry, Mathematics	-

Learning Objectives

The Objectives of this course are as follows:

- To familiarize the students with the interactions of metal atom with organic molecules (or not so typical organic molecule), which is in an entirely different fashion as compared to coordination compounds.
- To familiarize the students with the structure and bonding in organometallic compounds
- To familiarize the student with how organometallic compounds can act as good catalysts for organic transformations and hencehave industrial importance associated with medicines, bioorganic synthesis, and energy production.

Learning Outcomes

By studying this course, the students will be able to:

- Identify and classify organometallic compounds of different types.
- Explain the stability of organometallic compounds and hence the requirement of special experimental conditions for their synthesis.
- Explain the bonding modes through VBT and MOT in these compounds.
- Explain the chemical nature of these compounds through various reactions thus acquiring skills to understand their applications.
- Explain the mechanism of catalysis by these compounds. This may prepare the student to predict the catalytic pathways for new reactions

SYLLABUS OF DSC-13

Unit-1: Introduction to Organometallic Chemistry (Hours: 6)

Definition**,** brief history, classification of organometallic compounds on the basis of bond type. Common notation used in organometallic chemistry, concept of hapticity of organic ligands, importance of organometallic chemistry, organometallic compounds as reagents, additives, and catalysts. Introduction to the 18-electron rule or effective atomic number rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series and finding metal-metal bonds.

Unit-2: Structure and Bonding in Organometallic Compounds (Hours : 12)

Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT.

Molecular orbital theory applied to organometallic compounds, description of bonding of two electron ligands to transition metals. π-acceptor behavior of CO (MO diagram of CO to be discussed), π-bonding of CO with metal (synergic effect) and use of IR data to explain extent of back bonding, bonding modes of CO, symmetry of metal carbonyls.

Bonding between metal atoms and organic π- systems: linear (ethylene, allyl, butadiene) and cyclic (cyclopentadiene, benzene), Zeise's salt and comparison of synergic effect with that in carbonyls.

Metal alkyls and Metal-carbene complexes

Unit-3: Synthesis, Reactions and Applications of Organometallic Compounds (Hours: 16)

General methods of synthesis of metal carbonyls: direct carbonylation, reductive carbonylation, thermal and photochemical decomposition, of mono and binuclear carbonyls of 3d series.

Reaction of metal carbonyls: reduction, oxidation, photochemical substitution, migratory insertion of carbonyls, and nucleophilic addition of CO.

Synthesis of metal-alkene complexes through ligand addition, reduction and substitution and reaction of metal bound alkenes, Zeise's salt

Metal–sandwich compounds**:** Ferrocene: synthesis, physical properties and reactions: acylation, sulfonation, alkylation metallation, acetylation, chloromercuration, Mannich reaction, comparison of aromaticity and reactivity of ferrocene with that of benzene.

Synthesis and reactions of Metal alkyls and Metal-carbenes

Unit-4: Catalysis by Organometallic Compounds **(Hours: 11)**

General principles of catalysis, properties of catalysts, homogeneous and heterogeneous catalysis. (Catalytic steps, examples and industrial applications), deactivation and regeneration of catalysts, (catalytic poisons and promoter).

Organometallic catalysis of the following reactions of commercial importance and their mechanism:

1. Alkene hydrogenation (using Wilkinson's Catalyst)
2. Synthetic gasoline preparation (Fischer Tropsch reaction)
3. Polymerisation of ethene using Ziegler-Natta catalyst
4. Wacker oxidation process (Smidth process)
5. Hydroformylation reaction (Oxo-process)
6. Monsanto Acetic Acid process

	Week	**Topic**
1.	1st week	Introduction to the 18-electron rule or effective atomic number rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series and finding metal-metal bonds
2.	2nd week	Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT.
3.	3rd week	Molecular orbital theory applied to organometallic compounds, description of bonding of two electron ligands to transition metals. π-acceptor behavior of CO (MO diagram of CO, π-bonding of CO with metal (synergic effect) and use of IR data to explain extent of back bonding, bonding modes of CO, symmetry of metal carbonyls.
4.	4th week	Bonding between metal atoms and organic π- systems: linear (ethylene, allyl, butadiene) and cyclic (cyclopentadiene, benzene), Zeise's salt and comparison of synergic effect with that in carbonyls. Metal alkyls and Metal-carbene complexes
5.	5th week	Reaction of metal carbonyls: reduction, oxidation, photochemical substitution, migratory insertion of carbonyls, and nucleophilic addition of CO.
6.	6th week	Synthesis of metal-alkene complexes through ligand addition, reduction and substitution and reaction of metal bound alkenes, Zeise's salt
7.	7th week	Metal–sandwich compounds: Ferrocene: synthesis, physical properties and reactions: acylation, sulfonation, alkylation metallation, acetylation
8.	8th week	Chloromercuration, Mannich reaction, comparison of aromaticity
9.	9th Week	Reactivity of ferrocene with that of benzene.
10.	10th Week	Synthesis and reactions of Metal alkyls and Metal-carbenes
11.	11th Week	Alkene hydrogenation (using Wilkinson's Catalyst)
12.	12th Week	Synthetic gasoline preparation (Fischer Tropsch reaction)
13.	13th Week	Polymerisation of ethene using Ziegler-Natta catalyst
14.	14th Week	Wacker oxidation process (Smidth process)
15.	15th week	Hydroformylation reaction (Oxo-process)

16.	16th week	Monsanto Acetic Acid process
17.		Tests / Assignments