
11.1.14. Course Code: DSC14: CHEMISTRY-5 (C5)
Course Title: COORDINATION CHEMISTRY AND ORGANOMETALLICS

Total Credits: 04 (Credits: Theory-02, Practical-02)
(Total Lectures: Theory- 30, Practical-60)

Objectives: The course introduces the students to basics of coordination chemistry and organometallics which are of immense importance to biological systems, qualitative and quantitative analysis, catalysis, medicines, paints and pigments etc. Nomenclature, isomerism,

bonding in coordination compounds has been dealt with in sufficient detail along with special emphasis on important coordination compounds in the biological system. In organometallic chemistry, the students are introduced to classification of organometallic compounds, the concept of hapticity and the 18-electron rule governing the stability of a wide variety of organometallic species with special emphasis on metal carbonyls.

Learning Outcomes:

By the end of this course, students will be able to:

- Understand terms: ligand, denticity of ligands, chelate, coordination number.
- Systematically name coordination compounds.
- Discuss the various types of isomerism possible in Octahedral and Tetrahedral coordination compounds.
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes.
- Explain the meaning of the terms Δ_o , Δ_t , pairing energy, CFSE, high spin and low spin and how CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy.
- Explain magnetic properties and colour of complexes on basis of Crystal Field Theory
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species.
- Learn how IR data can be used to understand extent of back bonding in metal carbonyls

Unit I: Introduction to Coordination compounds

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands. Structural and stereoisomerism in complexes with coordination numbers 4 and 6.

(Lectures: 06)

UNIT II: Bonding in coordination compounds

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes, Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields, Crystal field stabilization energy (CFSE), concept of pairing energy, Factors affecting the magnitude of Δ , Spectrochemical series, Splitting of d orbitals in tetrahedral symmetry, Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry, Jahn-Teller distortion

(Lectures: 14)

UNIT III: Organometallic chemistry

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, sigma, pi and multicentre bonds), Structure and bonding of methyl lithium and Zeise's salt, Structure and bonding of ferrocene, mononuclear and polynuclear carbonyls of 3d metals, 18-electron rule as applied to carbonyls, π -acceptor behaviour of carbon monoxide (MO

diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

(Lectures: 10)

PRACTICALS: (Credits: 02; Laboratory Periods: 60)

1. Estimation of Mg^{2+} by direct complexometric titrations using EDTA.
2. Estimation of Zn^{2+} by direct complexometric titrations using EDTA.
3. Estimation of Ca^{2+} by direct complexometric titrations using EDTA.
4. Preparation of the following inorganic compounds and their characterization using appropriate analytical techniques:
 - (i) Tetraamminecopper(II) sulphate
 - (ii) Potassium trioxalatoferrate(III) trihydrate
 - (iii) Chrome alum
 - (iv) Cuprous chloride
 - (v) Manganese(III)phosphate ($MnPO_4 \cdot H_2O$)
 - (vi) Potash alum
 - (vii) Acetylacetonate complex of Cu^{2+} and Fe^{3+}
 - (viii) Tetraamminecarbonatocobalt(III)nitrate

REFERENCES:

Theory:

- Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education
- Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), Inorganic Chemistry 2nd Ed., Oxford University Press.
- Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Inorganic Chemistry, 5th Edition, W. H. Freeman and Company.
- Cotton, F.A.; Wilkinson, G.; Gaus, P.L. Basic Inorganic Chemistry, 3rd Edition, Wiley India.
- Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
- Greenwood, N.N.; Earnshaw, A. (1997), Chemistry of the Elements, 2nd Edition, Elsevier.

Practical:

- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.
- Marr, G.; Rockett, B.W. (1972), Practical Inorganic Chemistry, Van Nostrand Reinhold.

Teaching Learning Process:

- Conventional chalk and board teaching,
- Class interactions and discussions
- Power point presentation on important topics.

Assessment Methods:

- Class Tests at Periodic Intervals.
- Written assignment (s) / Presentation by individual students
- End semester University Theory and Practical Examination

Keywords: Coordination Compounds, Organometallic Chemistry.