Course Code	Course Name	Credits
26CH502	COORDINATION CHEMISTRY	04

Course Objectives

- To understand bonding in coordination compounds.
- To study reaction mechanisms of coordination compounds.
- To learn about electronic spectra of coordination compounds.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Understand bonding theories, molecular structure, and geometry using VB, MO, and VSEPR models.
- Apply Crystal Field Theory and MO concepts to explain bonding, spectra, and magnetic properties of complexes.
- Analyze electronic spectra, term symbols, and energy level diagrams of transition metal complexes.
- Evaluate isomerism and reaction mechanisms of coordination compounds, including substitution and electron transfer reactions.

Unit-1 – Bonding and Structure (12 Hrs.)

Types of bonds – ionic, covalent, coordinate, double and triple bonds; orbital symmetry and overlaps; valence bond theory; resonance and conditions of resonance; formal charge; hybridization and energetics of hybridization; molecular orbital theory – homo- and heteronuclear diatomic molecules; VSEPR model; shapes of molecules – methane, ethylene, acetylene, ammonia, water, ClF_3, ICl_4^-, TeF_5^-, I_3^-, $TeCl_6^{2-}$, XeF_6, $SbCl_6^{3-}$, IF_7, ReF_7, XeF_8^{2-}, TaF_8^{3-}.**Unit 2 – Crystal Field Theory (CFT) (12 Hrs.)**

Assumptions of CFT; crystal field splitting of d-orbitals in different geometries; crystal field stabilization energy (CFSE); measurement of Δ_o or 10 Dq; determination of CFSE; factors affecting magnitude of Δ_o or 10 Dq; consequences of crystal field splitting; merits and limitations of CFT; occupancy of d-orbitals in octahedral complexes – weak and strong field cases; high-spin and low-spin complexes; Jahn–Teller distortion – splitting pattern in trigonal pyramidal, square pyramidal and cubic symmetries; dynamic and static Jahn–Teller effect; consequences of Jahn–Teller effect; molecular orbital theory and energy level diagrams; concept of weak and strong fields; sigma and pi bonding in complexes; nephelauxetic effect.

Unit 3 - Term symbol (12 Hrs.)

Coupling scheme (L–S); spectroscopic term symbols for d^n ions – derivation and ground state term symbol; Hund's rules; selection rules; correlation diagrams; energy level diagrams; Orgel and Tanabe–Sugano diagrams; electronic spectra of d^1–d^9 complexes; evaluation of Dq and B values for octahedral complexes; charge transfer spectra; magnetic properties of coordination complexes.

Unit 4 – Isomerism of metal complexes (12 Hrs.)

Classification – structural isomerism, stereoisomerism and optical isomerism; experimental separation and identification of isomers by conductivity measurement, electrolysis, freezing point depression, IR spectroscopy, X-ray diffraction, dipole moment, NMR spectroscopy, mass spectroscopy; chemical methods – Grinberg's method; resolution of racemic mixture.

Unit 5 - Reactions of metal complex (12 Hrs.)

Labile and inert complexes; ligand displacement reactions in octahedral and square planar complexes; trans effect – theory and applications; mechanisms of substitution reactions; factors affecting rate of substitution in square planar complexes; electron transfer reactions – complementary and non-complementary types; inner-sphere and outer-sphere processes; applications of electron transfer reactions in inorganic complexes.

References:

1. J.E. Huheey, E.A. Keiter and R.L. Keier, Harper and Row, Inorganic Chemistry, 4th Edn., 1993.
2. Satya Prakash, G.D. Tuli, S.K. Basu, R.D. Madan, Advanced Inorganic Chemistry, Volume- I, 2014, S. Chand and Company Pvt. Ltd, New Delhi.
3. Ajai Kumar, Coordination Chemistry, 2014, Aarysh Educations, Ghaziabad, India.
4. R. Copalan, V. Ramalingam, Concise Coordination Chemistry, 2001, Vikas Publishing House Pvt. Ltd, New Delhi.

Websites and eLearning Sources:

1. https://nptel.ac.in/courses/104105033
2. https://youtu.be/k4VZWMFaAX0?si=6PwvXA067-KOJkT_
3. https://allen.in/jee/chemistry/isomerism-in-coordination-compounds

COs and Bloom's Taxonomy Mapping – 26CH502		
Course Outcomes	**On completing P.G. program the students will be able to**	**BTL**
CO1	Understand and recall the basic concept of electronic spectroscopy and magnetic properties of coordination chemistry.	K1, K2
CO2	Construct shapes of various molecules using VSEPR and MOT.	K3
CO3	Classify isomerism and analyze its experimental separation and identification by conductivity measurement.	K4
CO4	Determine crystal field theory and explain its consequences and Jahn teller distortion.	K5
CO5	Construct mechanism of substitution reactions and build reactions of metal complexes.	K6

BTL K1 and K2 – remembering and understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6- Create

Relationship Matrix – 26CH502												
Course Outcomes	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	1	1	1	3	2	2	1	1	1.7
CO2	2	3	2	1	1	1	2	3	2	2	1	1.8
CO3	2	2	3	2	1	1	2	3	3	2	2	2.1
CO4	2	2	3	2	2	1	2	2	3	3	2	2.2
CO5	2	2	3	2	2	3	2	2	3	3	3	2.5
											Total	2

Mean Score: 3- High, 2- Medium/Moderate, 1-Low