BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2020-21
COURSE HANDOUT

Date: 15.01.2021

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **CHEM F241**
Course Title : **Inorganic Chemistry-II**
Instructor-in-Charge : **SUROJIT PANDE**
Instructor(s) : -

1. Course Description:
Coordination Chemistry: Bonding - Valence Bond, Crystal Field, and Molecular Orbital theories; Complexes - nomenclature, isomerism, coordination numbers, structure, electronic spectra, magnetic properties, chelate effect; Reactions - nucleophilic substitution reactions, kinetics, mechanisms; descriptive chemistry of Lanthanides and Actinides; Organometallic Chemistry: structure and reaction of metal carbonyls, nitrosyls, dinitrogens, alkyls, carbenes, carbynes, carbides, alkenes, alkynes, and metallocenes; catalysis by organometallic compounds; stereochemically non-rigid molecules.

2. Scope and Objective of the Course:
Throughout the semester representative topics from inorganic chemistry will be discussed to expose the students to the theories of bonding, electronic spectra and magnetic properties of complexes, reactions of metal complexes, detailed description of organometallic compounds and chemistry of lanthanides and actinides. Various theories such as VBT, CFT followed by MOT will explain many topics encompassed by electronic spectra, magnetic properties and finally in organometallic complexes in the field of Inorganic Chemistry. However, we will strive in this course to address the most important theories and applications of Inorganic Chemistry with the state of the art level which may motivate the students towards research.

By the end of the semester, you will be able to
- Predict structure and geometry of inorganic complex
- Envisage spinel structure and chelate effect
- Learn the application of character table
- Investigate the origins of color and transitions in inorganic complexes
- Indentify the magnetic properties of inorganic compounds
- Be familiar with the organometallic reactions, mechanism, structure & bonding, catalytic properties
- Explore the chemistry of bridging ligands
- Be trained in *f*-block elements from the periodic table

3. Text Books:
T1. "Inorganic Chemistry – Principles of Structure and Reactivity" Huheey, J. E.; Keiter, E. A.; Keiter, R. L.; Medhi O. K.; 4th Edition, Pearson.

4. Reference Books:
R1. "Chemical Applications of Group Theory", F. Albert Cotton, 3rd Edition; A Wiley Interscience Publication
R2. "Concise Inorganic Chemistry", Lee, J.D. 5th Edition, Wiley India Edition.
R3. "Inorganic Chemistry", Shriver, D.F.; Atkins, P.W.; Overton T. L., Rourke, J. P., Weller, M. T., Armstrong, F. A. 4th edition, Oxford.

5. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
1: Crystal Field Theory	L 1.1: Crystal field splitting; *d* orbitals in different crystal fields L 1.2-1.3: applications of CFT such as predicting stability of spinels T1: Exercise based on CFT	T1: 428-444	Structure prediction of complexes using CFT
2: Character Table and its Applications	L 2.1: Reducible and Irreducible Representations L 2.2 Character Tables L 2.3 Optical Activity, Dipole Moments L 2.4-2.5 Infrared and Raman Spectroscopy, Bonding T2: Exercise based on applications of Character table	T1: 52-65 R1: 17-29; R1: 44-50; R1: 54-61; R1: 304-317; R1: 328-337	Application of character table, Verification of the optical activity, dipole moment, IR and Raman activity of compounds using group theory
3: MO theory of Coordination Compounds	L 3.1- 3.3: σ MO diagrams of octahedral, Tetrahedral and sq. planar complexes L 3.4-3.5: π MOs relation to crystal field splitting T3: Exercise based on MO theory	T1: 444-459 R1: 209-230	Structure elucidation using MOT
4: Electronic spectra of complexes	L 4.1-4.3: Term symbols; *d-d* transitions L 4.4-4.6: Tanabe-Sugano diagrams T4: Exercise based on electronic spectra	T1: 461-475 R1:253-281	Predicting the electronic transitions in a complex; Investigate the origins of color and transitions in inorganic complexes
5: Octahedral distortion; charge transfer	L 5.1: Stability through distortions L 5.2: Allowed charge transfer transitions T5: Exercise based on distortion	T1: 475-485	
6: Coordination Chemistry: Structure	L 6.1: Nomenclature; Geometry of the complexes based on coordination number	R2: 230-232 T1: 495-506 T1: 508-511 T1: 520-526	Naming the coordination complexes
7: Coordination Chemistry: Isomerism & Chelate Effect	L 7.1: Geometrical and Optical isomerism, Linkage, Ligand, Ionization, Solvate, Coordination isomerism, Stabilization due to entropy factors and electron delocalization in the rings	T1: 507-508 T1: 511-520 T1: 526-539 R2: 232-236 R3-225-229	Identification of geometrical and optical isomers possible for a given formula.
8: Magnetic Properties of Complexes	L 8.1: Para, ferro and antiferro-magnetisms; Spin transitions T6: Exercise based on nomenclature, isomerism and magnetic properties	T1: 485-492 R3-544-546	Identify the magnetic properties of inorganic

			compounds
9: Coordination Chemistry: Reactions	L 9.1: Substitution reactions in square planar complexes L 9.2: Trans Effect, Thermodynamic and Kinetic Stability L 9.3: Kinetics of Octahedral Substitution L 9.4: Mechanism of Redox reactions T 7: Exercise based on substitution reactions	T1: 542-569 R3: 551-576	Predict the reaction mechanisms of square planar and octahedral complexes
10: Introduction to organometallic chemistry, Metal carbonyl Complexes	L 10.1: The 18 electron rule, Preparation & properties of carbonyl complexes L 10.2: Polynuclear Carbonyl Complexes; Carbonylate ions; Carbonyl hydride complexes; Parallels with non-metal chemistry	T1: 572-600	Be familiar with the organometallic compounds, structure & bonding
11: Metal nitrosyl and dinitrogen complexes	L 11.1: Terminal and Bridging ligands; Geometry of complexes T8: Exercise based on metal carbonyl, nitrosyl and dinitrogen complexes	T1: 601-606	
12: Metal Alkyls, Carbenes, Carbynes and Carbides	L 12.1: Synthesis; Structure of ligands in complexes; Orbital representations of Fischer and Schrock Carbenes; structural examples of carbido complexes;	T1: 606-615	
13: Metallocenes	L 13.1: Molecular Orbitals of Metallocenes; Structures and Synthesis of Cyclopentadienyl compounds; Covalent versus ionic bonding; Arene complexes; Cycloheptatriene and tropylium complexes; Cyclooctatetraene and Cyclobutadiene complexes. T9: Exercise based on metal alkyls, carbenes, carbynes, carbides and metallocene	T1: 615-627	
14: Reactions of organometallic complexes	L 14.1: Substitution reactions in carbonyl complexes; Ligand Cone Angles; Oxidative Addition and Reductive Elimination; Insertion and Elimination L 14.2: Nucleophilic and electrophilic attack of coordinated ligands, Carbonylate anions as nucleophiles T10: Exercise based on reactions of	T1: 634-649	Study the mechanism, catalytic properties of organometallic complexes Explore the chemistry of bridging ligands

	organometallic complexes		
15: Catalysis by organometallic compounds	L 15.1: Alkene hydrogenation; Tolman Catalytic Loops; Synthesis Gas; Hydroformylation; Monsanto Acetic acid process L 15.2: The Wacker Process; Synthetic Gasoline; Ziegler-Natta Catalysis; Immobilized homogeneous catalyst; photodehydrogenation catalyst	T1: 649-661	
	T11: Exercise based on catalysis by organometallic compounds		
16: Stereochemically non-rigid molecules	L 16.1: Fluxional molecules, Techniques to study Fluxional molecules	T1: 196-202	Study of dynamic molecular structure
17: The Lanthanides and Actinides	L 17.1: Stable oxidation states; Lanthanide and Actinide Contractions, the f orbitals, L 17.2: Absorption Spectra; Magnetic Properties; Coordination Chemistry; Lanthanide Chelates; Transactinide elements; Periodicity of Translawrencium elements	T1: 407-419	f-block elements and their unique properties
	T12: Exercise based on Stereochemically non-rigid molecules, lanthanides and actinides		

6. Evaluation Scheme:

Component	**Duration**	**Weightage (%)**	**Date & Time**
Mid-Semester Test	90 min	30%	<TEST_MS>
Tutorials* (Quiz/Assignment)	----	30%	Continuous
Comprehensive Examination	120 min	40%	<TEST_C>

***Tutorials**: The tutorial hour will be used for a quick review of the highlights of the material covered in the lectures, clarification of doubts, and problem solving and conducting tests. Tutorial tests will be conducted through cloud instance of Nalanda only.

7. Chamber Consultation Hour: Thursday, 5.00 pm

8. Notices: Notices, if any, will be displayed **on Nalanda website.**

9. Make-up Policy: Make up would be considered only for **genuine cases.**

10. Note (if any): -

Instructor in-Charge
CHEM F241