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

SECOND SEMESTER 2020-21
COURSE HANDOUT

Date: 16.01.2021

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 G552**
Course Title : **Advanced Inorganic Chemistry**
Instructor-in-Charge : **BHARTI KHUNGAR**

1. Course Description: Bonding: ionic, metallic and covalent bonding; The concepts of symmetry and theory involved in group theory; Coordination chemistry: properties of *d* block elements, bonding in coordination chemistry, spectroscopy and magnetic properties of the coordination compounds, reaction, mechanism and kinetics involved in coordination chemistry; Organometallic chemistry: synthesis, structure and bonding; Inorganic chains and cages.

2. Scope and Objective of the Course: The course aims at covering topics in advanced areas of inorganic chemistry, with the broad classification of the entire subject into the domains viz., bonding, structure, coordination chemistry and organometallic chemistry. Starting with the fundamental principles and their applications, the ultimate purpose of this course is to provide a comprehensive survey involved in the different areas of inorganic chemistry before starting formal research in any of the chemistry areas.

3. Text Books: 'Inorganic Chemistry - Structure and Reactivity', James E. Huheey, Elien A. Keiter, Richard L. Keiter, Okhil K.Medhi, 4th Edition, Pearson Education.

4. Reference Books:

1. 'Chemical Applications of Group Theory' F. A Cotton, 3rd edition,
2. 'Inorganic chemistry', Albert Cotton, Geoffrey Wilkinson, 3rd Edition, Willey Eastern Limited.
3. 'Concise Inorganic Chemistry', J.D. Lee, 5th Edition,
4. 'Inorganic Chemistry', D.F. Shriver, P.W. Atkins, C.H. Langford, 1st edition, ELBS

5. Course Plan:

Module Number	Lecture session/Tutorial Session.	Reference	Learning Outcome
1. Molecular symmetry	L1-L2 Symmetry elements and operations, Point group and molecular symmetry	T1: Chapter 3 R1: Chapter 1	Analyzing the molecular symmetry, assigning point groups
2. Group Theory	L3-L7 Reducible and Irreducible Representations and Character Tables, Optical Activity, Dipole Moments, Infrared and Raman Spectroscopy, Bonding	T1: Pages 52-65 R1: Pages 17-29; 44-50; 54-61; 304-317; 328-337	Application of character table; Verification of the optical activity, dipole moment, IR and Raman activity of compounds using group theory
3. Ionic Bonding	L8-L9 Ionic bond, theoretical estimations of lattice energy; covalent character in ionic bonds, covalency polarization relations solids held together by covalent bonding	T1: Chapter 4	Understanding the ionic size effects on lattice energy, metallic bonding and charge conduction

4. Valence Shell Electron Pair Repulsion (VSEPR) theory	L10 Structures of molecules using VSEPR	T1: Chapter 6	Basic structure prediction of molecules using VSEPR
5. Coordination Chemistry: Valence Bond Theory (VBT)	L11-L12 concept of Valence Bond Theory and their application in coordination chemistry	T1: pages 118-129; 424-428	Understanding the coordination compounds by VBT
6. Coordination Chemistry: Crystal Field Theory (CFT)	L13-L15 Crystal field splitting of d orbitals, applications of CFT in predicting the stability of complexes/spinels	T1: pages 428–444	Structure prediction of complexes using CFT
7. Molecular Orbital Theory (MOT)	L16-L18 Quantum mechanical approach of σ and π MOs, Construction of MO diagrams for different molecules	T1: pages 444-459 R1: pages 209-230	Structure elucidation using MOT
8. Electronic spectra of complexes	L19-L22 Term symbols; d-d transitions; Tanabe-Sugano diagrams,	T1: pages 461-475 R1: pages 253-281	Predicting the electronic transitions in a complex; Investigate the origins of color and transitions in inorganic complexes
9. Octahedral distortion; charge transfer	L23-24 Stability through distortions; Allowed charge transfer transitions	T1: pages 475-485	
10. Magnetic Properties of Complexes	L25 Para, ferro and antiferromagnetisms; Spin transitions	T1: pages 485-492 R4: pages 544-546	Identify the magnetic properties of inorganic compounds
11. Coordination Chemistry: Reactions	L26-28 Substitution reactions in square planar complexes, Trans Effect, Mechanism; Thermodynamic and Kinetic Stability, Kinetics of Octahedral Substitution, Mechanism of Redox reactions	T1: pages 542-569	Understanding the fundamentals of coordination chemistry. Predicting the reaction mechanisms
12. Introduction to organometallic chemistry, Metal carbonyl Complexes	L29-31 The 18 electron rule, Preparation & properties of carbonyl complexes; Polynuclear Carbonyl Complexes; Carbonylate ions; Carbonyl hydride complexes; Parallels with non-metal chemistry	T1: pages 572-600	Understanding the concept of terminal and bridging ligands, organometallic chemistry of metal carbonyl complexes
13. Metal nitrosyl and dinitrogen complexes	L32 Terminal and Bridging ligands; Geometry of complexes	T1: pages 601-606	Understanding the structure and bonding of,

14. Metal Alkyls, Carbenes, Carbynes and Carbides	L33 Synthesis; Structure of ligands in complexes; Orbital representations of Fischer and Schrock Carbenes; structural examples of carbido complexes	T1: pages 606-615	nitrosyl, dinitrogen complexes, metal Alkyls, carbenes, carbynes, carbides and metallocenes
15. Metallocenes	L34 Molecular Orbitals of Metallocenes; Structures and Synthesis of Cyclopentadienyl compounds; Covalent versus ionic bonding; Arene complexes; Cycloheptatriene and tropylium complexes; Cyclooctatetraene and Cyclobutadiene complexes	T1: pages 615-627	
16. Reactions of organometallic complexes	L35-36 Substitution reactions in carbonyl complexes; Ligand Cone Angles; Oxidative Addition and Reductive Elimination; Insertion and Elimination; Nucleophilic and electrophilic attack of coordinated ligands; Carbonylate anions as nucleophiles	T1: pages 634-649	Learning the catalytic mechanism using organometallic complexes
17. Catalysis by organometallic compounds	L37-38 Alkene hydrogenation; Tolman Catalytic Loops; Synthesis Gas; Hydroformylation; Monsanto Acetic acid process; The Wacker Process; Synthetic Gasoline; Ziegler-Natta Catalysis	T1: pages 649-661	Exploring the catalytic potential of organometallic complexes
18. Inorganic chains, Rings and Cages	L39-40 Chain catenation, Heterocatenation, Silicate minerals, Intercalation Chemistry, Borazines, Boranes, Phosphazenes	T1: pages 292–313	Understanding the chemistry of main group elements

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time
Mid-Semester Test	90 Minutes	30	
Quiz/Assignment/Seminar	-	30	Continuous
Comprehensive Examination	120 Minutes	40	

7. Chamber Consultation Hour: Tuesday 11.00 am to 12.00 noon

8. Notices: Notices, if any, concerning the course will be displayed on Nalanda.

9. Make-up Policy: Make up will be allowed for **genuine cases as per institute rule.**

10. Note (if any): -

Instructor-in-charge
Course No. CHEM G552