KTT 212/3 - Inorganic Chemistry II

Course Objectives :

1) To introduce the basic aspects of coordination chemistry and the development of d-block elements or transition metals.
2) To gain some familiarity of the application of transition metal complexes in organometallic and bioinorganic fields.

Topic	**Content**	**Number of lecture hours**	**Expected outcome - upon completion of this course, the student should be able to:**
1. Introduction on Transition Metal Complexes or Coordination Compounds	• Background and the development in block d elements (transition metals) • Basic aspects related to the coordination compounds • Definition of coordination compounds • Coordination number and oxidation state for central metal atom • Characteristics and types of ligands	5	• Understand the differences between the block d and f elements with those from other groups. • Understand the basic terminologies including the coordination number, oxidation state of central metal atom, coordination sphere and Werner complexes. • Understand the fundamental concept related to the bond formation between metal and ligands such as the adduct formation based on Lewis acid-base interaction. • Understand the characteristics of coordination compounds, transition metal complexes, the development of these compounds from the experimental viewpoints and based on the postulates proposed by Werner and Jorgensen. • Understand the relationship between the electronic configuration of metals and the characteristics of its complexes. • Understand the basic characteristics and types of various ligands.
2. Structure, Isomerism and Nomenclature	• Establishment of different geometries and structures in transition metal complexes • Presence of isomers in transition metal complexes • The naming of transition metal complexes based on IUPAC system. • Concept of Soft and Hard Acid and Base (HSAB).	5	• Understand the concept towards the obtainment of various geometries depending on different coordination numbers. • Predict the geometry of transition metal complexes. • Uderstand the nomenclature of coordination compounds. • Write the name, chemical formula and structure for transition metal complexes. • Understand different types of ligands which give particular isomers consisting of 4 and 6 coordination numbers. • Adopt the concept of Lewis acid-base in the formation of transition metal complexes.

Topic	Content	Number of lecture hours	Expected outcome - upon completion of this course, the student should be able to:
3. Formation Constant for Transition Metal Complexes.	• Complex stability which can be deduced from the formation constant • Various factors which affect the complex stability • Chelate effect • Labile and inert concepts in transition metal complexes • Effective atomic number and 18-electron rules.	5	• Understand the basic concept related to the formation of coordination compounds which includes formation and stability constants for adducts and acid-base complexes. For instance, the stepwise formation constant and the overall formation constant. • Understand the characteristics of labile and inert based on thermodynamics and kinetics. • Discuss the main factors contributing to the complex formation, electronic effect, steric effect, chelate effect and the explanation based on the thermodynamic concept.
4. Preparation of Coordination Compounds and Spectroscopy	• Introduction on the preparative methods for transition metal complexes • Application of spectroscopy in characterization.	4	• Recognize the methods used in the preparation of transition metal complexes. • Understand the characterization techniques on transition metal complexes such as FTIR, UV-visible, FTNMR.
5. Bonding Theory in the Formation of Transition Metal Complexes	• Valence bond theory (VBT) • Crystal field theory (CFT) • Molecular orbital theory (MOT) • Metal-metal bond theory • Tanabe-Sugano diagram • Metal-metal bonding in the multinucleic compounds and cluster	9	• Understand the presence of different colors associated with various coordination compounds. • Understand the basic approach towards the development of all bonding theories including valence bond theory, crystal field theory and molecular orbital theory. • Discuss and understand the advantages and disadvantages of each theory when one needs to explain the bonding of transition metal complexes which possess 4 and 6 coordination numbers. • Understand the concepts related to back-bonding, Jahn-Teller effect, spectrochemical series, crystal field stabilization energy, splitting of degenerated d orbitals, pi bonding, strong and weak fields, high and low spins, paramagnetic, diamagnetic and metal-metal bonding. • Understand the information and evidence related to bonding theories. • Understand the concepts associated with labile and inert properties based on crystal field theory. • Apply the Tanabe-Sugano diagram in explaining the electronic spectroscopy (UV and visible) in transition metal complexes. • Understand the concept and approach related to the multiple bonding between the metals and the metal-metal bonding in the cluster compounds.

Topic	Content	Number of lecture hours	Expected outcome - upon completion of this course, the student should be able to:
6. Introduction on the Reaction Mechanism Leading to Transition Metal Complexes	• Introduction on the reaction mechanism which leads to the formation of coordination compounds	4	• Understand at least 3 types of reaction mechanisms which involve transition metal complexes; for example (i) associative, (ii) dissociative and (iii) redox. • Use the 'trans-effect' in facilitating the preparation of 4-coordination compounds.
7. Application of Transition Metal Complexes in Organometallic and Bioinorganics	• Discussion given is based on the concept associated with the formation of transition metal complexes which give the organometallic compounds and of those exist in life cycle • Introduction towards the nanomaterials obtainable from transition metals	4	• Understand the type of transition metals which are important for the biological systems and biochemistry. • Understand the importance of transition metals towards the mankind. • Understand the application of transition metals in medicine. • Understand the concept related to the formation of vitamins and haemoglobin, and also the role of transition metals in the respective mechanism. • Understand the role of transition metals (especially for organometallic compounds) as catalysts. • Understand the current development on nanomaterials obtained from transition metals and their roles in the preparation of nano materials.
TOTAL		**36**	