UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
DEPARTMENT OF CHEMISTRY
COURSE SYLLABUS
WINTER 2019

1. **Course: CHEMISTRY 333, Inorganic Chemistry: Transition Metals**

LEC	DAYS	TIME	ROOM	PROFESSOR	OFFICE	EMAIL	OFFICE HOURS
L01	MWF	11:00-11:50	ST 135	Dr. F. Jalilehvand	SB 213	faridehj@ucalgary.ca	By Appointment

To avoid IT problems, it is recommended that the students use their U of C account for all course correspondence. Please use "CHEM 333 inquiry" as the Subject of your e-mail.

Desire 2 Learn (D2L): CHEM 333 L01 - (Winter 2019) - Inorganic Chemistry: Transition Metals
https://d2l.ucalgary.ca/d2l/home/252812

Departmental Office: Room SA 229, Tel: (403) 220-5341, e-mail: uginfo@chem.ucalgary.ca

2. **Course Description:** ***Lectures:*** Bonding models for metals and for transition metal compounds; interpretation of redox and thermodynamic properties based on ligand field theory; coordination and organometallic compounds of the transition metals; metal complexes as catalysts in industry and biology**.** ***Laboratory:*** Synthesis, analysis, and physical investigations of transition metal compounds which illustrate their important properties.

3. **Recommended Textbook:** Missler, G. L.; Fischer, P. J., and Tarr, D. A., "Inorganic Chemistry", 5th Ed., Pearson, 2014 (available in the Bookstore)

4. **Topics Covered and Suggested Readings:**

Course Contents	**Chapter in Textbook** *(not all sections will be covered)*
TRANSITION METAL COMPLEXES – General Aspects Electronic Configuration of Transition Metal Atoms/ Ions (Review) Oxidation States Trends in 1st Ionization Energy, Atomic/ Ionic Size of d-block Elements Inner- vs. Outer-sphere Coordination Classification of Ligands Chelation Nomenclature	Chapters 9, 10
TRANSITION METAL COMPLEXES – Structural Aspects & Characterization Methods Coordination Number & Coordination Geometry X-ray Crystallography X-ray Absorption Spectroscopy Isomerism Symmetry (Review) IR Spectroscopy Hard Soft Acid Base (HSAB) Theory 18 Electron Rule Organometallic complexes	Chapters 6, 9, 13
TRANSITION METAL COMPLEXES – Properties & Bonding Theories Crystal Field Theory (CFT) Splitting, Spectrochemical Series, high and low spin, Jahn-Teller Effect Color and Electronic Absorption (UV-vis.) Spectra Electronic Transitions & Selection Rules Charge Transfer Solvatochromism & Thermochromism	Chapters 10, 11, 15

Magnetism & Magnetic Properties

Molecular Orbital Theory (MOT)
- σ and π-bonding
- Experimental Evidence for π-bonding (IR & Crystallography)
- Metal – Metal Bonding

TRANSITION METAL COMPLEXES – Reactions & Mechanisms Chapter 12

Kinetic vs. Thermodynamic Factors
Inert vs. Labile Complexes
Mechanisms
- Substitution Reactions
  - The Trans Effect
- Redox Reactions
  - Electron Transfer
  - Marcus Theory

TRANSITION METAL COMPLEXES – Applications

Bio-inorganic Chemistry N/A
- Biological Ligands
- Iron Transport & Storage
- Oxygen Transport & Storage (Hemoglobin & Homocyanin)
- Enzymes

Organometallic Reactions & Catalysis - Highlights Chapter 14

5. Laboratory Experiments: (10 weeks, 3 hours/ week)

1. Coordination Complexes of Cobalt (III) Amine Complexes

   Syntheses of $[Co(NH_3)_4(CO_3)]NO_3$ and $[Co(NH_3)_5Cl]Cl_2$, comparing their electrical conductance

2. Coordination Complexes - Geometrical Isomerism in Octahedral Complexes

   Syntheses of *cis*- and *trans*- isomers of $[Co(en)_2Cl_2]Cl$, comparing their UV-vis. spectra

3. Optical Activity at an Octahedral Cobalt Complex (2 weeks)

   Preparation of a racemic mixture of $[Co(en)_3](SO_4)Cl$ (en = ethylenediamine); separation of enantiomers using barium (+)-tartarate; cleaving the resolving agent from [(+)-$Co(en)_3$] [(+)-tart]Cl and formation of [(+)-$Co(en)_3]I_3.H_2O$; using a polarimeter to determine [α_D] for the later complex 2.

4. Carbonyl Complexes (2 weeks)

   Syntheses of $Mo(CO)_4(bpy)$ (bpy = 2,2′-bipyridine) and two isomers of $Mo(CO)_4(PPh_3)_2$ from $Mo(CO)_6$; their structural characterization using IR spectroscopy

5. The Paramagnetic Complex $Mn(acac)_3$

   Synthesis of $Mn(acac)_3$ complex (Hacac = acetylacetone) and finding its spin state (high-spin or low-spin) by measuring its magnetic susceptibility

6. Chemistry of Titanium (III) (in aqueous solution)

   Synthesis of $[Ti(H_2O)_6]Cl_3$ by electrolytic reduction of $TiCl_4$, and measuring its UV-vis. spectrum; analyzing %Ti(III) in solution using titration; chemical reactions of Ti(III)

7. Magnetochemistry & Electronic Spectra of Ni(II) Complexes with Different Coordination Environments (2 weeks)

   Syntheses of $[NiBr_2(PPh_3)_2]$, $[Ni(NH_3)_6]Cl_2$ and bis(triphenylphosphine)dithiocyanatonickel(II), correlating their magnetic susceptibilities and UV-vis spectra with their coordination geometries; identifying SCN^- coordination mode to Ni(II) ion using IR spectroscopy.

Department Approval: Approved by Department Head Date: January 7, 2019