SC/CHEM 3030 3.0 Transition Metal Chemistry

Term	Fall 2018		
Location and Time	Lectures	MWF	12:30PM – 1:30PM (CLH M)
	Tutorials	MW	8:30AM – 9:30AM (CLH M)
Prerequisite	SC/CHEM 2030 3.0	Basic Inorganic Chemistry; AND	
	SC/CHEM 2020 6.0	Introductory Organic Chemistry I; or	
	SC/CHEM 2021 3.0	Introductory Organic Chemistry II	

Contact Information

Course Director:	Prof. Gino G. Lavoie
E-mail:	glavoie@yorku.ca
Phone:	ext. 77728
Office:	PSE 145
Office hour:	Fridays 1:30PM – 2:20PM (strictly to address issues that cannot be covered in tutorials)

Course Description

The chemistry of the transition metals is discussed from an historical perspective and within the context of modern theories of bonding, structure and spectroscopy. Topics include classical coordination compounds and their spectroscopy, organometallic complexes (including metallocenes, metal carbonyls and metal alkyls), their reactivity and use in catalysis. The course is a continuation of lower level SC/CHEM 1000 and 2000 inorganic (and organic) chemistry courses, and builds upon concepts learned therein.

Purpose and Objectives of the Course

The purpose of the course is to further expand the knowledge gained in general chemistry, and in introductory inorganic and organic chemistry courses. The course focuses on the chemistry of d-block transition metals. At the end of the course, students should be able to:

1. communicate effectively with chemists in the field using proper nomenclature, including knowing the first-row transition metals and their respective group number (Groups 3–12);
2. assign group points and derive the irreducible representation of transition metal complexes;
3. derive the ground-state electronic configuration (using microstates and term symbols) for any transition metals with one or more d-electrons, and predict/explain absorption in UV-Vis spectra;
4. use the crystal field theory, the angular overlap model and the molecular orbital theory (using ligand group orbitals) to derive energy diagrams for transition metal complexes;
5. assign oxidation state of metals, determine the total number of valence electron in complexes, and explain the binding mode of ligands;
6. name and assign reaction classes that complexes undergo, and draw catalytic cycles for well-known transition metal-mediated transformations;
7. describe other concepts presented in class, such as the electroneutrality principle, the Kepert model, the isolobal analogy, the turnover number and turnover frequency, etc.

Course Outline (subject to change)

1. Molecular Symmetry (Chap. 3 from Housecroft and Sharpe's *Inorganic Chemistry*, 4th Ed.)
    a. Symmetry operations and elements
    b. Point groups and character tables
    c. Reducible and irreducible representations
2. Bonding in Polyatomic Molecules (Chap. 5)
    a. Molecular orbital theory (polyatomics)
    b. Application of character tables
    c. Ligand group orbitals/symmetry-adapted linear combinations
    d. Linear combination of atomic orbitals
3. *d*-Block Metal Chemistry (general consideration) (Chap. 19)
    a. Ground-state electronic configurations
    b. Electroneutrality principle
    c. Kepert model
    d. Coordination numbers (incl. isomerism)
    e. Total valence electron count
4. Coordination Complexes (Chap. 20)
    a. Crystal field theory
    b. Angular overlap model
    c. Molecular orbital theory (transition metal complexes)
    d. Microstates and term symbols
    e. Electronic absorption spectroscopy
5. Organometallic Complexes (Chap. 24)
    a. σ- and π-Ligands
    b. 18-Valence electron rule
    c. Isolobal analogy
    d. Reaction classes
6. Reaction Mechanisms (Chap. 26)
    a. Dissociation, association and interchange mechanisms
    b. Thermodynamics and kinetics
    c. Substitutions in square planar complexes
    d. Inner- and outer-sphere electron transfers
7. Catalysis (Chap. 25)
    a. Homogeneous and heterogeneous catalysis
    b. Catalytic reactions and catalytic cycles (polymerization, hydrogenation, hydroformylation and metathesis of alkenes, oxidation, cross-coupling, etc.)

Organization of the Course

A number of pedagogical approaches will be used to deliver the course and achieve the objectives. Lectures will be delivered by the course director using slide shows. A copy of the slides with missing key words will be provided on Moodle. The course will require active participation of the students using "polls" held during each class, and unannounced "quizzes" (see details below). Tutorial sessions, when confirmed by the course director, will be on either Monday or Wednesday (8:30–9:20 in CLH M).

Sample problems will be assigned on a regular basis to facilitate learning of the concepts presented in class. These problems will be taken mostly from *Inorganic Chemistry*, 4th Edition by C.E. Housecroft and A.G. Sharpe. The problems will NOT be graded as the answers are included at the end of the textbook. This is NOT part of the final grade for the course.

Evaluation

Class polls and quizzes (see details below)	10%
Midterm exam 1 (50 min; **Oct. 5th**)	20%
Midterm exam 2 (50 min; **Nov. 5th**)	25%
Final exam (3 h)	45%

No make-up midterm exams will be available. The weight of any midterm exam missed will be added to the final exam IF AND ONLY IF a valid medical reason is provided to the course director. The "Attending Physician's Statement" (available at https://secure.students.yorku.ca/pdf/attending-physicians-statement.pdf) MUST be filled out by a medical doctor (M.D.) and provided to the course director within one week of the missed test. Otherwise, a grade of zero will result.

Students who have a conflict with a religious holiday must contact the course director at least two weeks prior to the exam to learn how they will be accommodated. Late requests will likely not be accepted for consideration.

Class Polling and Pop Quizzes

Polling (and quizzing) exercises will begin on September 7th. Marks earned from these exercises will count towards the final grade starting on September 19th (i.e., the first class after the last day to enroll in the course without permission, Sept. 18th). It is the responsibility of the student to install the Reef app on their devices to participate in those exercises and to become proficient in its use.

iClicker Cloud (used in conjunction with Reef) has an attendance feature that allows the course director to determine who is polling from the classroom rather than from home. **The course director will be taking attendance on random days**. Students not in the classroom will not have their polling answers count for marks on those days. No accommodation will be granted for absences during class polling.

There are 28 lectures (not including those used for midterms) from September 19th to December 3rd. No polling for marks will be performed during tutorial times (and midterms). Each class provides a chance to earn 1 "raw mark" out of a potential 28 marks throughout the term. Twenty-five (25) days will be "normal" class days (with class polling) and the remaining three (3) days will be "pop quiz" days, which will be unannounced (see details below).

On "normal" class days, it does not matter if the question is answered correctly or not. Students will earn 1 raw mark for answering **all** questions on the particular class day.

On "pop quiz" days, there will be 4 (or 5) questions asked. Each question will be graded according to whether or not the answer is correct. Each pop quiz question is worth 0.25 (or 0.20) raw marks, meaning getting all 4 (or 5) questions correct gives a student 1 raw mark. Pop-quizzes will be treated as closed-book assessments. Students will be expected **not to communicate with others** during this time. Failure to do so represents a breach in academic integrity (see details below) and will be treated according to the University policy.

The **28 possible raw marks** accumulated will count towards the final course polling grade in a bracketed scheme as follows:

≥22.0 raw marks: full polling credit (10% towards final course grade)
≥18.0 and <22.0 raw marks: 70% polling credit (7% towards final course grade)
≥14.0 and <18.0 raw marks: 50% polling credit (5% towards final course grade)
≥10.0 and <14.0 raw marks: 30% polling credit (3% towards final course grade)
<10.0 raw marks: no polling credit (0% towards final course grade)

This bracketed policy accounts for occasional absences due to illness, forgotten devices, religious obligations and other unforeseen circumstances. The course director will not look for or accept documentation for absences related to this course component.

Important Dates

Sept. 5	F18 Classes start (first CHEM 3030 class: Sept. 5)
Sept. 18	Last date to enrol in CHEM 3030 without permission (no permission will be granted to enrol past this date)
Sept. 19	**Class polls and pop quizzes start counting toward the final grade**
Oct. 5	**Mid-Term Exam 1** (held in class)
Oct. 6–12	Fall reading week (no classes held)
Nov. 5	**Mid-Term Exam 2** (held in class)
Nov. 9	Last date to drop a course without receiving a grade
Nov. 10–Dec. 4	Course withdrawal period (and receive a grade of "W" on transcript)
Dec. 4	F18 Classes end (last CHEM 3030 class: Dec. 3)
Dec. 6–21	**Final examination**. Students are expected to be available at all times during the Fall examination period and must not make travel plans within that period.

Textbooks/Course Kit

Much of the course will be based on the following textbook, including recommended practice problems to enhance concepts presented in class:

Housecroft, C. E.; Sharpe, A. G. *Inorganic Chemistry.* 4th Eds. (2012) Wiley-Interscience Publication.

In addition to the above textbook, materials from the following textbook will also be presented, with relevant sections available on Moodle free of charge.

Miessler, G. L.; Fischer, P. J.; Tarr, D. A. *Inorganic Chemistry.* 5th Ed. (2014) Pearson.

Many other books presenting concepts of transition metal chemistry are available at the Steacie Library. The following textbooks (in addition to current and previous edition of the ones above) are on reserve at the Library and can be borrowed on a short-term basis.

Miessler, G. L.; Tarr, D. A. *Student Solution Manual: Inorganic Chemistry.* 4th Ed. (2011) Pearson.

Shriver, D.; Weller, M.; Overton, T.; Rourke, J; Armstrong, F. *Inorganic Chemistry.* 6th Ed. (2014) Freeman.

Crabtree, R. H. *The Organometallic Chemistry of the Transition Metals*. 5th Ed. (2010) Wiley.

Douglas, B.; McDaniel D.; Alexander, J. *Concepts and Models of Inorganic Chemistry*. 3rd Ed. (1994) Wiley.

Supplementary Activities

Students are encouraged to attend organometallic/inorganic seminars given by internal and external (invited) speakers, normally held on Thursday afternoons. The Course Director will bring such seminars to the attention of the class.

E-mail Communications

E-mail messages must have “CHEM 3030” as subject line. Most course-related questions and issues will however be addressed during class or during tutorial. Any administrative questions and issues should be directed to the Undergraduate Program Assistant in the Chemistry Building (CB 124).

Grading Scheme and Academic Integrity

The grading scheme for the course conforms to the point system used in other undergraduate programs at York. The final grade for the course will be calculated using the grading scheme listed above under "**Evaluation**".

Academic Integrity

In addition, students are expected to abide by rules set forth by York University. Any cases of academic misconduct or dishonesty will be treated accordingly. Ignorance of the Policies is not an acceptable excuse and students are strongly encouraged to become familiar with such Policies. The link to the Academic Integrity for Students web site is provided for convenience (http://www.yorku.ca/academicintegrity/students/index.htm). Students MUST also complete the Academic Integrity Tutorial, if they haven't already done so (http://www.yorku.ca/tutorial/academic_integrity/).

Counselling and Disabilities

According to York University policy, arrangements for students with disabilities should be made before the start of the academic term. Failure to do so may prevent services from being available (http://www.yorku.ca/web/futurestudents/requirements/disabilities.html).

Attending university and coping with all the expectations, over and above other responsibilities you may have outside school, can be very challenging. A number of options are available to you, on and off campus, to help you deal and cope with difficult situations. For example, York University offers **personal counselling services** (www.yorku.ca/cds/pcs). They are located in Room N110 of the Bennett Centre for Student Services and can be reached at ext. 55297). Alternatively, postsecondary students in Ontario can call 1-866-925-5454 to reach the **Good2Talk helpline** (www.good2talk.ca). In addition, Prof. Lavoie has been trained by the Centre for Human Rights and is familiar with issues related to sexually and gender diverse individuals (http://rights.info.yorku.ca/positive-space/). His office (PSE 145) is a designated "**Positive Space**".

Pan-University Statement

Students must make themselves aware of university policies on Academic Honesty/Integrity, Access/Disability, Student Conduct, Religious Observance and other matters. A periodically updated Information Sheet summarizing this information can be downloaded (see http://secretariat.info.yorku.ca/files/CourseInformationForStudentsAugust20121.pdf) and printed. The Registrar's Office issues a list of Religious Observance Days available at http://registrar.yorku.ca/enrol/dates/religious-accommodation-guidelines-2018-2019.

(updated on September 5th, 2018 at 13:30)