Physical Inorganic Chemistry Course Syllabus

Winter 2024, Chem 3031

Course Instructor: Jennifer Chen

How to address me: Professor or Dr. Chen

Personal Pronouns: (she/her/hers)

Email: jilchen@yorku.ca

Note: If you have or question or would like to talk with me, you can send an email to make an appointment (on zoom or in-person).

Appointment times: see Calendly link on eClass

Class Times: MWF, 12:30 pm – 1:20 pm

Class Location: See registrar calendar

Course Format: in-person lectures. Lectures may be recorded and posted on eClass; however recording should not be treated as the primary mode of learning because of unexpected technical issues

Prerequisites: CHEM 3030

Office Location: CB 456

Course Description. This course builds on materials presented in Chem 2030 and Chem 3030 and is divided into three major areas. The first part of the course deals with spectroscopies for structural determination of inorganic compounds. The second part of the course examines the theories for describing the bonding and properties of inorganic compounds. The third part of the course introduces 1D and solid state materials, with emphases on their electronic properties and technological applications.

Course Objectives. At the end of this course students will have an appreciation for the theory and physical characterization techniques for inorganic compounds and solid state materials. Students will also be exposed to the application of these compounds in relation to real world and industrial processes.

Recommended texts and references (in Steacie Reserve):

Inorganic Spectroscopic Methods (Oxford chemistry primer) - A. Brisdon
Miessler and Tarr Inorganic Chemistry
Housecroft and Sharpe Inorganic Chemistry
Solid State Chemistry An Introduction – Smart and Moore
(http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=2557475)
Basic Solid State Chemistry – A. R. West
Chemical Applications of Group Theory – A. Cotton
Understanding Inorganic Chemistry– J. Barrett
The Electronic Structure and Chemistry of Solids – P. A. Cox

Evaluation:

Adjusted Mar. 25*
Quizzes[1] – 20% total
2 Midterm tests – 20% each*
Written assignment – 15%
Final exam – 25%[3*]

[1]Quizzes (~5) based on problem sets will either be in-class (pop quiz) or on eClass. Missed quizzes will not be rescheduled and will count as zero.

[3]Final exam will focus on the second part of the course (not cumulative unless a midterm was missed, see course policies below).

Missed midterm test will not be rescheduled and the weight will be added to the final exam, which would contain additional sections corresponding to the first part of the course.

*Alternative marking scheme: 1 midterm test at 20% and the final exam at 45% where an additional section corresponding to the first part of the course is to be completed; the other evaluations remain the same (quizzes – 20%, written assignment – 15%)

Tentative Schedule:

Midterm tests: Feb. 9, Mar. 15
Written assignment: Mar. 25

Final exam period: Apr. 10 – Apr. 26 (must stay for the whole period)

Learning Outcomes:
Upon completion of the course, students will be able to:

1. Predict the NMR and ESR spectra of inorganic complexes containing nuclei of different spins and abundance
2. Solve the structure of inorganic compounds through a combination of magnetic resonance, vibrational, optical and photoelectron spectroscopies.
3. Summarize the working principle of spectroscopic techniques for characterizing inorganic compounds; they include Circular Dichroism, Raman Spectroscopy, X-ray diffraction, Neutron diffraction, and Photoelectron Spectroscopy
4. Apply symmetry operations to identify the point group of a compound
5. Generate irreducible representations that are used to predict the IR and Raman vibrational modes
6. Derive molecular orbitals (MOs) of diatomic, polyatomic and coordination complexes based on symmetry-adapted linear-combination of atomic orbitals
7. Deduce MOs of molecules of various geometry and symmetry groups based on σ interactions (they include linear, trigonal planar, trigonal pyramidal, square planar, square pyramidal and octahedral molecules)
8. Critically evaluate how sigma and pi interactions affect MO
9. Use the angular-overlap approximation to predict the relative energies of the metal d orbitals, evaluate the lability of ligands and the likelihood of a Jahn-Teller distortion
10. Apply frontier orbital theory to explain chemical reactivity such as acid-base reactions
11. Analyze chemical equilibria state using hard-soft acid-base theory
12. Summarize band theory for 1D chain from the extension of LCAO
13. Critically comment on the band theory from atomic orbitals and MO perspectives
14. Describe the electronic properties based on band theory of 1D materials such as molecular stackers (metal glyxoimates, Krogmann's salt) and polymers (Silicon pthalocyanine, polyferrocenylsilane)
15. Summarize the origin and effect of Peierl's distortion on 1D structures (e.g. temperature and pressure dependence, metal-to-non-metal transition at low temperature)
16. Describe the bonding and properties of different types of 1D intervalence charge transfer compounds (e.g. Wolfram's salt, Prussian Blue)
17. Apply band theory to 3D solids and describe the electronic properties of metal, doped and undoped semiconductors, and insulator
18. Describe the different chemical bonding in solids and complex crystal structures including perovskite and magnetite
19. Provide examples of the synthesis of solid state materials and their applications

Course policies:
1. Email etiquette:

- **You must use your YorkU email address and put "Chem 3031" in the subject line**. Emails not conforming to the rules may go into the spam folder and will not receive a response.
- As a courtesy and being respectful to your correspondent, write your email professionally (i.e. text-messaging language is unacceptable). Questions regarding calculations or involving equations should be avoided and are best discussed in person during office hour.

2. Missed exam:

- **If you miss a midterm**, no document is required. The weight of the missed midterm will be added to the final exam automatically. There will be an additional part of the final exam to be completed within the same duration.
- **If you miss both midterms**, you will be required to write a make-up test for 20% of your mark. The other missed midterm will be added to the final exam (as above)
- Deferred standing for final exam is rarely granted and petition to your home faculty will be required. A two-day notice will be given for the makeup final exam. Denied petitions will result in a zero on the final exam. See http://www.registrar.yorku.ca/petitions/academic/for information.

3. Re-grading of course work:

- If you believe a written answer on a test was marked incorrectly, you must resubmit it to me detailing your rationale within 5 business days of the return of the test. For tests done in person, ONLY those answers written in ink are eligible for re-marking. NOTE: re-marking can result in the mark being raised, confirmed, or lowered.

4. Academic Honesty

- **Any student who breaches York's Academic Honesty Policy will be charged**. Some offences include:
  - Plagiarism (see White Paper - Plagiarism Spectrum on eClass)
  - Students who misrepresent themselves during iClicker activity, a quiz or examination
  - Students who engage in unauthorized collaboration (e.g. sharing work or answer for on-line quiz)
  - Students who submit any material for remarking that has been modified in any manner to misrepresent the original assessment

Important Information for All Students:

All students are expected to familiarize themselves with the following information, at *http://secretariat-policies.info.yorku.ca/*.

• York's Academic Honesty Policy
• Policy on Accommodation for Students with Disabilities
• Code of Student Rights and Responsibilities
• Policy on Religious Observance Accommodation