

# CHM 338H1Y: Intermediate Inorganic Chemistry

## I CONTACTS

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### INSTRUCTOR

Name: Professor Douglas Stephan

Email: [douglas.stephan@utoronto.ca](mailto:douglas.stephan@utoronto.ca)

Availability for online student hours: 1:00-5:30 pm (M-F) see:  
<https://outlook.office365.com/owa/calendar/DouglasStephan@utoronto.onmicrosoft.com/bookings/>

### LAB COORDINATOR

Name: Professor John De Backere

Email: [john.debackere@utoronto.ca](mailto:john.debackere@utoronto.ca)

Office: LM 223, *Student Hours TBD*

## II COURSE OVERVIEW

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### COURSE DESCRIPTION:

This course will cover the following topics:

- *Coordination Chemistry*: bonding, electronic spectra, magnetic properties, reactivity trends, and reaction mechanisms.
- *Organometallics*: M-C and M-H compounds, synthesis and reactivity.
- *Catalysis*: Hydrogenation and various other industrial processes, mechanisms of action and applications.

### STUDENT LEARNING OUTCOMES:

To give the student a clear understanding of the basics of the properties and chemistry of transition metals and its application in catalysis.

On successful completion of this course, students will be able to:

1. Understand color and magnetic properties of transition metal complexes
2. Understand the common bonding models for transition metal complexes
3. Understand the basic reactivity patterns for transition metal coordination complexes
4. Understand the synthesis and reactivity patterns for transition metal organometallic complexes
5. Understand the applications and mechanisms of action of organometallic complexes in several catalytic applications
6. Understand the potential of main group compounds in catalysis
7. Be aware of some of the major challenges in catalysis

### PREREQUISITE COURSE:

The prerequisite for this course is CHM 238Y1 (Introduction to Inorganic Chemistry).

*Recommended Preparation*: CHM217H1, CHM247H1/CHM249H1

### Recommended Supplemental Texts (Optional):

- Inorganic Chemistry, 5th Edition, C. Housecroft, Pearson, New York (2018).
- Inorganic Chemistry, 7th Edition, M. Weller, T. Overton, J. Rourke and F. Armstrong, Oxford University Press, New York (2018)

### III HOW THE COURSE IS ORGANIZED

For the 2020-2021 academic year, CHM 338H1Y will be taught throughout the fall and the winter semesters. The lecture materials will be on-line only during the Fall 2020 semester. Lectures will be posted on Quercus and will be available for asynchronous viewing. The content covered in two lectures will be broken into smaller sections and uploaded each Thursday. Students are expected to view the appropriate content prior to the normal lecture time, when the instructor will discuss/review the material and answer students' questions. Each Wednesday, there will be short on-line quizzes due by the end of class (4 p.m.), which are open-book and designed to encourage every student to stay up to date with the material. The laboratory section of this course will be offered during the Winter 2021 semester, and is scheduled to take place as weekly in-person activities. Please note that the Fall/Winter 2020-2021 timetable is subject to change, and we encourage you to check back often (<https://timetable.iit.artsci.utoronto.ca/>) for updates.

### COURSE SCHEDULE & RELEVANT SESSIONAL DATES:

LECTURE DATES	UNIT	SUBJECT
Sept 14/16	Introduction to the Transition metals	1. The periodic table 2. Basic terms
Sept 21/23	Ligand and coordination chemistry	3. classical ligands 4. non-classical ligands 5. Ligand Properties 6. isomers and chirality
Sept 28/30	Survey of the Transition metals.	7. first row of transition metals 8. heavy metals
Oct 5/7	Bonding theories and Absorption Spectroscopy	9. crystal field theory 10. CFT-part 2 11. molecular orbital theory 12. multiple electron systems 13. Other Absorptions
Oct 12	THANKSGIVING	
Oct 14/19	Magnetism and spectroscopy	14. Magnetism 15. EPR spectroscopy 16. NMR spectroscopy-basics 17. NMR spectroscopy-special
<b>OCT 21</b>	<b>MIDTERM</b>	
Oct 26/28	Species with Metal-Carbon $\sigma$ -bonds.	18. Metal Carbonyl preparation 19. Metal-Carbon bonds
Nov 2/4	Species with Metal-Carbon $\pi$ -bonds, Metal-Hydrides and metal-small molecule interactions	20. Metal-olefins 21. Metal-alkynes 22. Metal-Allyl species 23. Cyclopentadienyls etc. 24. Metal Hydrides

		25. Interactions with small molecules
Nov 7/9	READING WEEK	
Nov 16/18	Reactions of Organometallics and Hydrogenation Catalysis	26. substitution reactions 27. Oxidative Addition 28. Reductive elimination 29. Insertion 30. Hydrogenation catalysis 31. Wilkinson's catalyst 32. P3RhCOH 33. Schrock's catalyst
<b>Nov 23</b>	<b>MIDTERM 2</b>	
Nov 25	Other Catalysis	34. Asymmetric reductions 35. Hydrosilylation 36. Monsanto acetic acid 37. Hydroformylation 38. Polymerization 39. Metathesis 40. Fischer Tropsch
Nov 30/Dec 2	Frustrated Lewis pairs	41. The concept 42. Hydrogenation 43. Activation of small molecules
Dec 7	REVIEW	
Jan 4 - Apr 1	<b>In-Person</b> Laboratory Sessions	<i>Experiments to be announced</i>

### LABORATORY OBJECTIVES:

Upon completing the practical experiments of this course, students will be able to:

- i) safely synthesize and characterize a variety of inorganic compounds using standard laboratory techniques and spectroscopic methods;
- ii) apply the fundamental principles learned in lecture to explain the properties and aspects of the inorganic systems investigated;
- iii) interpret data and clearly/concisely communicate results using proper scientific writing through lab reports;
- iv) use the scientific literature to prepare for, understand, and evaluate experimental procedures and results.

### IV EVALUATION/GRADING SCHEME

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Quizzes	10% (quizzes due at the end of each Week during Fall semester)
Mid-term1*	15% (Oct 21)
Mid-term2*	15% (Nov 23)
Laboratory	30% (offered during the Winter semester:in-person)
Final Assessment	30% (Date to be determined)

The marks on the 2 mid-terms will be weighted such that the higher grade will be weighted to 20% of the total grade and the lower only 10%.

### V COURSE POLICIES

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- I will make every effort to respond to email within 24 h on weekdays ([douglas.stephan@utoronto.ca](mailto:douglas.stephan@utoronto.ca)).

- Student hours: I will be available M-F (1-5:30 pm); barring other commitments. Please use the link below to arrange a TEAMS meeting using the booking webpage: <https://outlook.office365.com/owa/calendar/DouglasStephan@utoronto.onmicrosoft.com/bookings/>
- All members of CHM338H1Y agree to fulfill the University's statement regarding a positive learning environment: *"The University of Toronto is committed to equity, human rights, and respect for diversity. All members of the learning environment in this course should strive to create an atmosphere of mutual respect where all members of our community can express themselves, engage with each other, and respect one another's differences. U of T does not condone discrimination or harassment against any persons or communities."*
- This course, including your participation, will be recorded on video and will be available to students in the course for viewing remotely and after each session.  
Course videos and materials belong to your instructor, the University, and/or other source depending on the specific facts of each situation, and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.
- The deadlines for quizzes posted on Quercus. Late submissions will not be accepted (i.e. a grade of zero will be assigned for a quiz submission after the due date).
- The midterm will be posted and a 2h time limit placed on submission. Students are expected to answer these questions without aid or notes. If you are absent for a medically documented reason, there will be no make up exam, rather your average will be calculated with increase weight on the final assessment.

## **VI TECHNOLOGY REQUIREMENTS**

Specific guidance from the U of T Vice-Provost, Students regarding student technology requirements is available here: <https://www.viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/>

Advice for students more broadly regarding online learning is available here: <https://onlinelearning.utoronto.ca/getting-ready-for-online/>

This course requires the use of computers, and of course sometimes things can go wrong when using them. You are responsible for ensuring that you maintain regular backup copies of your files, use antivirus software (if using your own computer), and schedule enough time when completing an assignment to allow for delays due to technical difficulties. Computer viruses, crashed hard drives, broken printers, lost or corrupted files, incompatible file formats, and similar mishaps are common issues when using technology, and are not acceptable grounds for a deadline extension.

## **VII INSTITUTIONAL POLICIES AND SUPPORT**

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### **ACADEMIC INTEGRITY**

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behavior on Academic Matters (<https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019>) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

In papers, assignments and laboratory reports:

1. Using someone else's ideas or words without appropriate acknowledgement.
2. Submitting your own work in more than one course without the permission of the instructor.
3. Making up sources or facts.
4. Obtaining or providing unauthorized assistance on any assignment.

On tests and exams:

1. Using or possessing unauthorized aids.
2. Looking at someone else's answers during an exam or test.
3. Misrepresenting your identity.

In academic work:

1. Falsifying institutional documents or grades.
2. Falsifying or altering any documentation required by the University.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behavior on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behavior or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see <https://www.academicintegrity.utoronto.ca/>).

### **Use of Turnitin**

Normally, students will be required to submit their course essays to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so,

students will allow their essays to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site.

### **COPYRIGHT**

Course videos and materials belong to your instructor, the University, and/or other source depending on the specific facts of each situation and are protected by copyright. In this course, you are permitted to download session videos and materials for your own academic use, but you should not copy, share, or use them for any other purpose without the explicit permission of the instructor.

### **ACCESSIBILITY NEEDS**

Students with diverse learning styles and needs are welcome in this course. The University of Toronto is committed to accessibility: if you require accommodations for a disability, or have any other accessibility concerns about the course, please contact [Accessibility Services](#) as soon as possible.

### **ADDITIONAL SERVICES and SUPPORT**

The following are some important links to help you with academic and/or technical service and support

- General student services and resources at [Student Life](#)
- Full library service through [University of Toronto Libraries](#)
- Resources on conducting online research through [University Libraries Research](#)
- Resources on academic support from the [Academic Success Centre](#)
- Learner support at the [Writing Centre](#)
- Information for [Technical Support/Quercus Support](#)