

Chemistry 4000/5000: Organometallic Chemistry
Fall 2016

Professor: Dr. P. G. Hayes

Contact Information: Office: E870 (University Hall)

E-mail: p.hayes@uleth.ca

URL: <http://people.uleth.ca/~p.hayes/>

Phone: (403) 329-2313

Office Hours: 9:00 – 11:00 M (or by appointment)

Class URL: <http://classes.uleth.ca/201603/chem4000a/>

Email: Due to the complex nature of the subject, it is not possible to properly answer questions about course material via email. Thus, all such inquiries should be made in person. Only emails of an administrative nature (*e.g.* exam absence, appointment set-up, *etc.*) will receive responses. Grades will not be given out by email.

Credit Hours: 3.0

Pre-requisites: Chemistry 2600

Co-requisites: Chemistry 3830

Course Subject: An in depth examination of the synthesis and reaction chemistry of transition metal organometallic complexes with a focus on structure and bonding. Homogeneous catalysis and selected special topics will be discussed in detail.

Lectures: 10:50 – 12:05 TTh in C620

Labs: There is no laboratory component for this course.

Exams: Midterm #1 – Thursday, October 13, 2016 (in class)

Midterm #2 – Thursday, November 17, 2016 (in class)

Final – Thursday, December 15, 2016 (14:00 – 17:00)

Note: As stated in the 2016/2017 University of Lethbridge calendar (Pg. 81), failure to attend an exam without a valid reason (*e.g.* illness) will earn a grade of zero. Proof of illness requires presentation of a signed medical certificate. Notify Prof. Hayes **as soon as possible** if you are going to miss an exam. ***If any course component is missed for a valid reason, that portion of the course grade will be shifted to the final examination.***

IMPORTANT NOTE: Exams will cover all course material including demonstrations, practice problems and assigned readings up to the end of the preceding lecture unless otherwise stated. They are **cumulative** covering all material presented in lecture, assignments, *etc.* throughout the semester. Assignments and suggested problems are intended as partial preparation for exams. Failure to put forth effort is perilous.

Assignment Due Dates:

- #1 – Thursday, September 29, 2016
- #2 – Thursday, October 27, 2016
- #3 – Thursday, December 1, 2016

Note: All assignments are due at the beginning of class. Late assignments will not be accepted (a grade of 0 will be given).

Course Textbook:

- G. O. Spessard, G. L. Miessler, *Organometallic Chemistry 3rd Ed.*, Oxford University Press, 2016. ISBN: 9780199342679, [QD411.S65 2015].

Other Useful References:

- R. H. Crabtree, *The Organometallic Chemistry of the Transition Metals, 5th Ed.*, Wiley-Interscience, 2009. ISBN: 9780470257623, [QD411.8.T73 C73 2009].
- C. Elschenboich, *Organometallics, 3rd Ed.*, Wiley-VCH, Weinheim, 2006. ISBN: 3527293906, [QD411.E4413].
- M. Bochmann, *Oxford Primer No. 12: Organometallics 1 – Complexes with Transition Metal-Carbon σ -Bonds*, Oxford University Press, Toronto, 2002. ISBN: 0198557507, [QD411.8.T63 B63].
- M. Bochmann, *Oxford Primer No. 13: Organometallics 2 – Complexes with Transition Metal-Carbon π -Bonds*, Oxford University Press, Toronto, 2001. ISBN: 0198558139, [QD411.8.T73 B632].
- J. P. Collman, L. S. Hegedus, J. R. Norton, R. G. Finke, *Principles and Applications of Organotransition Metal Chemistry*, University Science Books, Mill Valley, California, 1987. ISBN: 0935702512, [QD411.C64].

Additional Useful Materials:

- It is highly recommended that students obtain a molecular model kit. These kits are permitted for all assignments and exams. Model kits can be purchased from the Chemistry and Biochemistry Undergraduate Society (Contact Dr. Patenaude in E782 – \$30.00). In addition, the University Book Store sells a more expensive, alternate model kit (~\$80.00).

Evaluation Mechanisms:**Undergraduate Credit**

- Assignments (10%).
- Research Program Outline and Budget (5%)
- Research Proposal (15%)
- 2 Midterms (30%; First Midterm: 10%, Second Midterm: 20%)
- 1 Final exam (40%)

Graduate Credit

- Assignments (10%).
- Research Program Outline and Budget (5%)
- Research Proposal (15%)
- Oral presentation (30 minutes) of the research proposal. (10%)
This will be scheduled for one of the final classes – material covered will be eligible for questioning (for both undergraduate and graduate students) on the final exam.
- 2 Midterms (30%; First Midterm: 10%, Second Midterm: 20%)
- 1 Final exam (30%)
- Additional/more difficult questions on assignments and exams.

Course Contents (may be subject to change):

Section I: Structure and bonding in transition metal organometallic complexes

- Transition Metal Chemistry Review Chapter 2
- What is Organometallic Chemistry? Chapter 1
- Electron Counting Chapter 3
- 18 Electron Rule Chapter 3
- Properties and Types of Ligands Chapter 4-6, 10
 - CO, NO, N₂, isonitriles, phosphines, acyclic π ligands, cyclic π ligands, alkyl complexes, carbenes, carbynes, carbides, hydrides, dihydrogen, alkane complexes

Section II: Reactions of organometallic transition metal complexes

- Substitution Reactions Chapter 7
- Oxidative Addition Chapter 7
- Reductive Elimination Chapter 7
- Migratory Insertion/Deinsertion Chapter 8
- Reactions with Nucleophiles Chapter 8
- Reactions with Electrophiles Chapter 8

Section III: Homogeneous catalysis

- What is Catalysis? Chapter 9
- Alkene Isomerization Chapter 9
- Hydrogenation Chapter 9
- Hydroformylation Chapter 9
- Monsanto Acetic Acid Process Chapter 9
- Palladium Catalyzed Reactions Chapter 12
- Metathesis Chapter 11
- Olefin Polymerization Chapter 11

Section IV: Special Topics (Time Permitting – Possible Examples Shown Below)

- Metal – Main Group Multiple Bonding: Beyond Carbon
- Recent Advances in C–H activation
- Lanthanide and Actinide Metals in Organometallic Chemistry

Plagiarism & Cheating:

If caught cheating on any component of Chemistry 4000 you will be assigned a grade of F for the course. A letter describing the offense will be placed in your student file. Two such letters is grounds for expulsion from the university.

STUDENTS WHO CHEAT, CHEAT THEIR FELLOW STUDENTS BY DEVALUING THEIR HARD WORK, EARNED GRADES AND DEGREE. If you see someone cheating during an exam, inform the proctor in the following way: 1) Write a message on your exam paper indicating what is happening and where. 2) Raise your hand and the proctor will come over -- point out your note. The proctor will take it from there. It is often pointless to report cheating after the event.

What is plagiarism? Plagiarism is defined as the taking of someone's thoughts, writings or inventions and using them as one's own.

When writing a paper or lab report on a given topic, you must read up on the topic, get the necessary information and then present it **IN YOUR OWN WORDS**. If you use a sequence of text verbatim (*i.e.* exactly) from someone else's work, **THAT IS A QUOTE** and must be cited (to give proper credit to the author). If you use an idea or data from someone else's work, then that work must be cited specifically as a reference, and/or in your paper's bibliography. Beware of information that is found on the web -- it is rarely primary source information and is generally not acceptable (*i.e.* Wikipedia!)

IF, IN THE COURSE OF WRITING A REPORT, YOU EXECUTE A CUT AND PASTE FROM A WEBSITE OR OTHER SOURCE (without a citation) YOU HAVE COMMITTED PLAGIARISM.

It is important to point out that there is a difference between working out answers to an assignment or a lab report with a friend and plagiarism. If, after conferring with others, what you write down is based on your own understanding of the material and **is in your own words**, then that is acceptable. If, however, you look at a friend's answer to a question, and then simply write (essentially) the same thing on your assignment (a mental cut and paste), then you have committed plagiarism (even if a few words, structures, etc. were changed). Similarly, **IF TWO OR MORE STUDENTS TURN IN IDENTICAL REPORTS/ASSIGNMENTS, THAT IS PLAGIARISM.** Accordingly, you must take care when you share work that you have completed with other students. If they take your material and plagiarize it, you are all subject to disciplinary action. If you have completed a course and loaned marked material from it to someone who is currently taking it, you will be called upon to explain your actions if this material is plagiarized. This also applies to taking marked course material and making it generally available as in a website.

PLAGIARISM IS CHEATING and is subject to discipline as described in the university calendar. If you are unclear about any aspect of the student discipline policy for academic offences, refer to Pages 75-77 of the 2016/2017 University of Lethbridge calendar.

Calculator Policy:

While calculations are not the primary focus of Organometallic Chemistry, a simple calculator may still be useful. You will be informed prior to each test whether or not you are permitted to bring your calculator. You are not allowed to store/download text to your calculator. Any calculators found to be in violation of this policy during a test will be confiscated along with the test paper; this is cheating and will be dealt with as such. **CALCULATORS WITH WIRELESS COMMUNICATION CAPABILITIES ARE STRICTLY FORBIDDEN.**