

**Chemistry 4000/5000/7000: Organometallic Chemistry**  
**Fall 2021**

**Professor:** Dr. P. G. Hayes

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Office Hours: 3:00 – 5:00 Wednesdays (or by appointment)

**Class URL:** <http://people.uleth.ca/~p.hayes/Chem 4000 Web Page 2021/index - Chem 4000>

**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 3840

**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:** 1:30 – 2:45 MW in C620

(Note: Classes will be online between September 8 and 20, inclusive)

**Labs:** There is no laboratory component for this course.

**Attendance Policy:** It is strongly recommended that you attend the lectures as all material discussed in lectures is examinable, and not all course material is covered in the recommended textbook. Students who do not attend class regularly and punctually tend to fail this course.

**Special Needs Students:** Please contact the Accommodated Learning Centre to arrange for accommodations. Also, feel free to inform Professor Hayes of any documented disabilities in order to have a productive learning experience.

**Exams:** Midterm #1 – Wednesday, October 6, 2021 (in class)

Midterm #2 – Wednesday, November 3, 2021 (in class)

Midterm #3 – Wednesday, December 8, 2021 (in class)

Note: 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 Professor 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 evenly distributed to all other components.***

**IMPORTANT NOTE:** Exams will cover all course material including demonstrations, assignments, graduate student presentations 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.

<b>Assignments:</b>	#1	To be assigned: Wednesday, Sept. 22 <sup>nd</sup>	Due: Wednesday, Sept. 29 <sup>th</sup>
	#2	To be assigned: Wednesday, Oct. 20 <sup>th</sup>	Due: Wednesday, Oct. 27 <sup>th</sup>
	#3	To be assigned: Wednesday, Nov. 24 <sup>th</sup>	Due: Wednesday, Dec. 1 <sup>st</sup>

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

### Recommended Textbook:

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

### Other Useful References:

- R. H. Crabtree, *The Organometallic Chemistry of the Transition Metals, 7<sup>th</sup> Ed.*, Wiley-Interscience, 2019. ISBN: 9781119465881, [QD411.8.T73 C73 2019].
- J. Hartwig, *Organometallic Chemistry: From Bonding to Catalysis*, University Science Books, USA, 2010. ISBN: 9781891389535, [QD411.8.T73 H37 2010].
- C. Elschenboich, *Organometallics, 3<sup>rd</sup> Ed.*, Wiley-VCH, Weinheim, 2006. ISBN: 3527293906, [QD411.E4413].
- M. Bochmann, *Oxford Primer No. 12: Organometallics 1 – Complexes with Transition Metal-Carbon  $\sigma$ -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  $\pi$ -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 SA8456; ~\$30.00). In addition, the University Book Store sells a more expensive, alternate model kit (~\$80.00).

### Evaluation Mechanisms:

#### Undergraduate Credit

- Assignments (15%).
- Research Program Outline and Budget (5%)
- Research Proposal (20%)
- 3 Midterms (60%; 20% each)

**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.
- 3 Midterms (60%; 20% each)
- Additional/more difficult questions on assignments and exams.

**Conversion of Overall Percentage Grade to Letter Grade**

The normal overall percentage grade to letter grade conversion will take place according to the following table:

A+	91.00% – 100%
A	85.00% – 90.99%
A–	80.00% – 84.99%
B+	76.67% – 79.99%
B	73.34% – 76.66%
B–	70.00% – 73.33%
C+	66.67% – 69.99%
C	63.34% – 66.66%
C–	60.00% – 63.33%
D+	57.00% – 59.99%
<u>D</u>	<u>50.00% – 56.99%</u>
F	0% – 49.99%

However, it should be noted that Prof. Hayes reserves the right to adjust the conversion table when there are multiple students who have overall percentage grades close to one another (*i.e.* when overall percentage grades for students are within 0.33% of each other) and those grades span the intended percentage to letter grade cut-off.

For example, if the following overall percentage grades were obtained:

80.97%	78.62%
80.25%	78.45%
80.13%	78.11%
79.89%	
79.75%	

the overall percentage to letter grade conversion for the bottom end of A– might be lowered from 80.00% to 79.75%.

Similarly, if the following overall percentage grades were obtained:

71.59%	70.32%
71.28%	70.19%
71.00%	70.01%
	69.73%
	69.55%
	69.42%
	69.16%
	68.91%
	68.65%

the overall percentage to letter grade conversion for the bottom end of B– might be raised to 71.00%.

The purpose of maintaining such flexibility in overall percentage grade to letter grade conversion is to provide the professor with an ability to accommodate for “natural breaks” in overall percentage grade distributions that correspond to a meaningful difference in course performance. In the event that the actual overall percentage grade to letter grade conversion deviates from the provided table, that deviation will be limited to a maximum of  $\pm 3.00\%$ .

#### **Plagiarism & Cheating:**

**If caught cheating on any component of Chemistry 4000 you 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 your research proposal or completing an assignment, 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 (*e.g.* 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.**



Section II: Reactions of organometallic transition metal complexes

- Ligand Attachment Protocols
- 1,1-Insertions
- 1,2-Insertions
- $\alpha$ -Olefin Polymerization
- Late Transition Metal Olefin Polymerization Catalysts
- Reactions with Nucleophiles
- Reactions with Electrophiles
- Oxidative Coupling
- Alkene and Alkyne Metathesis

Section III: Homogeneous Catalysis

- What is Catalysis?
- Early and Late Transition Metal Hydroamination/Hydrophosphination
- Hydroboration
- Alkene Hydrocyanation
- Hydrosilation
- Hydrogenation

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

- Recent Advances in C–H activation
- Pincer Ligands
- Metal-Ligand Cooperation
- Metal – Main Group Multiple Bonding: Beyond Carbon
- Multinuclear NMR Spectroscopy
- Lanthanide and Actinide Metals in Organometallic Chemistry

Section V: Graduate Student Presentations