Chemistry 503 : Organometallics (3 credits) Spring 2016

Monday, Wednesday, Friday 1:10-2 pm in Fulmer 225

Syllabus

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Office Hours: Tuesday 10-11 am, Wednesday 11-12 pm, or by appointment
Website: The course website and gradebook will be maintained in Blackboard (http://learn.wsu.edu/)
Recommended: Chemistry 401 (Inorganic Chemistry) or equivalent
Required Text: Crabtree The Organometallic Chemistry of the Transition Metals, 6th Ed.
(ISBN : 978-1-118-13807-6)

Recommended Resources: These texts listed below may provide useful explanations, but are not required for the course.

Fundamentals of Organometallic Catalysis, Steinborn (ISBN : 978-3-527-32717-1)
Organometallics, Elsenbroich (ISBN : 978-3-527-29390-2)
Organotransition Metal Chemistry From Bonding to Catalysis, Hartwig (ISBN: 978-1891389535)
NMR in Organometallic Chemistry, Pregosin (ISBN: 978-3-527-33013-3)

Student Learning Outcomes

Chemistry 503 is designed to advance students toward the WSU Learning Goals, especially Scientific Literacy, Critical and Creative Thinking, Quantitative Reasoning, Communication, and Information Literacy. This course will provide graduate students and senior undergraduates with a foundation in the theoretical principles and the descriptive chemistry of organometallic chemistry. The objective is to apply the concepts of symmetry, bonding, oxidation-reduction, molecular structure, and acid-base chemistry, to understand the chemistry of organometallic compounds. The level of the course assumes an entering graduate student with a B.S. in Chemistry with some experience with the topic of inorganic chemistry.

By the end of the course it is expected that every student will:

1) Be able to read, understand, and communicate about the current chemical literature.
2) Be able to predict the geometry of an organometallic molecule from spectroscopic data.
3) Be able to propose a plausible reaction mechanism for a chemical transformation from experimental data and chemical intuition.

Assessment

Student Learning Outcomes At the end of this course, students should be able to:	Course Topics/Dates The following topic(s)/dates(s) will address this outcome:	Evaluation of Outcome: This outcome will be evaluated primarily by:
Be able to read, understand, and communicate about the current chemical literature.	*Discussions on Organometallic Complexes and their Reactivity (Lectures 6-37)* *Special Topics Presentations (Lectures 38-41)*	*Class exercises, problem sets, exams, and the special topics presentations*
Be able to predict the geometry of an organometallic molecule from spectroscopic data.	*Physical Methods in Organometallic Chemistry (Lectures 30-31)* *Solving NMR Problems in Organometallic Chemistry (Lectures 36-37)*	*Class exercises, problem sets, and exams*
Be able to propose a plausible reaction mechanism for a chemical transformation from experimental data and chemical intuition.	*Organometallic Catalytic Transformations* *(Lectures 21-29)*	*Class exercises, problem sets, exams*

Grading Scheme:	**Problem Sets (5)**	**100 pts**	(bi-weekly)
	Midterm Exams	**200 pts**	(February 19th and April 8th in class)
	Special Topics Presentation	**50 pts**	
	Take-Home Final Exam	**150 pts**	(Thursday, May 5th, due at 5:00 pm)

Grade Ranges: 500-450 pts A, 449-400 pts B, 399-350 pts C, 349-300 pts D, 299-0 pts F

Assignments

Problem sets: The problem sets will be assigned bi-weekly on Monday and be due the following Monday at the start of class. Each problem set will count for 20 points and will consist of seven problems. Problems will be assigned from Crabtree or will be provided by Prof. Heiden. The first six problems will be graded on a 0-3 scale. Three points will be awarded for answers completely or mostly correct, two points for answers missing a couple of key concepts, one point will be awarded if the answer provided does not sufficiently answer the question, and zero points if the question was not attempted. The last problem will be graded on a 0-2 scale. Late problem sets will not be accepted.

Problem Set Due Dates: Problem Set #1 – January 25th, Problem Set #2 – February 8th, Problem Set #3 – February 29th, Problem Set #4 – March 21st, Problem Set #5 – April 25th.

Special Topics Presentations: The last four lectures will consist of special topics presentations. A group of two students (one group of three) will present a topic of their choice relevant to the topic of organometallic chemistry that has not been discussed in class. The presentation will last one 50 minute class period. The choice of group members and topic is due by the end of class on March 11th. Please provide Prof. Heiden with a sheet of paper listing the two group members and the top two topics from the list below. In the event that two groups have the same first choice, the group that turns in their choices first will receive their first choice and the other group will receive their second choice. A topic not listed can be chosen, but only after approval by Prof. Heiden. The presentation will be worth 50 points, where half of the grade will come from peer evaluations and the other half will come from Prof. Heiden. A question from each presentation will appear on the final exam.

Possible topics include: N_2 Fixation, C-C Linkage of Dienes, Allylic Substitutions, C-H Functionalization, Bioorganometallic Chemistry, Main Group Organometallic Chemistry, Heterogeneous Organometallic Chemistry, Paramagnetic Organometallic Compounds in Catalysis, Lanthanide and Actinide Organometallic Chemistry, Photochemical (non-carbonyl) Organometallic Reactions, Carbonylation of Epoxides/Aziridines, Non-innocent Ligands in Catalysis, CO_2 Reductions.

Exams: There will be two midterm exams given during class time. Exam 1 will cover lectures 1-14. Exam 2 will cover lectures 15-29. The final exam will be a take-home final that will be due at 5:00 pm on May 5th. The final exam will be cumulative, with an emphasis on material from lectures 30-41. All exams will be short answer. You will be responsible for bringing a calculator and a pencil to all exams. No notes or books or other electronic devices are allowed, including cell phones or any device with headphones. No make-up exams will be given. If you are unable to take a scheduled exam for documented academic reasons beyond your control, you will be allowed to schedule the exam at an earlier time.

Tentative Course Schedule:

Date	Lecture Number/Topic	Textbook Sections
1/11/16	1) Coordination Chemistry/Werner Complexes/Isomers	Chapters 1 & 2 (Crabtree)
1/13/16	2) Crystal & Ligand Field Theory	Chapter 1 (Crabtree)
1/15/16	3) Trans Effect/ Soft vs. Hard Donors	Chapter 1 (Crabtree)
1/18/16	Martin Luther King Day (No class)	
1/20/16	4) d-Electron Counts and Types of Ligands	Chapter 1 (Crabtree)
1/22/16	5) Electron Counting and 18 Electron Rule	Chapter 2 (Crabtree)
1/25/16	6) Metal Hydrides	Chapter 3 (Crabtree)
1/25/16	Problem Set #1 Due	
1/27/16	7) Metal Hydrides	Chapter 3 (Crabtree)
1/29/16	8) Metal Alkyls	Chapter 3 (Crabtree)
2/1/16	9) Metal Carbonyls	Chapter 4 (Crabtree)
2/3/16	10) Metal Carbonyls/Metal Phosphines	Chapter 4 (Crabtree)
2/5/16	11) Metal Phosphines	Chapter 4 (Crabtree)
2/8/16	12) π Complexes	Chapter 5 (Crabtree)
2/8/16	Problem Set #2 Due	

Date	Lecture Number/Topic	Textbook Sections
2/10/16	13) π Complexes	Chapter 5 (Crabtree)
2/12/16	14) Cyclopentadienyl/Metallocene Complexes	Chapter 5 (Crabtree)
2/15/16	President's Day (No class)	
2/17/16	15) Metal-Ligand Multiple Bonds	Chapter 11 (Crabtree)
2/19/16	**Midterm Exam #1**	
2/22/16	16) Metal-Ligand Multiple Bonds/Metal Heteroatom Complexes	Chapter 11 (Crabtree)
2/24/16	17) Non-Innocent/Redox-Active Ligands	Literature Papers
2/26/16	18) Paramagnetic & High Oxidation State Complexes	Chapter 15 (Crabtree)
2/29/16	19) Oxidative Addition, Reductive Elimination, Insertion and Elimination Reactions	Chapters 6 & 7 (Crabtree)
2/29/16	Problem Set #3 Due	
3/2/16	20) Addition & Abstraction Reactions	Chapter 8 (Crabtree)
3/4/16	21) Catalytic Cycles	Chapter 9 (Crabtree)
3/7/16	22) Hydrogenation Reactions	Chapters 9 & 14 (Crabtree) & Chapter 4 (Steinborn)
3/9/16	23) Hydroformylation Reactions	Chapter 9 (Crabtree) & Chapter 5 (Steinborn)
3/11/16	24) Metathesis Reactions	Chapter 12 (Crabtree) & Chapter 7 (Steinborn)
3/14/16	Spring Break (No class)	
3/16/16	Spring Break (No class)	
3/18/16	Spring Break (No class)	
3/21/16	25) Oligomerization of Olefins	Chapter 12 (Crabtree) & Chapter 8 (Steinborn)
3/21/16	Problem Set #4 Due	
3/23/16	26) Polymerization of Olefins	Chapter 12 (Crabtree) & Chapter 9 (Steinborn)
3/25/16	27) C-C Coupling Reactions	Chapters 9 & 14 (Crabtree) & Chapter 11 (Steinborn)
3/28/16	28) Hydrocyanation, Hydrosilylation, & Hydroamination	Chapter 9 (Crabtree) & Chapter 12 (Steinborn)
3/30/16	29) Oxidation of Olefins & Alkanes	Chapters 9 & 14 (Crabtree) & Chapter 6 (Steinborn)
4/1/16	30) Physical Methods in Organometallic Chemistry	Chapter 10 (Crabtree)
4/4/16	31) Physical Methods in Organometallic Chemistry	Chapter 10 (Crabtree)
4/6/16	32) Chemical Shifts of Organometallic Compounds	Chapter 10 (Crabtree) & Chapter 6 (Pregosin)
4/8/16	**Midterm Exam #2**	
4/11/16	33) Coupling Constants of Organometallic Compounds	Chapter 10 (Crabtree) & Chapter 7 (Pregosin)
4/13/16	34) Variable Temperature & Dynamic NMR of Organometallic Compounds	Chapter 10 (Crabtree) & Chapter 8 (Pregosin)
4/15/16	35) Diffusion Constants and 2D NMR Techniques of Organometallic Compounds	Chapter 10 (Crabtree) & Chapters 3, 4, & 5 (Pregosin)

Date	Lecture Number/Topic	Textbook Sections
4/18/16	36) Solving NMR Problems	Chapter 11 (Pregosin)
4/20/16	37) Solving NMR Problems	Chapter 11 (Pregosin)
4/22/16	38) Special Topics Presentations	
4/25/16	Problem Set #5 Due	
4/25/16	39) Special Topics Presentations	
4/27/16	40) Special Topics Presentations	
4/29/16	41) Special Topics Presentations	
5/5/16	**Take-Home Final Exam is due by 5:00 pm**	

Students with Disabilities: Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217; Phone: 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center (335-3417, http://accesscenter.wsu.edu, Access.Center@wsu.edu).

Academic Integrity: I encourage you to work with classmates on assignments. However, each student must turn in original work. No copying will be accepted. Students who violate WSU's Standards of Conduct for Students will receive an F as a final grade in this course, will not have the option to withdraw from the course, and will be reported to the Office Student Standards and Accountability. Cheating is defined in the Standards for Student Conduct WAC 504-26-010 (3). It is strongly suggested that you read and understand these definitions.

Safety and Emergency Notification: Washington State University is committed to enhancing the safety of the students, faculty, staff, and visitors. It is highly recommended that you review the Campus Safety Plan (http://safetyplan.wsu.edu/) and visit the Office of Emergency Management web site (http://oem.wsu.edu/) for a comprehensive listing of university policies, procedures, statistics, and information related to campus safety, emergency management, and the health and welfare of the campus community.

Assigning Incompletes: University policy (Acad. Reg. #90) states that Incompletes may only be awarded if: "the student is unable to complete their work on time due to circumstances beyond their control".

Important Dates and Deadlines: Students are encouraged to refer to the academic calendar often to be aware of critical deadlines throughout the semester. The academic calendar can be found at http://registrar.wsu.edu/academic-calendar/ .