CHEM 2310 • Advanced Organic Chemistry 1 • Fall 2019
MW 0800 – 0915, 228 Eberly Hall

Instructor: Professor Yiming Wang
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Official course description: A discussion of the tools, both modern and classical, that are the basis of mechanistic interpretations of relations between structure and reactivity. Special emphasis is placed on the detailed molecular level analysis of organic molecules, including the transient reactive intermediates: carbanions, carbocations, carbenes, and radicals, to develop a predictive sense for reactivity. The factors that influence equilibria, product distribution, and reaction mechanisms are also explored.

Prerequisites: Enrollment as a graduate student in the chemistry department, a grade of A– or higher in CHEM 0320/0740, B+ or higher in CHEM 1310, or instructor permission.

Learning objectives: *This is a graduate-level course in organic reaction mechanisms and the principles of physical organic chemistry*. By the end of this course, you should be able to: 1) predict or rationalize the outcome of a reaction on the basis of molecular structure and chemical principles; 2) propose a reasonable mechanism for a reaction using known reactivity patterns and experimental data; 3) select and apply appropriate experimental tools to elucidate a reaction mechanism.

Diagnostic quiz: A 30 minute diagnostic quiz on undergraduate organic chemistry will take place during the first class meeting. The quiz will be scored but will not count towards your course grade. A low score on the quiz (< 50 %) indicates insufficient preparation for the course. If you received a low quiz score, you are strongly encouraged to schedule an appointment with me to discuss strategies to patch up gaps in your knowledge of chemistry, improve your test taking skills, or, in some cases, discuss whether it would be beneficial to postpone enrollment in CHEM 2310 until next year.

Grading policy: Course performance will be evaluated using the total number of points earned on the quiz, problem sets, and exams as a guide. Final letter grades will reflect a combination of how well learning objectives are met (*see the grading criteria below*) with consideration (up to 1/3 of a letter grade) of the quantity and quality of effort exerted. Letter grades will neither be assigned using an absolute scale, nor fitted to a predetermined distribution ("on a curve"): you are not competing against your classmates.

- One graded quiz: 1 × 50 pts. = 50 pts. (5 %)
- Three problem sets: 3 × 100 pts. = 300 pts. (30 %)
- Two midterm exams: 2 × 150 pts. = 300 pts. (30 %)
- Final exam: 250 pts. (25 %)*
- Participation (see below) 100 pts. (10 %) ∑ = 1000 pts. (100%)

*If you decide to not take the final exam, this score will be replaced by scaling the sum of your midterm and quiz scores.

Letter grade definitions: An **A+/A/A–** grade indicates a *deep understanding* of the course material, characterized by the ability to consistently and creatively apply concepts and extrapolate broad-based knowledge to solve problems on chemical systems not explicitly described during lecture or in the problem sets. A **B+/B** grade indicates a *good understanding* of the course material, characterized by the accurate recall of concepts and facts discussed during lecture, though ability to deal with unfamiliar chemical systems is somewhat limited. A **B–** grade indicates a *partial understanding* of the course material, characterized by an incomplete or flawed recall of concepts and significant gaps or errors in factual knowledge. A **C** grade indicates an *inadequate understanding* of the course material, characterized by widespread errors in conceptual understanding and factual knowledge. A **D/F** grade reflects unacceptable lack of effort or may result from a serious infraction of academic integrity.

Participation: The participation grade is meant to encourage those of you who are doing well in the class to help your classmates improve. It will be determined by (i) participation on the Discussion Board on *CourseWeb* or (ii) attendance of one of the two weekly office hours. For (i), you are expected to post a question about lecture or help answer a posted question every week. For (ii), you are expected to solve a problem at the board or help a classmate solve a problem every week. I will check postings regularly, moderate the discussions, and address important, interesting, or confusing issues in class.

Required textbooks: *Available from the Pitt bookstore and online retailers:* **I.** Anslyn, E. V.; Dougherty, D. A. *Modern Physical Organic Chemistry*; University Science Books: Mill Valley, Calif., 2006 (ISBN: 1891389319). **II.** Clayden, J.; Greeves, N.; Warren, S. *Organic Chemistry*, 2nd ed.; Oxford University Press: Oxford, 2012 (ISBN 0199270295). **III.** Grossman, R. B. *The Art of Writing Reasonable Organic Reaction Mechanisms*, 2nd ed.; Springer: New York, 2003 (ISBN 0387954686).

Recommended resources: I. A classical treatment of main organic reaction types: Norman, R. O. C.; Coxon, J. M. *Principles of Organic Synthesis*, 3rd ed.; CRC Press: Boca Raton, Fla., 1993 (ISBN 0748761624). **II.** A good overview of contemporary organic chemistry: Lewis, D. E. *Advanced Organic Chemistry*; OUP: Oxford, 2016 (ISBN 0199758972). **III.** A primer on orbital interactions in organic chemistry: Kirby, A. J. *Stereoelectronic Effects*; OUP: Oxford, 1996 (ISBN 0198558937). **IV.** Authoritative text providing mathematical details: Lowry, T. H.; Richardson, K. S. *Mechanism and Theory in Organic Chemistry*, 3rd ed.; HarperCollins: New York, 1987 (ISBN 0063504286). **V.** Detailed lecture notes and challenging problems: Evans, D. A.; Myers, A. G. *Advanced Organic Chemistry: Lecture Notes, Problem Sets, and Exams*; Harvard University (unpublished) available at:
https://archive.org/details/EvansD.A.HarvardsAdvancedOrganicChemistry2003/

Assigned reading: At the end of each Wednesday class meeting, portions of the texts (on average 25 – 30 pages per week) will be assigned as required reading for the following week. It is important to come to class prepared by doing the assigned reading before class.

Graded quiz: One graded quiz (allotted time: 30 min, 50 pts.) will take place from **0845** to **0915** on **02 Dec 2019.** The quiz will focus on material covered after the second midterm.

Problem sets: Three problem sets (100 pts. each) will be assigned as homework. The problem sets offer a valuable opportunity to practice your problem solving skills and deepen your understanding of the course material. You will be given at least two weeks to work on them. *Please start them early!* I will generally not answer problem set questions directly. Instead, during office hours, you will work on problem(s) at the board with a classmate; I will moderate the discussion. Unexcused late problem sets will be assessed a penalty of $^1/_3$ of its original point value each day after the due date. Working with your classmates is permitted and encouraged. However, the solutions you submit need to reflect your own understanding. Plagiarism will not be tolerated. If you obtain a key insight for solving a problem from a classmate, please include a written acknowledgement for their contribution. Illegible solutions may incur a loss of credit. For each problem set, three to five representative problems will be selected for grading.

Exams: Two midterm exams (allotted time: 90 min, 150 pts.) will take place from **1200** to **1330** on **25 Sep** and **30 Oct 2019** (*subject to change; any change will be announced at least two weeks in advance*). Midterm exams will focus on the topics covered after the previous exam. Nevertheless, due to the nature of the course material, the reappearance of fundamental concepts from earlier lectures is unavoidable. The final exam (allotted time: 180 min, 250 pts.) will be cumulative. During each exam, you may bring one $8^1/_2″ \times 11″$ sheet of handwritten notes and a molecular model set of your choosing. No other exam aids are permitted (in particular, no calculators). You will be provided with scrap paper to work out your answers, but only the responses in your exam packet will be graded. Illegible responses may incur a loss of credit. Except under rare circumstances, exams cannot be made up. However, you may take the exam up to 24 hours before the scheduled time if you anticipate a conflict.

Absences: If you have a planned absence for a family obligation, medical appointment, or religious observance, please let me know as soon as possible, in order for reasonable accommodations to be made. If you were absent for a quiz, midterm, or problem set due date due to an emergency, please

provide documentation to have your absence excused. Alternate assignments or a modified grading scheme can be arranged in the case of excused absences, while unexcused absences may result in a zero grade.

***Student Opinion of Teaching Surveys*:** Students in this class will be asked to complete a *Student Opinion of Teaching Survey* by the Office of Measurement & Evaluation of Teaching (OMET). Surveys will be sent via Pitt email and appear on your *CourseWeb* landing page during the last three weeks of class meeting days. Your responses are anonymous. Please take time to provide comments, suggestions, and criticisms for any aspect of the course, including format, content, policies, and overall effectiveness. Your feedback is very valuable, and your responses will be taken into account in future iterations of this course.

***University Policies on Academic Integrity*:** Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University's *Guidelines on Academic Integrity*. In particular, please take note of the following University statement on academic integrity:

> *Cheating/plagiarism will not be tolerated. Students suspected of violating the University of Pittsburgh Policy on Academic Integrity, from the February 1974 Senate Committee on Tenure and Academic Freedom reported to the Senate Council, will be required to participate in the outlined procedural process as initiated by the instructor. A minimum sanction of a zero score for the quiz or exam will be imposed.* — Academic Integrity Statement for Syllabi

***University Policies on Disability Services*:** If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS, https://www.studentaffairs.pitt.edu/drs/), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. Disability Resources and Services will verify your disability and determine reasonable accommodations for this course.

Course schedule & outline (subject to change; check Blackboard for announcements):

Problem set due dates: F 20 Sep, 25 Oct, and 06 Dec 2019

26 Aug – 23 Sep 2019 (7.6 class meeting days): Lewis structures and valence bond theory, orbital interactions, stereoelectronic effects, thermochemistry, conformational analysis and strain, aromaticity.

No class M 02 Sep (Labor Day)
Midterm #1: 0800 – 0930, W 25 Sep 2019, 228 Eberly

30 Sep – 28 Oct 2018 (9 class meeting days): Acid-base theories, stereochemistry, transition state theory, kinetic analysis, catalysis.

Midterm #2: 0800 – 0930, W 30 Oct 2019, 228 Eberly

04 Nov – 20 Nov 2018 (6 class meeting days): Linear free energy relationships, kinetic isotope effects, and other tools for elucidation of reaction mechanisms.

No class M 25 and W 27 Nov (Thanksgiving Break)
Graded quiz: 0845 – 0915, M 02 Dec 2018, 228 Eberly

02 Dec – 09 Dec 2018 (2.6 class meeting days): Hückel theory, Möbius and Hückel aromaticity, pericyclic reactions, Woodward–Hoffmann rules.

Final exam: W 11 Dec 2019, time (180 min) and location TBA