

# SYLLABUS: Advanced Organic Chemistry

## CHEM 432 I Fall 2020

**Instructor:** **Name:** Dr. Allegra Liberman-Martin (pronouns: she/her/hers)  
**Email:** libermanmartin@chapman.edu  
**Office Hours:** TBD

**Textbooks/Materials:** Pre-lecture videos and journal articles provided by the instructor.

**Course Description:** Prerequisites, Chem 331, 331L. This course teaches the detailed study of organic reaction mechanisms. Topics covered in this course may include the development of catalysts for organic reactions, the behavior of reactive intermediates, stereochemically controlled reactions, and the application of inorganic chemistry to organic reactions.

**Course-Wide Intended Learning Outcomes:** At the end of this course, each student will be able to:

- Relate the structure of a molecule to its expected properties and reactivity
- Predict or rationalize the outcome of a reaction based on molecular structure and chemical principles
- Propose a reasonable mechanism for an organic reaction using known reactivity patterns and experimental data
- Design experiments to test a proposed organic mechanism

**Program-Wide Intended Learning Outcomes:** In addition to the above learning outcomes, CHEM 331 supports, in part, the learning outcomes for the B.Sc. in Chemistry:

- Apply the scientific method to solve problems
- Demonstrate written, visual and oral presentation skills to communicate scientific knowledge
- Apply critical thinking and analytical skills to design and execute a scientific experiment, thoroughly analyze the results, and arrive at well-reasoned scientific conclusions.
- Demonstrate an understanding of core knowledge in chemistry

### Class Structure

Class sessions will be held on Zoom (link provided on course Canvas page).

Prior to each class time, you will be expected to:

- Watch the **pre-lecture videos** made by the instructor (and do the **pre-lecture readings** when assigned), and
- Take the **pre-lecture quiz**.

When you log into the Zoom class, you will be expected to:

- Download the **in-lecture worksheet** from Canvas.
- Think critically, communicate with your instructors and your peers, and solve the worksheet problems.
  - *To ensure an active and vibrant class, your visual and audio presence is expected. Please plan to have your webcam turned on and be prepared to speak during discussions and breakout sessions.*

After each class, you will be expected to:

- Solidify your learning by completing the **problem sets**.
- **Attend office hours** with questions you have on any of the concepts introduced in the pre-lecture materials, in-lecture worksheets, or in the problem sets.

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**Evaluation**

| Assessment                 | Date   | Weighting (%) |
|----------------------------|--|---------------|
| Attendance + Participation | Frequently (in class)  | 5%            |
| Pre-lecture Quizzes        | Frequently (posted 24 hrs before class)  | 10%           |
| Problem Sets               | Due at 11:59 pm on Fridays Sept. 18, Oct. 02, Oct. 16, Oct. 30, Nov. 13, and Dec. 04 | 45%           |
| Exam 1                     | Due at 11:59 pm on Friday, Oct. 09   | 13%           |
| Exam 2                     | Due at 11:59 pm on Friday, Nov. 06   | 13%           |
| Final exam                 | Due 11:59 pm on Wednesday, Dec. 16   | 14%           |

**Course Grading Rubric:**

| Score (%)   | Grade | Score (%)   | Grade |
|-------------|-------|-------------|-------|
| 92.5 – 100  | A     | 72.5 – 76.9 | C     |
| 89.5 – 92.4 | A–    | 69.5 – 72.4 | C–    |
| 87.0 – 89.4 | B+    | 67.0 – 69.4 | D+    |
| 82.5 – 86.9 | B     | 62.5 – 66.9 | D     |
| 79.5 – 82.4 | B–    | 59.5 – 62.4 | D–    |
| 77.0 – 79.4 | C+    | < 59.5      | F     |

**Pre-Lecture Quizzes:** An online quiz will be assigned before every class (except on review days and exam days). Pre-lecture quizzes will be posted on Canvas  $\geq 24$  hours before the upcoming class and will be due at 5:00 pm on the day of class. Use this to assess your understanding of the assigned pre-lecture reading/video. **There are no make-up quizzes and your lowest four pre-lecture quizzes will be dropped.**

**Attendance and Participation:** You are expected to attend each Zoom session and participate fully in the in-lecture exercises and discussions. To foster this, I will take attendance each class day and will record your participation during in-class activities (through polls, file uploads, etc.) – each of which will be worth 1 point. Your accumulated attendance and participation points are worth a maximum of 5% of your total grade. Excused absences with documentation (due to illness, religious holidays, or an official University event) do not lower your attendance and participation score. **In addition, up to two unexcused absences are permitted without a grade penalty during the semester.**

**Problem Sets:** Homework problems will be assigned throughout the semester that are designed to extend your conceptual understanding of organic chemistry and practice using your problem-solving skills. **Late submission policy – 10% reduction every 24 hours. The problem set will receive a score of zero (and will not be eligible for revisions) if not submitted within 5 days of the deadline.**

**Exams:** Three exams (exam 1, exam 2, and the final exam) will be given, and exam questions will be based on topics covered in pre-lecture videos, class, readings, or problem sets. The topics will naturally build upon each other, so subsequent exams will require knowledge of concepts from earlier exams. New material will be emphasized on lecture exams 1 and 2, while the final exam will be comprehensive.

**Make-Up Policy for Lecture Exams ONLY:** The only reasons that qualify for a make-up exam are: (1) serious illness with proper documentation (i.e., doctor's note or Dean of Students' letter), or (2) required attendance at an **OFFICIAL** University event with written notification to the professor **PRIOR** to the exam and as early as possible.

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**Revisions Policy for Problem Sets and Exams:** I think the goal of upper-division electives is to gain (and demonstrate) a deep understanding of a specialized area. Making mistakes is a natural part of learning (especially for organic chemistry!), and there is much to be gained by revising your work when it is incorrect rather than being provided the correct solution.

For problem sets and exams, you will be given the opportunity to revise incorrect answers to regain a maximum of 50% of the initially deduced points. **Revisions must be turned in within 48 hours** of receiving initial problem set or exam feedback. **For any questions you revise, you should include a sentence or two describing what went wrong the first time along with your revised answer.** Part of the goal here is for you to figure out what was incorrect about your answer as well as fix it, so my feedback on your initial submission will be extremely brief (either just the score for each question or possibly some brief notes/hints). And I won't provide an answer key until after revisions have been submitted.

Each problem set or exam can only be revised once. If the revised score is lower than the original score, the better score will be kept.

To prevent people from trying to game the revisions system to gain an extension on work, **questions that have been left blank or contain wildly irrelevant information are not eligible for revisions.** But as long as you make a good faith effort to answer a question, you will have the opportunity to revise it.

**Problem Set Authorizations:** You are authorized to use any class resources (essentially anything found on Canvas plus your notes) and collaborate with other students in the class while completing problem sets or problem set revisions. Although you may search the internet to gain a general understanding of concepts, you may not consult SciFinder or primary literature articles while completing or revising problem sets. Although you may collaborate with others on problem sets, you must submit your own work. As a part of your problem set submissions (both initial and revised), you'll be asked to provide a list of the people you collaborated with while completing the problem set.

**Exam Authorizations:** All exams will be take-home exams, and you are authorized to use your notes and class resources (Canvas site) while completing the exams. **You are not authorized to speak with anyone other than your instructor (including classmates) or use the internet (beyond the course Canvas page) while completing exams.**

For both problem sets and exams, you are not authorized to post questions online (to websites like Chegg, CourseHero, etc.) at any point during or after the course.

**Course Policy on Unauthorized Assistance in Problem Sets or Exams:** I take cases of academic integrity violations very seriously. All suspected academic integrity violations will be investigated fully according to Chapman's Academic Integrity Policy. See below for the baseline sanctions for an academic integrity violation in each assessment type.

| Assessment  | Violation  | Baseline Sanction for Academic Integrity Violation |
|-------------|--|--|
| Problem Set | posting problem set question(s) online                 | A zero on the problem set                          |
| Exam        | working with others or posting exam question(s) online | An 'F' in the course                               |

## Chapman Policies

**Academic Integrity Policy:** Chapman University is a community of scholars that emphasizes the mutual responsibility of all members to seek knowledge honestly and in good faith. Students are responsible for doing their own work and academic dishonesty of any kind will be subject to sanction by the instructor/administrator and referral to the university Academic

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Integrity Committee, which may impose additional sanctions including expulsion. Please see the full description of Chapman University's policy on Academic Integrity at [www.chapman.edu/academics/academicintegrity/index.aspx](http://www.chapman.edu/academics/academicintegrity/index.aspx).

**Students with Disabilities Policy:** In compliance with ADA guidelines, students who have any condition, either permanent or temporary, that might affect their ability to perform in this class are encouraged to contact the Disability Services Office. If you will need to utilize your approved accommodations in this class, please follow the proper notification procedure for informing your professor(s). This notification process must occur more than a week before any accommodation can be utilized. Please contact Disability Services at (714) 516-4520 or visit [www.chapman.edu/students/student-health-services/disability-services](http://www.chapman.edu/students/student-health-services/disability-services) if you have questions regarding this procedure or for information or to make an appointment to discuss and/or request potential accommodations based on documentation of your disability. Once formal approval of your need for an accommodation has been granted, you are encouraged to talk with your professor(s) about your accommodation options. The granting of any accommodation will not be retroactive and cannot jeopardize the academic standards or integrity of the course.

**Equity and Diversity Policy:** Chapman University is committed to ensuring equality and valuing diversity. Students and professors are reminded to show respect at all times as outlined in Chapman's Harassment and Discrimination Policy. Please see the full description of this policy at <http://www.chapman.edu/faculty-staff/human-resources/eoo.aspx>. Any violations of this policy should be discussed with the professor, the dean of students and/or otherwise reported in accordance with this policy.

**Student Support at Chapman University:** Over the course of the semester, you may experience a range of challenges that interfere with your learning, such as problems with friend, family, and or significant other relationships; substance use; concerns about personal adequacy; feeling overwhelmed; or feeling sad or anxious without knowing why. These mental health concerns or stressful events may diminish your academic performance and/or reduce your ability to participate in daily activities. You can learn more about the resources available through Chapman University's Student Psychological Counseling Services here: <https://www.chapman.edu/students/health-and-safety/psychological-counseling/>

**Food Pantry Assistance:** If you or a student you know could benefit from access to the food pantry or would like more information on the food pantry program, contact the Dean of Students at (714) 997-6721.

## TENTATIVE SCHEDULE

| Week | Day | Date  | Topic  | Literature Article   |
|------|-----|-------|--|--|
| 1    | M   | 08.31 | <b>Bonding I:</b> Atomic Orbitals, VSEPR, Hybridization  | Why Think Up New Molecules? American Scientist, <b>2008</b> , <i>96</i> , 372–374.                     |
|      | W   | 09.02 | <b>Bonding II:</b> Molecular Orbital Theory, Frontier Molecular Orbitals                             |  |
| 2    | M   | 09.07 | NO CLASS: LABOR DAY  | Learning from Molecules in Distress. <i>Angew. Chem. Int. Ed.</i> <b>2008</b> , <i>47</i> , 4474–4481. |
|      | W   | 09.09 | <b>Bonding III:</b> Reactive Carbon Intermediates (Carbocations, Carbanions, Radicals, and Carbenes) |  |
| 3    | M   | 09.14 | <b>Thermodynamics I:</b> Gibbs Free Energy, Van't Hoff Plots   |  |
|      | W   | 09.16 | <b>Thermodynamics II:</b> Stability & Persistence  |  |

**Problem Set #1 due**

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|                           |   |       |  |   |
|---------------------------|---|-------|--|---|
| 4                         | M | 09.21 | <b>Conformational Analysis:</b> Acyclic systems, 6-Membered Rings, Anomeric Effect   |   |
|                           | W | 09.23 | <b>Kinetics I:</b> Rates and Rate Constants, Reaction Coordinate Diagrams  |   |
| 5                         | M | 09.28 | <b>Kinetics II:</b> Transition State Theory, Activation Parameters   |   |
|                           | W | 09.30 | <b>Kinetics III:</b> Principles Related to Kinetic Analysis  |   |
| <b>Problem Set #2</b>     |   |       |  |   |
| 6                         | M | 10.05 | <b>Kinetics IV:</b> Kinetics Experiments   |   |
|                           | W | 10.07 | <b>Kinetics V:</b> Multistep Reactions + <b>Review</b>   |   |
| <b>Exam 1 (Weeks 1–5)</b> |   |       |  |   |
| 7                         | M | 10.12 | <b>Mechanistic Experiments I:</b> Primary Kinetic Isotope Effects  | Deuterated Drug Molecules: Focus on FDA-Approved Deutetrabenazine. <i>Biochemistry</i> <b>2018</b> , 57, 472–473. |
|                           | W | 10.14 | <b>Mechanistic Experiments II:</b> Secondary Isotope Effects, Equilibrium Isotope Effects  |   |
| <b>Problem Set #3</b>     |   |       |  |   |
| 8                         | M | 10.19 | <b>Mechanistic Experiments III:</b> Hammett Plots  |   |
|                           | W | 10.21 | <b>Mechanistic Experiments IV:</b> Competition Experiments, Cross-Over Experiments, Stereochemical Analysis, Isotope Scrambling  |   |
| 9                         | M | 10.26 | <b>Mechanistic Experiments V:</b> Radical Clocks   |   |
|                           | W | 10.28 | <b>Alkene Reactions:</b> Halogenation, Epoxidation   |   |
| <b>Problem Set #4</b>     |   |       |  |   |
| 10                        | M | 11/02 | <b>Carbene Reactions:</b> Alkene Addition, C–H Bond Insertion  |   |
|                           | W | 11.04 | <b>Review</b>  |   |
| <b>Exam 2 (Weeks 6–9)</b> |   |       |  |   |
| 11                        | M | 11.09 | <b>Substitution on Benzene Rings:</b> Electrophilic Aromatic Substitution, Nucleophilic Aromatic Substitution, Benzyne Reactions | Concerted Nucleophilic Aromatic Substitutions. <i>Nature Chem.</i> <b>2018</b> , 10, 917–923.                     |
|                           | W | 11.11 | <b>S<sub>N</sub>2 and S<sub>N</sub>1 Reactions:</b> Kinetics, Competition Experiments, Stereochemistry, Solvent Effects          |   |
| <b>Problem Set #5</b>     |   |       |  |   |

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|    |                                       |       |  |  |
|----|---------------------------------------|-------|--|--|
| 12 | M                                     | 11.16 | <b>S<sub>N</sub>1 Reactions II:</b> Carbocation Rearrangements, Anchimeric Assistance                                |  |
|    | W                                     | 11.18 | <b>S<sub>N</sub>1 Reactions III:</b> Non-Classical Carbocations  | Crystal Structure Determination of the Nonclassical 2-Norbornyl Cation. <i>Science</i> , <b>2013</b> , <i>341</i> , 62–64.   |
| 13 | <b>THANKSGIVING BREAK! Nov 23 –27</b> |       |  |  |
| 14 | M                                     | 11.30 | <b>Rearrangements I:</b> Pinacol Rearrangement, Benzylic Acid Rearrangement, Beckman Rearrangement                   |  |
|    | W                                     | 12.02 | <b>Rearrangements II:</b> Radical Hydrogen Shifts, Radical Aryl and Vinyl Shifts, and Radical Ring-Opening Reactions |  |
|    |                                       |       | <b>Problem Set #6</b>  |  |
| 15 | M                                     | 12.07 | <b>Rearrangements III:</b> Reactions Involving Biradical Intermediates   | Design, Synthesis, and Study of Simple Monocyclic Conjugated Eneidyne. The 10-Membered Ring Eneidyne Moiety of the Eneidyne Anticancer Antibiotics. <i>J. Am. Chem. Soc.</i> <b>1992</b> , <i>114</i> , 7360–7371. |
|    | W                                     | 12.09 | <b>Review</b>  |  |
| 16 | <b>Final Exam (Cumulative)</b>        |       |  |  |