SYLLABUS

CHEM 331 I Demille Hall 101 I Spring 2020

Instructor:

Name: Dr. Allegra Liberman-Martin (pronouns: she/her/hers)
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Office Location: Keck 236
Office Hours: Monday and Wednesday 4:00pm–6:00pm (Keck 236)

Textbooks/Materials: Organic Chemistry (w/Wiley Plus Card & SSM/SG), Author: Klein, Publisher: John Wiley & Sons, Incorporate, Edition: 3rd, Year Published: 2017 **(required)**

Supplemental Instructors (SI):

Name: Ethan Vieira	**S.I. Session:** TBA
Name: Edena Khoshaba	**S.I. Session:** TBA
Name: Olivia Durant	**S.I. Session:** TBA
Name: Lindsay Zumwalt	**S.I. Session:** TBA

Course Description: Prerequisites, Chem 230, 230L. CHEM 331 is the second semester of a two-semester (one year) lecture course in organic chemistry; a continuation of learning some of the fundamentals of organic chemistry. Topics of discussion will again be structure and properties of organic compounds, with additional functional groups, nomenclature, stereochemistry, and spectroscopic methods of analysis. There will be an emphasis on the relationship between structure, functionality and reactivity in organic compounds; as well as the reaction mechanism for many of these organic reactions. Synthetic organic chemistry will be an important part of this course.

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

- Describe, and give examples of the basic principles, concepts, and theories from the second semester of organic chemistry, including the central role of the scientific method and the importance of observation.
- Apply reasoning skills acquired in the classroom to solve problems through assigned homework sets, guided inquiries and laboratory exercises.
- Apply the scientific method to evaluate and analyze data and draw conclusions based upon that analysis.

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

Success Strategies: Frequent and consistent practice of conceptual and algorithmic problems is **crucial** for success in this course. As we progress through the course material, you will build on, and reinforce, fundamental concepts from previous chapters. Therefore, to keep up with the work, it is imperative that you:

- **Attend Supplemental Instructor (SI) Sessions Once Per Week**: All SIs are students who not only excelled in the course in previous years, but are also trained to teach effectively. Each SI will engage you in instructor-approved practice conceptual and algorithmic problems. They will also answer any ongoing questions you have. You may go to any SI session you wish per week – you will get the same experience!
- **Spend 3-6 hours studying for every 50-minute lecture**.
- **Attend all classes.**
- **Visit faculty during office hours.**

Alternate Meeting Times for Lecture Exams: It is our goal to ensure consistency across all sections of **CHEM 230**, and to give all students enough time to demonstrate their knowledge during lecture exams. To support these goals, the three lecture exams for this course will be administered to all students taking **CHEM 230** on the following **Friday** dates from **12:00pm to 1:15pm**: **February 21, 2020; March 20, 2020**; and **May 1, 2020**. The location for these exams will be announced on the Canvas site. Note that the exam testing period is ***not*** during the regular class time and there will be ***no***

organic chemistry classes on these days. Students are required to attend the scheduled test periods in order to take the lecture exams, so be sure to make all your travel plans with these exam dates and times in mind (*see below for limited exceptions)*. All efforts have been made prior to the beginning of this course to accommodate students with potential conflicts of the exam times with other courses. However, should you foresee conflicts with other courses during Add/Drop period, it is imperative that you let your instructor know as soon as possible.

Alternate Meeting Times for Lecture Exams for students with course conflicts: Students enrolled in courses during the scheduled test periods (with approval by the Chemistry Program Director) will take the lecture exams on the scheduled lecture exam dates from 1:00-2:15pm in TBA.

Students with Testing Accommodations who take accommodated exams at the Testing Center will reserve a time on the scheduled exam dates of February 21, 2020; March 20, 2020; and May 1, 2020.

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. Please note that Greek events are not considered official University events.

Evaluation: Your grade in this course is based on pre-lecture quizzes, three lecture exams, and a final cumulative exam.

Assessment	Date	Location	Weighting (%)
Pre-lecture quizzes	Frequently (24 hrs before class)	Online	10
Lecture exam 01	Fri., Feb. 21, 12:00 – 1:15pm	TBA	20
Lecture exam 02	Fri., Mar. 20, 12:00 – 1:15pm	TBA	20
Lecture exam 03	Fri., May 1, 12:00 – 1:15pm	TBA	20
Final exam	9am Section: Tues., May 19, 8:00–10:30am 10am Section: Tues., May 19, 1:30–4:00pm	Demille 101	30

Class Structure: Prior to each class time, you will be expected to do the assigned reading and/or watch online videos made by the instructor. In-class time will be spent thinking critically, communicating, and solving problems in organic chemistry.

Pre-Lecture Quizzes: Quick, online quizzes will be assigned frequently (every class except for exam dates). The quizzes will be posted on Canvas ≥24 hours before the upcoming class, and will be **due one hour before class time**. Use these quizzes as a way to assess your understanding of the content from the assigned reading/video and the previous class day. **There are no make-up quizzes and the lowest six quizzes are dropped.**

Progressive Improvement Exam Scoring: To encourage consistent study habits throughout the semester and lower stress levels surrounding exams, we use an exam scoring system that encourages progressive improvement. If you **score higher** on an exam **directly after** an exam with a **lower score**, your score on the prior lower exam will be **increased to the average of the two scores.** For example, if you receive a 60% on Exam 1 and an 80% on Exam 2, your Exam 1 score will be retroactively raised to 70%. Note that Exam 3 and the Final have no effect on Exam 1. Also, note that **a lower score on a later exam will never lower an earlier exam score**.

Extra Credit Policy: After Lecture Exams 1, 2, and 3, a link to a post-exam survey will be provided. This survey is designed to help you to analyze your exam performance and find strategies that work best for you in learning the material. Completing the post-exam survey one time after a given lecture exam will result in one percentage point of extra credit being added to your exam percent score. There are no additional extra credit opportunities for this course.

Course Electronic Access: Course materials including the syllabus are available on Canvas. The Canvas site will be the primary repository of all documents for this class including lecture notes, lectures, solutions, and handouts.

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 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.

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 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/

Laptop Rental Program: An automated laptop rental kiosk is available in the Student Union, which is free to all Chapman students with a valid ID. You can swipe your ID card, take a laptop anywhere on campus, and return it within the 4-hour time limit. There are six Dell laptops and six Macbook Pro laptops available to rent.

All Gender Restrooms: To find Chapman University's all-gender restrooms, click on Restrooms on the drop-down menu of the interactive campus map at https://www.chapman.edu/about/maps-directions/campus-map/index.aspx. All-gender restrooms are labeled and identified across campus.

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.

Detailed Intended Learning Outcomes (useful study guide)

Unit 01: Spectroscopy

- Define electromagnetic radiation.
- Determine the relationship between wavelength, frequency, and energy of EM radiation.
- Sketch an electromagnetic spectrum including the arbitrary division into several regions by wavelength.
- Define IR spectroscopy; determine the associated region in the EM spectrum, the method of generating IR spectra, and the information obtained from each spectrum.
- Identify the absorption bands of X-H, triple, double, and single bonds on an IR spectra.
- Predict the wavenumber, intensity, and shape of an absorption band from its molecular structure.
- Distinguish between compounds based on their IR spectra.
- Use the hydrogen-deficiency index (in addition to other spectroscopic tools) to elucidate molecular structure.

- Define diamagnetism and identify its implications in NMR spectroscopy.
- Explain the relationship between B0, ΔE (between α and β spin states), and the operating frequency.
- Identify chemically equivalent protons in any compound.
- Determine whether two protons are homotopic, enantiotopic, or diastereotopic.
- Predict the number of signals in an NMR spectrum for any organic molecule.
- Predict the chemical shifts for all protons in any organic compound.
- Explain how diamagnetic anisotropy affects the chemical shifts of protons proximal to π bonds.
- Derive the number of protons giving rise to each signal using integration values in combination with molecular formula.
- Predict the splitting patterns of signals on a 1H NMR spectrum.
- Predict the number of signals and location of each signal in a 13C NMR spectrum.
- Use 1H,13C, and 13C DEPT NMR spectra to identify unknown compounds.
- Use multiple spectral data to identify unknown compounds.

Unit 02: Conjugated π Systems

- Propose a mechanism and predict the major products for electrophilic addition to conjugated dienes.
- Use temperature information to predict whether 1,2-addition or 1,4-addition will predominate for electrophilic addition to conjugated dienes.
- Predict the major products of the Diels-Alder reaction, electrocyclic reactions, and sigmatropic rearrangements (Cope and Claisen rearrangements).
- Describe the information obtained from a UV-Vis spectrum.
- Identify benzene and its common derivatives.
- Identify ortho, meta, and para relationships on benzene rings.
- Identify aromatic, nonaromatic, and antiaromatic compounds and rationalize experimental observations involving aromatic stabilization.
- Determine whether a lone pair participates in aromaticity.
- Predict the products and identify reagents for reactions at the benzylic position, including oxidation, free-radical bromination, substitution reactions, and elimination reactions.
- Predict the products, identify reagents, propose plausible mechanisms, and rationalize origins of reactivity for electrophilic aromatic substitution reactions.
- Predict the activating/deactivating and directing effects of substituents on an aromatic ring in electrophilic aromatic substitutions.
- Propose the efficient synthesis of poly-substituted benzenes.
- Predict the products, identify reagents, propose plausible mechanisms, and rationalize origins of reactivity for nucleophilic aromatic substitution reactions.
- Analyze spectroscopic data to propose the structure of an aromatic compound.

Unit 03: Chemistry of Carbonyl Compounds

- Prepare aldehydes and ketones for synthesis.
- Rationalize the reactivity of aldehydes and ketones.
- Propose plausible mechanisms for nucleophilic addition to carbonyl centers under basic or acidic conditions.
- Predict the products and propose plausible mechanisms for the nucleophilic addition of O,N, and S nucleophiles to aldehydes and ketones.
- Propose mechanisms for the hydrolysis of acetals, hemiacetals, imines, and enamines.
- Use cyclic acetals as protecting groups in organic synthesis.
- Predict the products, identify reagents/conditions, and propose reasonable mechanisms for reaction of hydrogen and carbon nucleophiles on carbonyl compounds in synthesis.
- Predict the products of a Baeyer-Villiger oxidation and use in the synthesis of diols.
- Use carbonyl chemistry in organic synthesis.
- Prepare carboxylic acids.
- Rationalize acidity of carboxylic acids.
- Rationalize reactivity of carboxylic acid derivatives.
- Predict the products, identify reagents/conditions, and propose reasonable mechanisms for nucleophilic acyl substitution reactions of acid chlorides, acid anhydrides, esters, amides and nitriles.

- Identify keto-enol tautomers, and propose mechanisms for tautomerization reactions under acidic and basic conditions.
- Predict and rank the acidity of alpha protons.
- Prepare enols and enolates, and use in organic synthesis.
- Predict the products, identify reagents, and propose mechanisms for alpha halogenation reactions.
- Predict the product, identify appropriate reagents and conditions, and propose plausible mechanisms for aldol and Claisen condensation reactions.
- Predict the products, identify reagents, and propose mechanisms for α-alkylation reactions, the malonic ester synthesis, the acetoacetic ester synthesis, To grasp a holistic understanding of mechanisms involving carbonyl compounds.
- Predict the products, identify reagents, propose plausible mechanisms, and rationalize origins of reactivity for Michael reactions.
- Predict the products, identify reagents, propose plausible mechanisms, and rationalize origins of reactivity for reactions involving Stork enamines.
- Predict the products, identify reagents, propose plausible mechanisms, and rationalize origins of reactivity for Robinson annulations.
- Analyze spectroscopic data to propose the structure of carbonyl-containing compound.

Unit 04: Organometallic Chemistry

- Prepare organolithium, organomagnesium, and organocuprates for synthesis.
- Predict the products and identify reagents for the Corey-Posner/Whitesides-House reaction and the Simmons-Smith reaction.
- Predict the products and identify reagents for Stille, Suzuki, Negishi, Heck, and alkene metathesis reactions.

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CHEM 331 | Demille Hall 101 | Spring 2020

TENTATIVE SCHEDULE (check Canvas for updated version)

Day	Date	Wk	Lec.	Topic	Reading	Suggested Problems
M	02/03/20	01	01	**Spec I**: syllabus + intro to spectroscopy	14: 01	
W	02/05/20		02	**Spec II**: IR wavenumber, intensity, shape	14: 02–05	14: 01–11, 52
F	02/07/20		03	**Spec III**: IR spectrum + HDI: DOU	14: 06,07,16	14: 12–17, 30–37, 42abd, 45, 48, 49, 51, 54–56,
Integrated and Challenge Problems: 16: 61, 63, 65, 66, 69, 71–73, 79						
M	02/10/20	02	04	**Spec IV**: NMR spectrum: # of signals + topicity + chemical equivalence	15: 01–04	15: 1–7, 32, 35, 41, 45, 46, 50
W	02/12/20		05	**Spec V**: Chemical shifts: inductive and anisotropic effects; integration	15: 05–06	15: 8–14, 47, 51, 52
F	02/14/20		06	**Spec VI**: Multiplicity + ^{1}H NMR analysis + pattern recognition	15: 07–10	15: 15–25, 38, 42, 49, 53, 57, 58
M	02/17/20	03	07	**Spec VII**: ^{13}C NMR + DEPT ^{3}C NMR	15: 10–13	15: 26–31, 33, 34, 36, 37, 39, 40, 43, 44, 48, 54, 60, 61, 62
W	02/19/20		08	**Spec VIII:** Combined IR + ^{1}H + ^{13}C NMR		15: 55, 56, 59
Integrated and Challenge Problems: 15: 63–69, 71–81						
F	**02/21/20**			**LECTURE EXAM 1 (Lec. 01–08)**		
M	02/24/20	04	09	**Conj. π + Pericyclics I**: Structure + stability + MOT + UV-Vis	16: 01–03, 11	16: 01–05, 27–28, 31–34, 41, 47–49, 54, 59
W	02/26/20		10	**Conj. π + Pericyclics II**: Electrophilic addition + thermo vs. kinetic control	16: 04–05	16: 09–11, 35–38
F	02/28/20		11	**Conj. π + Pericyclics III**: Intro to pericyclics + Diels-Alder	16: 06–07	16: 13–18, 39, 40, 42–44, 45, 46, 57, 58
M	03/02/20	05	12	**Conj. π + Pericyclics IV**: cycloaddition MO + electrocyclic reactions + sigmatropic rearrangement	16: 08–10	16: 19–26, 50–53, 55, 56
Integrated and Challenge Problems: 16: 60–65, 66–68, 69, 70, 73, 77–79						
W	03/04/20		13	**Aromatics I**: Intro + structure + stability	17: 01–05	17: 01–15, 24, 25, 29–41, 47, 57, 59
F	03/06/20		14	**Aromatics II**: Rxns @ benzylic position + reduction + spectroscopic considerations	17: 06–08	17: 17–23, 42–46
Integrated and Challenge Problems: 17: 48, 49, 59, 51–55, 57–61, 63, 70, 71, 74						
M	03/09/20	06	15	**Aromatics III**: Electrophilic aromatic halogenation + sulfonation + nitration + Friedel-Crafts alkylation + acylation	18: 01–06	18: 01–10, 48–50, 58

W	03/11/20		16	**Aromatics IV**: Activating + deactivating groups	18: 07–10	18: 11–17, 39–41, 42abcfh, 44, 45abcd, 46abdefg, 55ab, 61, 62,
F	03/13/20		17	**Aromatics V**: Directing + blocking effects + synthetic strategies	18: 11–12	18: 18–29, 38, 42deg, 45efgh, 46hijk, 47, 52–55, 59, 63–66, 68–71
M	03/16/20	07	18	**Aromatics VI**: Nucleophilic aromatic substitution + elimination-addition	18: 13–15	18: 30–37, 51, 56, 60, 67, 72,

Integrated and Challenge Problems: 18: 73–80, 82–85, 87, 92, 93

W	03/18/20		19	Review		
F	**03/20/20**			**LECTURE EXAM 2 (Lec. 09–19)**		
M	**03/23/20**	08		**SPRING BREAK**		
W	**03/25/20**			**SPRING BREAK**		
F	**03/27/20**			**SPRING BREAK**		
M	03/30/20	09	20	**Carbonyls I:** aldehydes/ketones preparation + nucleophilic addition reactions	19: 01–04	19: 5, 6, 49
W	04/01/20		21	**Carbonyls II:** oxygen & nitrogen nucleophiles, hydrolysis	19: 05-07	19: 7–24, 55, 56, 58, 59, 60, 61, 62, 63, 65, 68, 70, 71, 72
F	04/03/20		22	**Carbonyls III:** sulfur, hydrogen, and carbon nucleophile + Baeyer-Villiger oxidation	12: 06 19: 08–11	12: 13–15, 35, 37a, 40, 41 19: 26–39, 50, 51, 54, 64
M	04/06/20	10	23	**Carbonyls IV:** synthesis + spectroscopy	19: 12–13	19: 40–42, 53, 57, 66, 67, 69, 73

Integrated and Challenge Problems: 19: 74–80, 82–96

W	04/08/20		24	**Carbonyls V:** carboxylic acids acidity + preparation + reactions	20: 01–05	20: 4–7, 10, 11, 35, 36, 43
F	04/10/20		25	**Carbonyls VI:** derivatives + preparation, reactions of acid chlorides and anhydrides	20: 06–09	20: 14–19, 44, 57, 68
M	04/13/20	11	26	**Carbonyls VII:** Preparation and reactions of esters, amides, and nitriles	20: 10–13	20: 20–29, 45–48, 52, 53, 55, 56, 58, 60–63, 64a
W	04/15/20		27	**Carbonyls VIII:** Synthesis + spectroscopy	20: 14–15	20: 30–34, 41, 42, 49–51, 54, 59, 69

Integrated and Challenge Problems: 20: 70–90, 92, 93

F	04/17/20		28	**Carbonyls IX:** Introduction to alpha carbon chemistry + enols and enolates	21: 01-02	21: 1–13, 47–56, 59, 60, 65, 74ab
M	04/20/20	12	29	**Carbonyls X:** aldol	21: 03	21: 14–23, 57, 58, 61–64, 66, 71, 74c

W	04/22/20		30	**Carbonyls XI:** claisen + alkylation	21: 04-05	21: 24–34, 67–69, 76ab, 79, 84
F	04/24/20		31	**Carbonyls XI:** conjugate additions	21: 06	21: 35–41, 76cd, 83, 85, 86
Integrated and Challenge Problems: 21: 89–101, 103–108, 110, 112–115						
M	04/27/20	13	32	**Carbonyls XII:** mechanism strategies		21: 70, 75, 80–82, 87
W	04/29/20		33	**Carbonyls XIII:** synthesis strategies		21: 42–46, 72, 73, 77, 78, 88
F	**05/01/20**			**LECTURE EXAM 3 (Lec. 20–32)**		
M	05/04/20	14	34	**Organometallics I:** organolithium, organomagnesium, organocuprates, and organozinc	23: 01-04	23: 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 40a, 41, 43, 47
W	05/06/20		35	**Organometallics II:** Stille + Suzuki	23: 05–06	23: 12, 13, 14, 15, 16, 17, 18, 33, 40c, 44, 52,
F	05/08/20		36	**Organometallics III:** Negishi + Heck	23: 07–08	23: 19, 20, 21, 22, 23, 24, 25, 26, 37, 40bd, 42, 45, 49, 54, 56, 58
M	05/11/20	15	37	**Organometallics IV:** Alkene metathesis	23: 09	23: 27, 28, 29, 30, 31, 32, 36, 38, 39, 51, 53
W	05/13/20		38	**Organometallics V:** Synthesis		23: 34, 35, 46, 48, 50
Integrated and Challenge Problems: 23: 59, 60, 61, 62, 63, 64, 65, 66, 71, 73, 74, 75, 76						
F	05/15/20		39	Review + exit		