Chem. 432 Organic Chemistry

Spring 2021

Professor Jeffrey Gustafson
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COURSE INFORMATION

Class Days: MWF
Class Times: 11:00-11:50
Class Location: Meeting ID: 883 0630 6275
Passcode: 432432

Office Hours:
Office Hours Location: Meeting ID: 883 0630 6275
Passcode: 432432

Course Overview

Chem 432 is a continuation of Chem 232, and focuses primarily on organic reactions, including mechanisms and synthesis. **This is technically an upper division chemistry class and will be challenging,** you will need to study as hard if not harder then you did for 232. However, a number of the reactions and mechanisms we go over are well represented in biochemistry and possess applications in diverse interdisciplinary fields ranging from medicinal chemistry to material science. The following 'Student Learning Outcomes' represent every major concept in the course. **TLDR: This class builds off of chem 232 so you better feel comfortable with that material. This class will go through chapters 12-21 in the book**

Student Learning Outcomes (this is your Final exam study guide):

Concepts from Chem 232:

1) Application of bonding and anti-bonding orbitals to help explain reaction mechanism.

2) Predict electronegativity and other period trends of organic molecules.

3) Identify the hybridization of organic atoms.

4) Predict the shape of a functional group or molecule based on hybridization.

5) Application of resonance to explain structure and reactivity.

6) Predict pKa trends across classes of molecules using resonance, hybridization, and electronegativity.

6-B) Explain how structure relates to carbocation stability trends

Chapter 12

7) Identify the Oxidation state of Carbon based functional groups.

8) Application of appropriate oxidation condition to obtain desired oxidation state on carbon.

9) Application of appropriate hydride reagents to reduce carbonyl to desired oxidation state.

10) Predict products formed from nucleophile adding into different classes of carbonyl.

11) Identify the electrophilicity trend among a series of carbonyls.

12) Design syntheses of carbon based nucleophiles.

13) Apply hybridization, resonance, and electronegativity to explain reactivity of organometalics.

Chapter 13

14) Explain the effects of conjugation on trends in stability of anions, cations, and radicals.

15) Identify the Kinetic and Thermodynamic product of a given reaction.

16) Apply appropriate conditions to obtain desired product (Kinetic or thermodynamic).

17) Produce a reaction coordinate depicting the interplay of kinetics and thermodynamics.

18) dentify the HOMO and LUMO (often antibonding orbital) of simple organic molecules in context of a reaction.

19) Identify the electronic factors that raise or lower the energy level of a HOMO or LUMO.

20) Apply HOMO/LUMO factors to understand caveats of the Diels alder reaction.

Chapter 14

21) Identify aromaticity in organic molecules.

22) Depict qualitative molecular orbitals using 'Frost' diagrams, and use this to rationalize a molecule's aromaticity.

23) Identify and rationalize the differences in reactivity between alkenes and aromatic Pi systems.

Chapter 15

24) Identify the factors that determine the regioselectivity of electrophilic aromatic substitution/nucleophilic aromatic substitution.

25) Application of electrophilic aromatic substitution/Nucleophilic aromatic substitution on synthesis of aromatic compounds.

26) Identify functional groups that raise or lower the HOMO of an aromatic group, and predict the effect these groups will have on reaction rate.

Chapter 16

27) Identify and rationalize the differences in reactivity among common carbonyl containing functional group.

28) Rationalize the reactivities of common Hydride reagents (*i.e. DiBAlH)* based on structure.

29) Depict the acid catalyzed addition of alcohols into carbonyls.

30) Identify the factors that influence the eqilibrium between a carbonyl and acetal.

31) Recognize the difference between alcohol and amine nucleophiles, and the effect on reaction outcome (acetal Vs imine).

32) Recognize the differences in stability of resultant Imine between primary and secondary amines, and how this manifests itself in enamine chemistry.

33) Indicate the product outcome resulting from addition of nucleophiles into nitriles and factors that influence reaction outcome.

34) Apply concepts to rationalization of Wittig mechanism

Chapter 17

35) Application of carbonyl reactivities and leaving group pKas to predict reaction outcomes of acyl substitutions

36) Application of standard methods ($SOCl_2$, DCC) to activate carboxylic acids towards Acyl substitution

37) Application of strong acids or bases to hydrolyze amides, esters, nitriles, etc… to carboxylic acids.

38) Identification of key step and factors that drive the equilibrium of hydrolyses.

39) Design syntheses where functional groups are converted to other functional groups.

40) Rationalize pKa trends among carboxylic acids and related derivatives.

Chapter 18

41) Recognize the factors that influence Keto-Enol tautomerization.

42) Identifying acidic protons adjacent to carbonyls and other electron withdrawing groups

43) Apply enolate reactivity towards alpha halogenation of carbonyls and the haloform reaction

44) Apply enolate reactivity towards alpha alkylation of carbonyl compounds

45) Identify the factors that influence the regioselectivity (kinetic vs. thermodynamic) of enolization, and how this effects the reaction outcome of alpha-functionalization of carbonyls.

46) Recognizing the reactivity of enamines and application to catalytic carbonyl a-functionalization.

Chapter 19

47) Identifying the reactivity of enolates towards esters.

48) Recognizing the theromodynamic features that drive the Claissen condensation towards completion.

49) Identifying the reactivity of enols and enolates towards ketones and aldehydes

50) Recognizing the importance of the Aldol in synthesis and natural products

51) Identify the factors that can lead to Aldol condesation products

52) Identifying the reactivity of nucleophiles towards enones and related compounds

53) Recognize that many weaker nucleophiles can add reversibly, and that this correlates with pKa of conjugate acid of nucleophile, and can lead to kinetic (1,2) or thermodynamic (1,4) addition scenarios.

Chapter 20

54) Rationalize the pKa trends among amines, and how this correlates to reactivity.

55) Rationalize the pKa trends among phenols and how this correlates to reactivity compared to alcohols.

56) Explain the difference between benzyne addition and nucleophilic aromatic substitution.

Chapter 21

57) Describe the basic organometallic mechanistic steps that are a hallmark of transition metal chemistry and apply to the mechanism of alkene hydrogenation

58) apply these steps to the major Cross-coupling (Heck, Suzuki) reactions.

59) apply these reactions in designed syntheses of simple pharmaceutical reagents.

Enrollment Information

Prerequisites: A grade of 'C' or better in Chem 232 or corresponding course. If you have already taken and passed the 432 lab, bring proof to the first lecture. If you have taken 1st semester Organic chemistry elsewhere and want me to evaluate whether you have satisfied the prerequisites, bring written proof of what you have taken and written documentation of what the class entailed.

Course Materials

Book: *Organic Chemistry*, *12e.*, by Solomons, Fryhle, and Snyder, Wiley Publ. 2016; ISBN: 978-1-118-87576-6. Available from the SDSU bookstore. As the online homework is not mandatory, earlier editions should be for the most part OK. **WE WILL Be COVERING CHAPTERS 12-21.**

Homework: Homework for each chapter will be posted on Canvas. The Homework assignments will be due the morning of the exam covering that chapter. The homework assignments are there to help you learn and are set to allow students to do them as many times as they like (your highest score **before the due date** for each question will be counted).

Lectures: The lectures and office hours will be streamed live online via zoom and posted on Canvas. While attending lecture and office hours are not mandatory, it is **very highly** recommended to do so live.

Exams: The exams will be administered on canvas, using a similar format to that of the homework. Students must be logged into zoom with camera on.

Virtual Reality review: For each chapter, there will be a short 20-25 minute concept review shot in 3D. Watching the videos are optional, but they will review material from a different perspective and should be useful.

Recommended (Optional) Materials:

Molecular Visions Organic Model Kit or similar organic chemistry molecular modeling set. Optional, but highly recommended.

Course Structure and Conduct

This course will be taught in a traditional lecture 'chalk talk' format. Electronic homework through canvas will be due on the morning of each exam, **however it is imperative you start the homework as we cover the chapter in lecture**. It is also important that you read the book before lecture so that you are somewhat familiar with the material as I present it.

Course Assessment and Grading

Exams: Exams will be on Saturday February 20th, March 20th, April 17 1000-1200.
Final Exam: May 8th 230-430 PM

Exams: There will be three 2-hour midterm exams during the semester, **each worth 200 points**. The final exam (also 2 hours) is cumulative and is worth **200 points**. All exams will be administered on canvas and will be a combination of multiple choice, matching, fill in the blank and short-answer questions. Your answers for the short-answer questions must be handwritten and uploaded to canvas where specified. The TAs will show you how to embed your handwritten answers prior to the exam. All together the exams and final are worth **800 points.**

please note that If your final exam score is higher than **any of your midterm exam scores**, then it will replace the lower midterm exam scores. I.e., your final exam will count for more, replacing the lower midterm exam grades, and giving you a better overall class performance. This will change the curve in a good way…meaning your standing in the class will be hurt if you slack off on the final.

*** **There will be no make-up exams.*** ** If you miss an exam, for *any reason*, it will count as the dropped exam. The final exam is not optional and cannot be dropped.

Group work: The last 25 minutes of the Friday lecture before each exam will be dedicated to a group synthesis problem. Those in attendance will be randomly broken up into breakout rooms in groups of 5 students and given 25 minutes to work on an 'exam level' synthesis problem. At the end of the period one member of the team will upload the groups assignment (with the names of each team member) on canvas. Each group assignment will be worth **33 points**. The last lecture of the semester will be entirely dedicated to this type of activity, however this time each team will be given an FDA approved drug. As this will be a more difficult assignment, each team will have until the morning of the final (May 8th) to upload their synthesis. This final assignment will be worth **101 points**. Altogether, these 4 group assignments will be worth **200 points** (the same as an exam). If you are unable to be in attendance at the given time, you will be given a comparable alternative assignment to complete on your own, however you must coordinate with Professor Gustafson ASAP, and the assignment will still be due before the corresponding exam.

Homework: There are 12 HW assignments on canvas, each worth **20 points**. They are written in a similar format to that of the exams, so should be useful for preparing you for the exams. Please note that all questions that require you to upload a picture of a handwritten answer are optional, however similar questions will be on the exam this it is very much worthwhile to do them. Altogether the homework is worth **240 points.** ***No late homework will be accepted*** So start it early.

Overall grade: Your final grade will be based on a maximum of **1240 points**, distributed as follows: 3 exams (600 points), 1 Final Exam (200 points), 4 group syntheses problems (200 points), and the 12 homework assignments (240 points).

Letter Grade Assignment: Depending on class performance the course may be curved, **but never downward.** If necessary, the class average will be set to a B-. 68% (the lowest B).

Tentative cuttoffs:

A: 1100-1240-**A**; **A-:**1045-1099; **B+:** 1000-1044; **B**: 843-999; **B-**:800-842 **C+:** 750-799; **C**:620-749; **C-**:570-619 **D+:** 570-619 **D:**450-569**; F:** below 449 points

Students with Disabilities

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact

Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that accommodations based upon disability cannot be provided until you have presented your instructor with an accommodation letter from Student Disability Services. Your cooperation is appreciated.

Academic Honesty

The University adheres to a strict policy regarding cheating and plagiarism. These activities will not be tolerated in this class. Become familiar with the policy (http://www.sa.sdsu.edu/srr/conduct1.html). Any cheating or plagiarism will result in failing this class and a disciplinary review by Student Affairs.

Examples of Plagiarism include but are not limited to:

- Using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs and/or pages of work)
- Copying and pasting work from an online or offline source directly and calling it your own
- Using information you find from an online or offline source without giving the author credit
- Replacing words or phrases from another source and inserting your own words or phrases
- Submitting a piece of work you did for one class to another class

If you have questions on what is plagiarism, please consult the policy (http://www.sa.sdsu.edu/srr/conduct1.html) and this helpful guide from the Library:(http://infodome.sdsu.edu/infolit/exploratorium/Standard_5/plagiarism.pdf)

Labs

You must attend your first scheduled lab or your spot may be forfeited. If you cannot make it please email the lab coordinator

Extra help and tips for Success

Help is available in a variety of forms.

- Work with your classmates on difficult material.
- Talk to your laboratory TA.
- Get a tutor. The Chemistry office (GMCS 209) or I can also help you to find one.
- **There will be a review session the Thursday before each exam at 5:00 PM.**

10 Musts to get a good grade:

- Attend all lectures and labs.
- Read material in book and notes before lecture, prior knowledge will help you become engaged in lecture and better comprehend material.
- Write questions down, and attend office hours.
- Discuss concepts with classmates, or study partner.
- Don't fall behind!
- Try to see the big picture. Organic chemistry builds upon itself. Many of the topics within a chapter are just a slight variation of something you learned.
- Be curious. Always ask why? Curiosity makes a scientist tick.
- Focus on understanding concepts, not memorization.
- Actively read tests and notes… every few minutes you should try a problem.

You can't be a proficient scientist without a basis of factual knowledge, meaning that a little memorization is an essential part of your education. That said, exams will be designed as much as possible to test your ***comprehension*** rather than focusing on rote memorization. Expect that some exam questions will include a small "twist" that will be very easy to handle if you have understood, but very hard if you have only memorized. This will be completely clear; I do not intentionally use trick questions. This is an upper division organic chemistry class, you will have to study hard!!!