Chem. 432 Organic Chemistry

Fall 2019

Professor Jeffrey Gustafson
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COURSE INFORMATION

Class Days: MWF
Class Times: 11:00-11:50
Class Location: HT 140

Office Hours (and by appointment): MF 945-10:45, W 12:00-1:00
Office Hours Location: CSL 208

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 BR COVERING CHAPTERS 12-21**

Lecture Notes: Notes will be put up on Blackboard at beginning of semester. These notes cover the major topic I will go over, **but are not a replacement for coming to class!!** Worked problems and examples done on the board generally will not be posted. You will miss this material if you don't attend.

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 Wiley plus will be due on the Friday before 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. I will post PowerPoint notes on blackboard before lecture, as well as my personal hand written lecture notes after lecture. There will be a

review session the Thursday before each mid term at 5:00 PM where I will work out problems from my previous exams, and address questions.

Course Assessment and Grading

Exams: Exams will be on Saturday September 21, October 19, November 23 1000-1200 in TBD
Final Exam: December 14m 230-430 PM in **TBD**
There will be three 2 hour midterm exams during the semester, **each worth 150 points**, and there will be the opportunity to earn up to 15 extra credit points per exam. Any points earned above 100% will be carried over to your cumulative total. The final exam (also 2 hours) is cumulative and is worth **300 points**. If your final exam score is higher (based on percentage) 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. **There will be 6 short 10 minute pop quizzes worth 25 points each (150 total points**.) Your final grade will be based on a maximum of **900 points**, distributed as follows: 3 exams (150 points each), 1 Final Exam (300 points), 6 pop quizzes (150 points).

You final homework percentage will be scaled to 150 points, equal to one exam.

Letter Grade Assignment: Depending on class performance the Exams may be curved, **but never downward.** If necessary the class average of each exam will be curved upward to a 66% (the lowest B-). The cutoff for an A- will be 765 total points (85%). The cutoff for a B- will be 600 points (66%). The cut off for a C- will be 450 points (50%).

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!!!