

# Chemistry 432

## Organic Chemistry – Spring 2019

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Class Hours MWF 11:00 - 11:50 AM, NE-60  
Office Hours Mon 9 – 10 AM, Wed 1 – 2 PM and by  
appointment only  
Help Sessions: The times and dates will be  
announced in class

**Text:** "Organic Chemistry" Twelfth Edition, by T. W. Solomons, C. B. Fryhle and S. A. Snyder. A "Student Study Guide & Solution Manual for Organic Chemistry" 12th Edition of Solomons, Fryhle and Snyder is also available at the bookstore. Another study guide that is recommended is "Success in Organic Chemistry: A Problems Book" by Andrew Ternay or the Schaum's outline for "Organic Chemistry.". There are a number of alternative organic textbooks. Many of these use a slightly different approach to understanding the class material. A set of molecular models is **very** useful to visualize the three dimensions of compounds. There are several sets of molecular models available. You can order an inexpensive set from Andrus Education Supplies (see Blackboard page for details). Alternatively, a computer based molecular modeling kit is also available. These models are optional but recommended. The following chapters and dates for exams are given below.

<b>Chapter 12</b>	Alcohols from Carbonyl Compounds. Oxidation-Reduction and Organometallic Compounds
<b>Chapter 13</b>	Conjugated Unsaturated Systems
<b>Chapter 14</b>	Aromatic Compounds
<b>Exam #1</b>	<b>2/23/19 GMCS-333, 10:00 AM – 12:00 noon</b>
<b>Chapter 15</b>	Reactions of Aromatic Compounds
<b>Chapter 16</b>	Aldehydes and Ketones. Nucleophilic Addition to the Carbonyl Group
<b>Exam #2</b>	<b>3/16/19 GMCS-333, 10:00 AM – 12:00 noon.</b>
<b>Chapter 17</b>	Carboxylic Acids and their Derivatives. Nucleophilic Addition-Elimination at the Acyl Carbon
<b>Chapter 18</b>	Reactions at the $\alpha$ -Carbon of Carbonyl Compounds. Enols and Enolates.
<b>Chapter 19</b>	Condensation and Conjugate Addition Reactions of Carbonyl Compounds. More Chemistry of Enolates
<b>Chapter 20</b>	Amines (Partial)
<b>Exam #3</b>	<b>4/27/19 GMCS-333, 10:00 AM – 12:00 noon</b>
<b>Chapter 20</b>	Amines (Second half of chapter)
<b>Chapter 21</b>	Transition Metal Complexes. Promoters of Key Bond-Forming Reactions Left-overs and review

**Final** Tentative date, **Saturday, May 11, 2019. May 11, 2019, 14:30 – 16:30, GMCS-333 .**

All Exams are given Saturday mornings, 10:00 AM - 12:00 noon. The room(s) used for exams and assignments will be announced in class and on the final version of the syllabus. Students participating in official university events and activities must present the memorandum indicating reasons and dates of absences within the first two weeks of the semester. If you have a conflict between the midterm exams and one of your regularly scheduled classes, you may take the midterm exams at another time. However, you must contact me at least one week in advance of each of the midterm exams. You will need to bring a copy of class schedule and times that you can take the makeup exam the day before, day of or the day after the scheduled exams (Tuesday, Wednesday or Thursday). I will attempt to find one common time for these make-up exams. If you do not contact me the week before to the exam, you will not have a choice when these make-ups are given. If you are ill or have a family emergency, you **MUST** contact as soon as possible, preferably before the exam begins by either emailing me (preferred) or calling and leaving a message or on my office phone. You will need to present documentation to your illness or family emergency. Conflicts with other activities, such as interviews, vacations, and weddings are not acceptable excuses.

The keys to the exams are posted at the Blackboard web page along with supplemental information, handout information, and addendum's to the notes. I strongly recommend that you check your exams after they are returned. You can submit

an exam for a re-grade up to one week from either the return of the exam or the posting of the key, whichever is done last. After one week, I will not make any changes in your exam scores.

Chemistry 432 is a continuation of Chemistry 232. By the nature of this material, all exams are accumulative. In this course we will cover the properties and chemical reactivities of carbonyl (aldehydes, ketones and carboxylic acids), aromatics, amines and conjugated dienes. In addition, we will continue to examine the principles of spectroscopic identification of organic compounds adding the fundamentals of UV-Vis spectroscopy to that of NMR, and IR. This course is essential to the understanding of biochemistry, advanced organic chemistry and molecular biology.

Attendance is HIGHLY recommended, since additional material will be presented in lecture that is not found in the text. Frequently, alternative explanations of class material will be presented as well as approaches to the solution of problems. As a rule, lack of attendance strongly correlates to a low course grade. I strongly recommend that you attend, form and participate in study groups. You can learn a lot helping someone else. Another opportunity to master this material is attending the help sessions. I will be offering help sessions the approximate two weeks before the midterm exams. However, if attendance falls below a present level, I will cancel those help sessions for the remainder of the semester. Students are strongly encouraged to turn-off phones and lap top computers. Recent studies show paper and pencil notes are far more effective than electronic means.

#### Student Learning Outcomes:

1. Students will be able to use various reducing agents to selectively prepare alcohol products as well as use the different oxidizing reagents to prepare carbonyl compounds. In a similar fashion, they will also be able to use organometallic reagents to alkylate carbonyl compounds to form new carbon-carbon bonds. Students will be able to use draw resonance structures, allowing them to determine the relative stability of reactive intermediates, such as radicals and carbocations, especially those seen in 1,2 and 1,4-additions in conjugated diene systems. All students in this class will be able to recognize aromatic, heteroaromatic (carbocations and carbanions) from anti-aromatic and non-aromatic compounds. They will be able to predict reactivities in aromatic electrophilic additions, formation of the electrophile, and identify the factors that control the regioselectivity. In addition to the electrophilic aromatic substitution, one also needs to be able to identify conditions that favor nucleophilic addition/elimination and the benzyne route (elimination/addition) for substitution. Students will be familiar with aromatic side-chain modifications and be able to effectively plan synthesis of aromatic based compounds. Students in this class will be familiar with the major routes to prepare aldehydes and ketones and their conversions to hemiacetals, acetals, imines, enamines. Cyanohydrins, Wittig reaction as well as the oxidation of aldehydes and Baeyer-Villiger oxidation. Student will be able to predict products and write mechanisms for the interconversion of carboxylic acids and their derivatives as well as their use as synthetic intermediates.
6. The reactions at  $\alpha$ -carbonyl carbons are important for the formation of enol and enolates. Everyone in this class will be able to recognize the reaction conditions and write the mechanism that lead to these essential intermediates used in carbon-carbon bond forming reactions.
7. Condensation reactions involving enol or enolates with carbonyl compounds as well as those leading to conjugate addition reactions are very important. Students will learn how to identify these reactions, write an acceptable mechanism and predict the products formed in these types of reactions.
8. Students will be able to explain the basic reactions of amines, predict their relative basicity and write acceptable mechanisms of amine and their formation.
9. All students in this class will be able to understand the basic reaction steps in catalytic carbon-carbon bond forming reactions as well as developing a basic understanding of organometallic bonding and prediction of stable and reactive intermediates.

# The Important Concepts of Organic Chemistry

For Chemistry 432

Note - not in any particular order of importance

Electronegativity and the periodic table – predictions of reactivity (nucleophilicity/electrophilicity), role of hybridizations.

$pK_a$  – Know the basic and important compounds and the trends due to substituents. Phenols, carboxylic acids, amines  $pK_b$ , aliphatic compounds and roles of resonance. Also, be able to relate conjugate acid and base strengths.

The octet rule and the basic structure of organic compounds.

Reaction mechanisms

1. Nucleophilic additions to carbonyl compounds (strong and weak nucleophiles)
2. Electrophilic attack
3. Aromatic electrophilic substitution
4. Free radical substitution
5. Pericyclic reactions (decarboxylation, Diels-Alder, Claisen and Cope rearrangements, etc.
6. Nucleophilic substitutions,  $S_N1$ ,  $S_N2$  and  $S_NAr$  and factors that allows one to predict differences between.

Stabilities of carbocations and free radicals. Carbanions have an approximate inverse order of stability.

Stability of alkenes

Kinetic versus Thermodynamic Control of reactions

Aromaticity and antiaromaticity. Hückel's rule and application to compounds

Resonances, structures and stability

Principle of microscopic reversibility

## Truisms

Don't make strong acids in basic reaction conditions and don't make strong bases in acid reaction conditions. Acidity and basicity are all relative.

The higher the reactivity the lower the selectivity and the lower the reactivity the higher the selectivity.