**TENNESSEE STATE UNIVERSITY**

**Department of Chemistry**

**CHEM 2020-01/80 and 2022-01: Organic Chemistry II**

**Spring Semester 2018**

**Instructor: Dr. Cosmas Okoro**

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**Class Hours MW**(8:00-9:25 AM**); T**(5:30-8:30 PM**); W(**2:20-5:20 PM); **TR(**11:10-12:35 PM**)**

**Office Hours: M** (11-12 PM Boswell 106**); T** (2 – 3 PM); **R** (2 – 5 PM)

**Textbook:** “Organic Chemistry” by Janice G. Smith, 5th edition

**Connect:** (Highly encouraged) Optional

**Reference Books**: 1. Organic Chemistry, 8th Ed, 2016, by Brown, Iverson, Anslyn and Foote

3. Organic Chemistry Principles and Mechanism, 2014 by Joel Karty

4. Fundamentals of Organic Chemistry, 6th Ed, 2007, by McMurry and Simaneck.

5. Organic Chemistry 6th Ed. 2016 by Marc Loudon and Jim Parise

**Prerequisite: CHEM 1110/1120 (Formerly CHEM 1010/1020)**

**Course Description:** The course involves a systematic study of various classes of organic compounds including their physical and chemical properties, nomenclature, stereochemistry, synthesis and reactions. The course also introduces Mass Spectroscopy, Infra-Red Spectroscopy, Nuclear Magnetic Resonance Spectroscopy and Ultra-Violet Spectroscopy. Basic description of the theories of these spectroscopic techniques and their utilization in structure determination are the key focuses. Radical reactions, aromaticity and structural characteristics of aromatic compounds and their reactions are introduced. Nucleophilic aromatic substitution reactions are discussed in detail. Chemistry of other class of compounds includes: aldehydes, ketones, carboxylic acids and their derivatives. Acidity of alpha hydrogens of carbonyl compounds and their substitution reactions are introduced in detail. Mechanisms of various aldol condensation reactions are presented.

**Course Objectives:** This course is designed for all chemistry majors, pre-professionals, biology and other scientific areas. Its aims are comprehensive introduction to some of the principles of organic chemistry. The student will learn a realistic approach to the study of reaction mechanisms and be acquainted with a good scientific understanding and working knowledge in Organic Chemistry.

**Course Competencies:** Upon completion of this course, the student should have obtained the following competencies:

1. Understand the spectral properties of waves. Gain a general appreciation for wavelength and the relative energy of various regions of the electromagnetic spectrum.
2. Be able to understand the basic principles of NMR Spectroscopy
3. Understand the meaning of “Chemical Shift”, and the use of the terms “Upfield” and “Downfield”.
4. Understand the meaning signal splitting and integration
5. Know how to interpret spectra
6. Be able to understand the concept of radical formations, and their stability
7. Be able to write and explain radical reactions with mechanisms.
8. Be able to understand relative rate differences in radical halogenation of alkanes
9. Be able to understand the mechanism of radical addition of HX to an alkene
10. Understand molecular orbital theory to understand UV/VIS spectroscopic absorptions.
11. Recognize that UV/VIS spectroscopy is an important analytical tool in biochemical and environmental studies
12. Understand the concept of conjugation, resonance, dienes and special stabilization factors
13. 1,2 vs 1,4 addition to conjugated dienes
14. Kinetic vs thermodynamic reactions and their energy diagrams
15. The Diels-Alder reaction including stereochemistry
16. Know the nomenclatures rules for aromatic compounds
17. Recognize the unique reaction characteristics of aromatic compounds
18. Be able to apply Huckel 4n+2 rule to characterize aromatic compounds.
19. Be able to understand aromatic electrophilic substitution reactions and substituent effects in such a reaction
20. Be able to understand the structure, nomenclature and bonding in carboxylic acid and it’s derivatives
21. Understand the acidity and reactions of carboxylic acids and factors that affect acidity
22. Be able to understand reduction reactions of carbonyl compounds.
23. Be able to understand the mechanisms of various nucleophilic substitution reactions of carboxylic acid derivatives
24. Understand the reactivity differences between various carboxylic acid derivatives
25. Understand the reactions of carbonyl compounds with Grignard reagents for the preparation of alcohols
26. Be able to name simple aldehydes and ketones
27. Know the various preparations of aldehydes and ketones
28. Understand the nucleophilic addition reactions of aldehydes and ketones with various nucleophiles, such as: OH-, H2O, H-, ROH, R3C-, RO-, CN-, NH3, RNH2 etc.
29. Be able to write the detailed mechanisms of the above nucleophilic addition reactions
30. Understand the conjugate addition reactions of α,β-unsturated aldehydes and ketones
31. Understand the acidity of alpha hydrogens of aldehydes and ketones and the reactions at the alpha carbon including alpha alkylation, haloform reactions, alpha halogenation reactions, malonic ester synthesis and various aldol condensation reactions
32. Understand the mechanisms of acid and base-catalyzed aldol condensation reactions.
33. Reactions of epoxides
34. Oxidation reactions
35. Nucleophilic aromatic substitution reactions
36. Be able to recognize aromatic amines
37. Synthesis and reactions of amines.
38. Relate Organic chemistry to everyday life.

**Course Presentation:** Lecture material will be taken from the textbook and supplementary materials will be distributed as needed.

**Examination/Quizzes:** **3** tests will account for **70 %**, **10 %** from Quiz and home work of the course grade. The rest **20 %** will account from Comprehensive Final Exam.

#### Attention: No cell phone or electronic devices in the class room during lecture and Exam hour.

#### TESTS AND EXAMS POLICY:

Three Tests will be given during the semester. Test dates will be announced in class prior to each test at least 5 days ahead of the test date. There will be no make-up test. Quizzes will be given without prior announcements.

**Grading Scale:** 90-100 = A; 80-89 = B; 70-79 = C; 60-69 = D; below 60 = F

**Attendance and Expectations:** Students are expected to attend every lecture in its entirety. Students are expected to read and study the material to be discussed prior to the lecture. This includes working in-chapter and end-of-chapter problems and exercises in the text. Students should review the material discussed until comprehension is acquired and seek assistance when necessary. It is also highly recommended that students purchase the following supplementary materials: Study Guide and Solutions Manual; A Molecular Model Set.

**DISABILITY ACCOMMODATION STATEMENT**

TSU is committed to creating inclusive learning environments and providing all students with opportunities to learn and excel in their course of study. Any student with a disability or condition which might interfere with his/her class performance or attendance may arrange for reasonable accommodations by visiting the Office of Disability Services (ODS). ODS is located in Kean Hall, room 131 and can be reached at 963-7400 or [www.tnstate.edu/disabilityservices](http://www.tnstate.edu/disabilityservices). You will be required to speak with ODS staff and provide documentation of the need for an accommodation. If you qualify for an accommodation you will be provided with a document stating what type of classroom accommodations are to be made by the instructor. It is your responsibility to give a copy of this document to the instructor **as soon as you receive it**.  Accommodations will only be provided **AFTER** the instructor receives the accommodation instructions from ODS; accommodations are not retroactive.  You must follow this process for each semester that you require accommodations. All exams for students requiring disability accommodation will be given in Boswell 201 (faculty lounge). This room is quiet and non-distractive.

**SEXUAL MISCONDUCT, DOMESTIC/DATING VIOLENCE, STALKING**

TSU recognizes the importance of providing an environment free of all forms of discrimination and sexual harassment, including sexual assault, domestic violence, dating violence, and stalking. If you (or someone you know) has experienced or is experiencing any of these incidents, there are resources to assist you in the areas of accessing health and counseling services, providing academic and housing accommodations, and making referrals for assistance with legal protective orders and more.

Please be aware that most TSU employees, including faculty and instructors, are “responsible employees”, meaning that they are required to report incidents of sexual violence, domestic/dating violence or stalking. **This means that if you tell me about a situation involving sexual harassment, sexual assault, dating violence, domestic violence, or stalking, I must report the information to the Title IX Coordinator.** Although I have to report thesituation, you will still have options about how your situation will be handled, includingwhether or not you wish to pursue a formal complaint. Our goal is to make sure you areaware of the range of options available to you and have access to the resources youneed.

You are encouraged to contact TSU’s Title IX Coordinator to report any incidents of sexual harassment, sexual violence, domestic/dating violence or stalking.  The Title IX coordinator is located in the Office of Equity and Inclusion, McWherter Administration Building, Ste. 260 and can be reached at 963-7494 or 963-7438.  For more information about Title IX and TSU’s SART or policies and procedures regarding sexual, domestic/dating violence and stalking please visit:  [www.tnstate.edu/equity](http://www.tnstate.edu/equity).

If you wish to speak to someone confidentially, who is not required to report, you can contact the TSU Counseling Center, located in the basement of Wilson Hall, at 963-5611 or TSU Student Health Services, located in the Floyd Payne Campus Center room 304, at 963-5084. You may also contact the following off campus resources:  Sexual Assault Center of Nashville at 1-800-879-1999 or [www.sacenter.org](http://www.sacenter.org) or the Tennessee Coalition to End Domestic & Sexual Violence at 615-386-9406 or [www.tncoalition.org](http://www.tncoalition.org).

**HARASSMENT & DISCRIMINATION**

Tennessee State University is firmly committed to compliance with all federal, state and local laws that prohibit harassment and discrimination based on race, color, national origin, gender, age, disability, religion, retaliation, veteran status and other protected categories. TSU will not subject any student to discrimination or harassment and no student shall be excluded from participation in nor denied the benefits of any educational program based on their protected class. If a student believes they have been discriminated against or harassed because of a protected class, they are encouraged to contact the Office of Equity and Inclusion at McWherter Administration Building, Ste. 260, 615-963-7494 or 615-963-7438, [www.tnstate.edu/equity](http://www.tnstate.edu/equity).

**ACADEMIC MISCONDUCT, CHEATING & PLAGIARISM**

In accordance with the university’s policy on academic and classroom misconduct found in the catalog, cheating will not be tolerated in this course and a zero-tolerance policy regarding cheating will be followed throughout the course. A student who is caught cheating or attempting to cheat will be given a zero (F) for that particular assignment/test/quiz for the first offense. If a student is caught cheating a second time, that student will be given an overall grade of “F” for the course. To this end, the following classroom policies will be in effect and enforced.

1. Cell phones and any other electronic devices (including smart watches) that connect to wireless networks will not be permitted during any exam or quiz. These devices may not be on your desk during an exam or quiz and must be stored in your bag or purse and/or turned off. Calculators may be used, only if the questions on the exam or quiz warrant their use.
2. Once an exam or quiz period has started, you will not be permitted to leave to go to the restroom during the exam period. Please be sure to use the restroom before coming to class. Exceptions will only be made for those with documented medical needs.
3. No outside materials may be used during an exam or quiz. Any necessary materials (*i.e.* periodic table, equations & constants, scratch paper, *etc.*) will be provided for you.
4. Sunglasses and hats may not be worn during an exam or quiz period.
5. The use of headphones and/or earbuds during an exam or quiz is strictly prohibited.
6. Duplication or copying of homework assignments will result in a score of zero (F) for each student submitting a copied homework assignment.

**Organic Chemistry II (CHEM 2020 and 2022)**

**Lecture Schedule**

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| --- | --- | --- | --- | --- |
| **Week of** | **Chap** | **Title** | **Pages** | **Exercises** |
| 1st week | 14 | **Nuclear Magnet Resonance Spectroscopy:** An Introduction to NMR Spectroscopy, 1H NMR: Number of Signals, 1H NMR: Position of Signals, The Chemical Shift of Protons on *sp2* and *sp* Hybridized Carbons,1H NMR: Intensity of Signals, 1H NMR: Spin-Spin Splitting, More Complex Examples of Splitting, Spin-Spin Splitting in Alkenes, Other Facts About 1H NMR Spectroscopy, Using 1H NMR to Identify an Unknown, 13C NMR Spectroscopy, Magnetic Resonance Imaging (MRI). | 527 | 14.1-14.77 |
| 2nd week | 15 | **Radical Reactions:** Introduction, General Features of Radical Reactions, Halogenation of Alkanes, The Mechanisms of Halogenation, Chlorination of Other Alkanes, Chlorination versus Bromination, Halogenation as a Toll in Organic Synthesis, The Stereochemistry of Halogenation Reactions, Application: The Ozone Layer and CFCs, Radical Halogenation at an Allylic Carbon, Application: Oxidation of Unsaturated Lipids, Application: Antioxidants, Radical Reactions to Double Bonds, Polymers and Polymerization. | 570 | 15.1-15.79 |
| 3rd week | 16 | **Conjugation, Resonance, and Dienes:** Conjugation, Resonance and Allylic Carbocations, Common Examples of Resonance, The Resonance Hybrid, Electron Delocalization, Hybridization, and Geometry, Conjugated Dienes, Interesting Dienes and Polyenes, the Carbon-Carbon σ Bond Length in 1,3-Butadiene, Stability of Conjugated Dienes, Electrophilic Addition: 1,2-Versus 1,4-Addition, Kinetic Versus Thermodynamic Products, The Diels-Alder Reaction, Specific Rules Governing the Diels-Alder Reaction, Other Facts About the Diels-Alder Reaction, Conjugated Dienes and Ultraviolet Light. | 604 | 16.1-16.75 |
| 4th week | 17 | **Benzene and Aromatic Compounds:** Background, the Structure of Benzene, Nomenclature of Benzene Derivatives, Spectroscopic Properties, Interesting Aromatic Compounds, Benzene’s Unusual Stability, the Criteria for Aromaticity-Hückel’s Rule, Examples of Aromatic Compounds, What Is the Basis of Hückel’s Rule?, The Inscribed Polygon Method for Predicting Aromaticity, Buckminsterfullerene-Is It Aromatic?. | 641 | 17.1-17.69 |
| 5th -6th week | 18 | **Electrophilic Aromatic Substitution:** Electrophilic Aromatic Substitution, The General Mechanism, Halogenation, Nitration and Sulfonation, Friedel-Crafts Alkylation and Friedel-Craft Acylation, Substitution Benzenes, Electrophilic Aromatic Substitution of Substituted Benzenes, Why Substituents Activate or Deactivate a Benzene Ring, Orientation Effects in Substituted Benzenes, Limitations on Electrophilic Substitution Reactions with Substituted Benzenes, Disubstituted Benzenes, Synthesis of Benzene Derivatives, Halogenation of Alkyl Benzenes, Oxidation and Reduction of Substituted Benzenes, Mulitstep Synthesis. | 677 | 18.1-18.79 |
| 7th week | 19 | **Carboxylic Acids and the Acidity of the O-H Bond:** Structure and Bonding, Nomenclature, Physical Properties, Spectroscopic Properties, Interesting Carboxylic Acids, Aspirin, Arachidonic Acid, and Prostaglandins, Preparation of Carboxylic Acids, Reactions of Carboxylic Acids-General Features,Carboxylic Acids-Strong Organic Brønsted-Lowry Acids, Inductive Effects in Aliphatic Carboxylic Acids, Substituted Benzoic Acids, Extraction, Sulfonic Acids, Amino Acids. | 729 | 19.1-19.72 |
| 8th week | 20 | **Introduction to Carbonyl Chemistry; Organometallic Reagents; Oxidation and Reduction:** Introduction, General Reactions of Carbonyl Compounds, A Preview of Oxidation and Reduction, Reduction of Aldehydes and Ketones, the Stereochemistry of Carbonyl Reduction, Enantioselective Carbonyl Reductions, Reduction of Carboxylic Acids and Their Derivatives, Organometallic Reagents, Reaction of Organometallic Reagents with Aldehydes and Ketones, Retrosynthetic Analysis of Grignard Products, Protecting Groups, Reaction of Organomentallic Reagents with Carboxylic Acid, Reaction of Organometallic Reagents with Other Compounds, α,β-Unsaturated Carbonyl Compounds, Summary, Synthesis. | 764 | 20.1-20.81 |
| 9th -10th week | 21 | **Aldehydes and Ketones Nucleophilic Addition:** Introduction, Nomenclature, Physical Properties, Spectroscopic Properties, Interesting Aldehydes and Ketones, Preparation of Aldehydes and Ketones, Reactions of Aldehydes and Ketones-General Considerations, Nucleophilic Addition of H- and R- - A Review, Nucleophilic Addition of -CN, The Wittig Reaction, Addition of 1º Amines, Addition of 2º Amines, Addition of H2O-Hydration, Addition of Alcohols-Acetal Formation, Acetals as Protecting Groups, Cyclic Hemiacetals, An Introduction to Carbohydrates. | 817 | 21.1-21.86 |
| Week 11 | 22 | **Carboxylic Acids and Their Derivatives – Nucleophilic Acyl Substitution:** Introduction, Structure and Bonding, Nomenclature, Physical Properties, Spectroscopic Properties, Interesting Esters and Amides, Introduction to Nucleophilic Acyl Substitution, Reactions and Anhydrides, Reactions of Caboxylic Acids, Reactions of Esters, Appication: Lipid Hydroysis, Reactions of Amides, Applications: The Mechanism of Action of β-Lactam Antibiotics, Summary of Nucleophilic Acyl Substitution Reactions, Natural and Synthetic Fibers, Biological Acylation Reactions, Nitriles. | 868 | 22.1-22.85 |
| Week 12 | 23 | **Substitution Reactions of Carbonyl Compounds at the α Carbon:** Introduction, Enols, Enolates, Enolates of Unsymmetrical Carbonyl Compounds, Racemization at the α Carbon, A Preview of Reactions at the α Carbon, Halogenation at the α Carbon, Direct Enolate Alkylation, Malonic Ester Synthesis, Acetoacetic Ester Synthesis. | 924 | 23.1-23.74 |
| Week 13 | 24 | **Carbonyl Condensation Reactions:** The Aldol Reaction, Crossed Aldol Reactions, Directed Aldol Reactions, Intramolecular Aldol Reactions, the Claisen Reaction, The Crossed Claisen and Related Reactions, The Dieckmann Reaction, The Michael Reaction, The Robinson Annulation. | 962 | 24.1-24.73 |
| Week 14 toFinish syllabus | 25 | **Amines:** Introduction, Structure and Bonding, Nomenclature, Physical Properties, Spectroscopic Properties, Interesting and Useful Amines, Preparation of Amines, Reactions of Amines, Amines as Bases and their Relative Basicity, Amines as Nucleophiles, Hofmann Elimination, Reaction of Amines with Nitrous Acid, Substitution Reactions of Aryl Diazonium Salts and Applications. | 996 | 25.1-25.78 |
|  | **Final Exam: Actual date and time TBA** |  |  |

**Important Dates**

Jan 15 Holiday – MLK—No Classes

Jan 16 Classes begin

Jan 16-19 Late registration/schedule adjustments

Mar 3-9 Midterm Examination Week – all classes meet as scheduled

Mar 12-16 Spring Break

Mar 20 Honors Convocation, 10:00 am Kean Hall

Mar 30 Last day to withdraw from a course and/or the University

April 2-28 Registration for Summer 2018

April 23-25 Early Exams (Candidates for Spring 2018 graduation ONLY)

April 24-27 Faculty submit Grades (Candidates for Spring 2018 Graduation)

April 27 Last Day of Classes

April 28-May 4 Final Examinations for Spring 2018 Semester

May 4 Graduate Comencement Ceremony – 5:00 PM, Gentry Complex

May 5 Undergraduate Comencement Ceremony – 8:00 am., Hale Stadium

May 7 Faculty must have posted all grades via “Mytsu”