**ORGANIC CHEMISTRY I (CH 323)**

**COURSE OUTLINE**

# **FALL SEMESTER 2021**

## Bülent Terem

**Required Textbook:** Gorzinsky Smith, Janice. *Organic Chemistry*, 2nd Ed., McGraw-Hill, **2008**.

**Supplementary Books:**

Gorzinsky Smith, J. and Smith, E. *Student Study Guide / Solutions Manual to Accompany Organic Chemistry by Janice Gorzinsky Smith*, McGraw-Hill, **2008**.

Clayden, J., Greeves, N., Warren, S. *Organic Chemistry*, 2nd Ed., Oxford University Press, **2012**.

**Software:** ChemDraw (for Windows); Chem 3-D, Cambridge Soft Corp. (Perkin-Elmer)

**Supplementary Materials:** Molecular Models

**Course Objectives:**

This is the first part of a two-semester course in organic chemistry, where carbon compounds are studied on the basis of their functional groups. Following a review of basic principles in general chemistry,

acid-base reactions will be investigated with an emphasis on electron pair transfers and the way these can be illustrated using curly arrows. Chemistry of alkenes will be the most important topic of the semester, since a mechanistic approach to functional group inter-conversions will enhance a fuller understanding of the subject and minimize memorization. Throughout the semester students will be encouraged to view organic molecules in three dimensions. A comprehensive study of stereochemistry based on thermodynamic principles will be very helpful in spatial analyses. To summarize the course objectives in more tangible terms, at the end of the semester the students should be able to carry out the following tasks:

* Identify and classify organic molecules according to their functional groups
* Carry out functional group inter-conversions of the classes of compounds studied
* Illustrate the mechanism of each of the functional group inter-conversions identifying intermediates and transition states where appropriate.
* Identify thermodynamically favorable conformations for acyclic and cyclic molecules
* Use principles of stereochemistry to explain stereoselective reactions
* Distinguish mechanisms on the basis of stereochemical outcome
* Improve spatial skills

The depth of organic chemistry is beyond that of a basic science; at times it can be perceived as a philosophy, a form of art, or architectural design. It can also help to answer questions, which start with “why?” In a liberal arts college with a student population from different backgrounds and with different career interests, the multi-dimensionality of this discipline can be demonstrated much more easily. It is hoped that at the end of the semester, the student will be fulfilled intellectually, in addition to accumulating the knowledge, which is essential for his/her studies in molecular and/or biomedical sciences

### **Exams and Grading:**

### In order to pass the class, a student must score higher than 40% in clicker quizzes, regardless of all other

### exam scores.

### Three 60-minute midterms and a ninety minute comprehensive final will be given, in addition to quizzes

### and homework assignments. Approximately half of the questions in the midterm exams will be identical

### to those assigned previously.

Course Grade (all grades in percentages) –

= + .22 (average of the three midterms)

+ .22 (average of the two highest midterms)

+ .15 (average of the quizzes)

+ .05 (homework)

+ .36 (final)

Make-up exams will be given only under exceptional circumstances and on the basis of a written request submitted before the exam day or within 24 hours of the date and time of the exam.

Letter grades are assigned on the basis of the following scale:

A > 85

B 84 – 68

C 67 – 48

D 47 – 33

F < 33

**Office Hours:** By arrangement

**Review Sessions:** To be arranged

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**General Comments:**

The prescribed method for organic chemistry is “active learning”, which means that students should think about and reformulate the concepts presented. This aspect will be emphasized during lecture periods and will be reinforced with appropriate assignments. Active learning will also require solving problems presented within each chapter of the textbook, as well as redoing the exams and quizzes already taken.

This course is taught in accordance with Chaminade University’s policies and mission statement. Core values addressed during the semester, such as diversity, peace, equality and social justice are blended into the course.

Chaminade University recognizes the inherent dignity of all individuals and promotes respect for all people. Compliance with the “Patsy Mink Takemoto Equal Opportunity in Education Act” (Title IX) including further amendments is strictly mandated.

General policies adopted in this course are outlined in the Student Policy Manual.

Students are advised to review further divisional policies regarding the use of digital communication devices during class, as well as behavior which would cause distraction, such as (but not limited to) coming late to class and/or walking out of the room during class.

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| **Week** | **Start****Date** | **Chapter** **in Text** | Subject |
| 1 | 8/23 | 1 | Review of general chemistry (with a bias!): Electronic structure of atoms… Periodicity… Chemical bonding: Ionic and covalent bonds… Lewis Structures… The Octet Rule… Formal Charges (“curly arrow” representations)… Exceptions to the Octet Rule… Introduction to resonance theory… Drawing organic structures… |
| 1 | 8/30 | 1  2 | Hybridization: alkanes, alkenes, alkynes… Concept of Polarity...  Acids and bases: Lowry- Brønsted Model… |
| 2 | 9/7 | 2  3 | Acid strength: factors to consider… Lewis acids and bases…  Functional Groups: how they influence reactivity… Intramolecular forces… Physical properties… Large versus small molecules…Short hand methods to write structures… Constitutional isomerism…  Classification of carbon compounds based on Functional Groups… Constitutional isomerism… |
| 2 | 9/13 | 3  4 | Classification of carbon compounds based on Functional Groups…  C-NMR Spectroscopy…  Alkanes: Structural (constitutional) and Molecular Formulas… Nomenclature of alkanes (and cycloalkanes): IUPAC naming; Common Names… |
| 3 | 9/20 | 4 | Physical Properties of Alkanes… Equivalent carbons and hydrogens…  Complete combustion of alkanes… |
| 3 | 10/4 | 4 | Free rotation in alkanes: Conformational analysis… Newman Projections and  Saw-Horse Representations… Conformations of ethane…  Conformations of butane… Strain in cycloalkanes…  Cyclohexanes: chair and boat conformations; axial and equatorial bonds… |
| 4 | 10/11 | 4 | Monosubstituted cyclohexanes… Destabilizing factors…  Disubstituted cycloalkanes: *cis*-*trans* isomerism in cycloalkanes… |
| 4 | 10/18 | 4 | Combustion of cycloalkanes… Oxidation-reduction in Organic Chemistry… |
| 5 | 10/25-6 |  | **FIRST MIDTERM EXAM** |
| 5 | 10/28 | 5 | Stereochemistry: A survey of isomerism… Chirality… Tetrahedral molecules with stereogenic centers… Enantiomers… |
| 6 | 11/1 | 5 | Representation of chirality: 3-D drawings; Fischer Projection Formulas…  *R*/*S*-Representations… Molecules with more than one stereogenic center… Diastereomers… Achiral molecules (*meso*) with stereogenic centers…  Physical properties of chiral molecules: Optical activity… |
| 6 | 11/5 | 5  6 | Racemic mixtures…  Chiral biological molecules… The lock and key concept… Chiral molecules without chiral centers…  Classification of organic reactions: substitution, addition, elimination reactions… Nucleophiles-Electrophiles… Bond breaking and bond formation: curly arrows revisited… Reactive Intermediates in organic chemistry… |
| 7 | 10/8 | 6 | Reaction enthalpy (H) related to Bond Dissociation Energies (BDE)… Further thermodynamic parameters… Energy Diagrams… Kinetics… Catalysis… |
| 7 | 10/10 | 7 | Alkyl Halides: Nomenclature, structural features, and physical properties…  Nucleophilic Substitution Reactions: Common nucleophiles (basicity and nucleophilicity); Leaving Groups… Solvent effects… Kinetics of Substitution Reactions…  Mechanism and stereochemistry of SN2 reactions… Stereochemical outcomes: Inversion of configuration… |
| 8 | 10/15 | 7 | Mechanism and stereochemistry of SN1 reactions… Carbocation stability as predictor of an SN1 or an SN2 mechanism… Instability of vinyl and aryl carbocations. Relationship between reactive intermediates and transition states, the Hammond Postulate. |
| 8 | 10/17 | 8 | Elimination reactions of alkyl halides (dehydrohalogenation)… Alkenes: structural features; *cis*-*trans* isomers (diastereomers)… Mechanism of elimination reactions (E1 and E2)… Selectivity in dehydrohalogenation reactions (The Zaitsev Rule)… |
| 9 | 10/22 | 8 | Detailed mechanisms of E1 and E2 reactions… Stereochemistry of E2 reactions… Double dehydrohalogenation reactions: preparation of alkynes… Competition between SN1, SN2, E1, and E2 reactions. |
| 9 | 10/24 | 9 | Alcohols, ethers, and epoxides: structural features…  SN2 reactions as a method to prepare alcohols, ethers, and epoxides…  Preparation of ethers: from alcohols and alkyl halides (Williamson ether synthesis)… |

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| **Week** | **Start****Date** | **Chapter** **in Text** | Subject |
| 10 | 10/29 |  | **SECOND MIDTERM EXAM** |
| 10 | 10/31 | 9 | Ethers: Nomenclature and physical properties…  Crown ethers (host-guest complexation)… Reactions of ethers…  Reactions of epoxides: Acid and Base catalyzed ring-opening reactions… |
| 11 | 11/5 | 9 | Stereochemistry of epoxide ring-opening reactions… Biological significance of epoxides…  Carbocation rearrangements in SN1 reactions and during alcohol dehydration (9.9. and 9.11B)… Conversion of alcohols into alkyl halides… Dehydration of alcohols as a route to alkenes… |
| 11 | 11/7 | 10 | Alkenes: Structural features; Stereoisomerism in alkenes (*E*/*Z*-system of nomenclature)…  Electrophilic addition reactions of alkenes: General mechanism; Hydrohalogenation  –regioselectivity; Markovnikof’s Rule… Hydration… Halogenation… |
| 12 | 11/12 | 10 | Stereochemistry of halogenation and hydrohalogenation… Halohydrin formation… |
| 12 | 11/14 | 10, 11 | “Reversal” of regioselectivity, anti-Markovnikof products: Hydroboration (including stereochemical considerations)… Multi-step syntheses involving alkenes… Alkynes: structural features; preparations… |
| 13 | 11/19 | 11 | Acidity of terminal alkynes… Reactions of alkynes: Hydrogen halide addition; Halogen addition; Hydration… |
| 13 | 11/21 | 11 | Alkylation of acetylides (SN2 reactions)… |
| 14 | 11/27 |  | **THIRD MIDTERM EXAM** |
| 14 | 11/25-6 |  | **No class:** **Thanksgiving Break** |
| 15 | 12/3 | 11  12 | Multi-step syntheses involving alkynes…  Oxidadation and Reduction in Organic Chemistry: common oxidizing and reducing agents… Hydrogenation of alkenes and alkynes… Review… |
|  |  |  | **FINAL EXAM** –To be determined |

Please note that there might be changes in the dates of the midterm exams.

Under such conditions students will be given ample notice.