JEFFERSON COLLEGE

COURSE SYLLABUS

CHM201

ORGANIC CHEMISTRY II

5 Credit Hours

Prepared by:
Richard A. Pierce

Revised by:
Sean Birke
October, 2013

Ms. Linda Abernathy, Math, Science & Business Division Chair
Ms. Shirley Davenport, Dean, Arts & Science Education
CHM201 Organic Chemistry II

I. CATALOGUE DESCRIPTION

A. Course pre-requisites/co-requisites: CHM200 (Organic Chemistry I)

B. 5 semester credit hours

C. Organic Chemistry II is a continuation of Organic Chemistry I with emphasis on alcohols, thiols, ethers, epoxides, aromatic hydrocarbons and their derivatives, and carbonyl compounds for example ketones and aldehydes. Units on spectroscopic methods of structure determination are included. Organic Chemistry II involves three hours of lecture and four hours of laboratory a week (S, D)

II. EXPECTED LEARNING OUTCOMES/ CORRESPONDING ASSESSMENT MEASURES

<table>
<thead>
<tr>
<th>Expected Learning Outcomes</th>
<th>Assessment Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate a knowledge of the characteristics of aromatic compounds</td>
<td>Examinations, homework and quizzes</td>
</tr>
<tr>
<td>Predict products and understand the mechanism of electrophilic aromatic substitution reactions</td>
<td>Examinations, homework and quizzes</td>
</tr>
<tr>
<td>Demonstrate a knowledge of the reactions of substituted benzenes</td>
<td>Examinations, homework and quizzes</td>
</tr>
<tr>
<td>Demonstrate a knowledge of the structure, nomenclature, methods of preparation, physical properties, spectral properties, and reactions of aldehydes and ketones</td>
<td>Examinations, homework and quizzes</td>
</tr>
<tr>
<td>Demonstrate a knowledge of the structure and acidity, nomenclature, physical properties, spectral properties, methods of preparation, and reactions of carboxylic acids</td>
<td>Examinations, homework and quizzes</td>
</tr>
<tr>
<td>Understand how to use electronic spectroscopy, infrared spectroscopy, nuclear magnetic resonance spectroscopy, ultraviolet spectroscopy, and mass spectroscopy for the identification of organic structures</td>
<td>Examinations, homework and quizzes</td>
</tr>
<tr>
<td>Demonstrate a knowledge of the structures, reactivity, and spectral properties of carboxylic acid derivatives</td>
<td>Examinations, homework and quizzes</td>
</tr>
</tbody>
</table>
Demonstrate a knowledge of the nomenclature, methods of preparation, and reactions of acid halides, anhydrides of carboxylic acids, esters of carboxylic acids, amides, and nitriles

Examinations, homework and quizzes

Demonstrate a knowledge of the reactions of enolates and carbanions

Examinations, homework and quizzes

Demonstrate a knowledge of the classification, nomenclature, bonding, physical properties, spectral properties, methods of preparation, basicity, and reactions of amines

Examinations, homework and quizzes

Demonstrate the ability to identify if a compound is aromatic, nonaromatic, and antiaromatic

Examinations, homework and quizzes

Identify if a cycloaddition reaction is either photochemically allowed or thermodynamically allowed

Examinations, homework and quizzes

III. COURSE OUTLINE WITH UNIT OBJECTIVES

A. Alcohols
   1. Structures of alcohols
   2. Nomenclature of alcohols and phenols
   3. Physical properties of alcohols
   4. Commercially important alcohols
   5. Acidity of alcohols
   6. Grignard and organolithium reagents to form alcohols
   7. Grignard addition to carbonyl compounds, acid chlorides, esters, and ethylene oxide
   8. Reaction conditions for the Grignard reaction
   9. Reduction reactions with sodium borohydride and lithium aluminum hydride
   10. Catalytic hydrogenation of ketones and aldehydes
   11. Thiols reactions and nomenclature

B. Reactions of alcohols
   1. Oxidation of alcohols
   2. Biological oxidation of alcohols
   3. Alcohols as nucleophiles and electrophiles
   4. Reduction of alcohols
   5. Reactions of alcohols with hydrohalic acids
   6. Reactions of alcohols with phosphorus halides
   7. Reactions of alcohols with thionyl chloride
8. Dehydration reactions of alcohols
9. Pinacol rearrangement
10. Periodic acid cleavage of glycols
11. Esterification of alcohols
12. Esters of inorganic acids
   a. Sulfate
   b. Nitrate
   c. Phosphate
13. Williamson ether synthesis

C. Infrared spectroscopy and mass spectrometry
1. Electromagnetic spectrum
2. Introduction to infrared spectroscopy
3. Molecular vibrations
4. IR-active and IR-inactive vibrations
5. Bond stretching frequencies
   a. Carbon-carbon
   b. Carbon-hydrogen
   c. Carbon-oxygen
   d. Carbon-nitrogen
   e. Oxygen-hydrogen
   f. Nitrogen-hydrogen
6. Infrared spectra to determine functional groups within organic compounds
7. Introduction to mass spectrometry
8. Ionization sources
9. Fragmentation
10. Base peak and molecular ion (parent peak)
11. Identification of recognizable elements within the mass spectrum
12. Alcohols fragmentation

D. Nuclear magnetic resonance spectroscopy
1. Theory of nuclear magnetic resonance
2. ¹H and ¹³C NMR spectroscopy
3. Magnetic shielding
4. Chemical shifts
5. Number of signals and chemical equivalence
6. Integration of peaks
7. Spin-spin splitting and the N +1 rule
8. Coupling constants
9. Time dependence of NMR spectroscopy
10. Interpreting ¹H and ¹³C NMR spectroscopy
11. Difference between ¹H and ¹³C NMR spectroscopy
12. Nuclear magnetic resonance imaging
E. Ethers, epoxides, and sulfides
1. Physical properties of ethers
2. Nomenclature of ethers
3. Crown ethers
4. Spectroscopy of ethers
5. Synthesis of ethers
6. Cleavage of ethers
7. Nomenclature of sulfides
8. Synthesis of sulfides
9. Synthesis of epoxides
10. Acid-catalyzed ring opening of epoxides
11. Base-catalyzed ring opening of epoxides
12. Reactions of epoxides with Grignard reagents

F. Conjugated systems, orbital symmetry, and ultraviolet spectroscopy
1. Stabilities of dienes
2. Molecular orbitals of conjugated system
3. Allylic cations
4. Addition reactions to conjugated dienes
   a. Kinetic product
   b. Thermodynamic product
5. Allylic radical
6. Molecular orbitals of allylic systems
7. Diels-Alder reaction
8. Cycloaddition reactions
   a. [4 +2]
   b. [2 +2]
9. Ultraviolet absorption spectroscopy
10. Interpreting Ultraviolet spectra

G. Aromatic compounds
1. Structure and properties of benzene
2. Molecular orbitals of benzene
3. Molecular orbitals of cyclobutadiene
4. Determination of aromatic, antiaromatic, and nonaromatic
   a. Hückel’s Rule
5. Aromatic ions
6. Heterocyclic aromatic compounds
7. Polynuclear aromatic compounds
8. Fullerenes
9. Fused heterocyclic compounds
10. Nomenclature of aromatic compounds
11. Physical properties of aromatic compounds
12. Spectroscopy of aromatic compounds
H. Reactions of aromatic compounds
   1. Electrophilic aromatic substitution
   2. Halogenation of benzene
   3. Nitration of benzene
   4. Sulfonation of benzene
   5. Effect of substituted benzene
      a. Activating group (ortho and para-directing)
      b. Deactivating group (meta-directing)
      c. Halogens deactivating group (ortho and para-directing)
   6. Friedel-Crafts alkylation and acylation
   7. Nucleophilic aromatic substitution
   8. Birch reduction
   9. Reactions of phenols

I. Ketones and aldehydes
   1. Nomenclature of ketones and aldehydes
   2. Physical properties of aldehydes and ketones
   3. Spectroscopy of aldehydes and ketones
   4. Syntheses of aldehydes and ketones
   5. Reactions of aldehydes and ketones
   6. Wittig Reaction
   7. Hydration of aldehydes and ketones
   8. Acetals as protecting groups
   9. Oxidation of aldehydes
   10. Reduction of aldehydes and ketones

IV. METHOD OF INSTRUCTION
   A. Lectures
   B. Class discussion
   C. Laboratory work
   D. Research lecture

V. REQUIRED TEXTBOOK(S)

VI. REQUIRED MATERIALS
Textbook, notebook paper, pens/pencils, scientific calculator, laboratory notebook, molecular model set

VII. SUPPLEMENTAL MATERIALS

None

VIII. METHOD OF EVALUATION

A. Lecture examinations 35%
B. Quizzes 20%
C. Laboratory notebook 20%
D. Research lecture 5%
E. Final 20%
F. Grading scale
   90-100% = A
   80-89% = B
   70-79% = C
   60-69% = D
   Below 60% = F

IX. ADA STATEMENT

Any student requiring special accommodations should inform the instructor and the Coordinator of Disability Support Services (Library; phone 636-481-3169)

X. ACADEMIC HONESTY STATEMENT

Students who are caught cheating or plagiarizing material in this course will not receive credit for the assignment in question and may be dropped from the course with a failing grade. A detailed description of the Academic Honesty Policy statement can be found in the Jefferson College Student Handbook or online at: http://www.jeffco.edu/jeffco/index.php?option=com_weblinks&catid=26&Itemid=84

XI. ATTENDANCE STATEMENT

Students earn their financial aid by regularly attending and actively participating in their coursework. If a student does not actively participate, he/she may have to return financial aid funds. Consult the College Catalog or a Student Financial Services representative for
more details.