Syllabus

Course Code: Chem 204 **Title: Organic Chemistry II**

Institute: STEM **Department: Chemistry**

Course Description: A continuation of CHEM-203, students will extend their studies into topics including alkynes, conjugated alkenes, aromatic hydrocarbons, carboxylic acids and their derivatives, carbanion chemistry, amines, and heterocycles

Prerequisites: A grade of "C" or higher in CHEM 203 (Organic Chemistry I)

Corequisites: None

Credits: 5 **Lecture Hours: 4** **Lab/Studio Hours: 3**

Required Textbook/Materials:

- Laboratory Manual: Experimental Organic Chemistry, 1st Ed., by Isac-Garcia, Dobado, et. al. ISBN: 978-0-12-803893-2
- Lab Coat
- Calculator (Scientific at minimum)

Additional Time Requirements: None

Additional Support/Labs:
See https://www.brookdalecc.edu/academic-tutoring/

Course Learning Outcomes:

- Utilize the scientific critical thinking, informational & technical literacy and mathematical skills learned in general chemistry to explain concepts and problem solve in organic chemistry.
- Draw structures, provide IUPAC names, and describe classical preparation, reactions, and mechanisms for the following functional groups: alkynes, conjugated alkenes, aromatic hydrocarbons, carboxylic acids and their derivatives, carbanion chemistry, amines
- Develop spatial reasoning skills using models to visualize, draw, and analyze the stereochemistry of organic compounds
- Analyze the infrared, nuclear magnetic, and mass spectra to determine the identity of compounds
- Prepare and isolate organic compounds using common laboratory techniques, employ qualitative analysis to help identify functional groups, and introduce students to primary literature

Course Content:

Unit 1: Alkynes and Conjugated Dienes
Unit 2: Aromatic compounds and Aldehydes and Ketones
Unit 3: Carboxylic Acids and Their Derivatives
Unit 4: Alpha Substitution, Amines and Amides, and Introduction to Heterocycles

Department Policies: : Students receiving three zeroes for absence or absent equivalent issues or earn <65 in lab automatically fail the course. See lab syllabus for details

Grading Standard:

A = 92 - 100%
A- = 89 - 91%
B+ = 86 - 88%
B = 82 - 85%
B- = 79 - 81%
C+ = 76 - 78%
C = 70 - 75%
D = 65 - 69%
F = <65%

College Policies:

As an academic institution, Brookdale facilitates the free exchange of ideas, upholds the virtues of civil discourse, and honors diverse perspectives informed by credible sources. Our College values all students and strives for inclusion and safety regardless of a student's disability, age, sex, gender identity, sexual orientation, race, ethnicity, country of origin, immigration status, religious affiliation, political orientation, socioeconomic standing, and veteran status. For additional information, support services, and engagement opportunities, please visit www.brookdalecc.edu/support.

For information regarding:

- Academic Integrity Code
- Student Conduct Code
- Student Grade Appeal Process

Please refer to the student handbook and catalog**.**

Notification for Students with Disabilities:

Brookdale Community College offers reasonable accommodations and/or services to persons with disabilities. Students with disabilities who wish to self-identify must contact the Accessibility Services Office at 732-224-2730 (voice) or 732-842-4211 (TTY) to provide appropriate documentation of the disability and request specific accommodations or services. If a student qualifies, reasonable accommodations and/or services, which are appropriate for the college level and are recommended in the documentation, can be approved.

Mental Health:

24/7/365 Resources:

- Monmouth Medical Center Psychiatric Emergency Services at **(732) 923-6999**
- 2nd Floor Youth Helpline – Available to talk with you about any problem, distress, or hardship you are experiencing. Call or text at **888-222-2228** or visit the website at https://www.2ndfloor.org/

Faculty Counselors:

- Students who need to make an appointment with a faculty counselor can do so by calling 732-224-1822 (non-emergency line) during business hours. Faculty counselors are licensed mental health professionals who can assist students and refer them to other mental health resources.

Diversity Statement:

Brookdale Community College fosters an environment of inclusion and belonging. We promote a safe and open culture, encourage dialogue respecting diverse perspectives informed by credible sources, and uphold the virtues of civil discourse. We celebrate all identities with the understanding that ultimately, diversity, equity, and inclusion cultivate belonging and make us a stronger Brookdale community.

**The syllabus is intended to give student guidance in what may be covered during the semester and will be followed as closely as possible. However, the faculty member reserves the right to modify, supplement, and make changes as the need arise.*

Unit 1: Alkynes and Conjugated Dienes

UNIT OBJECTIVE: Draw structures for and provide IUPAC names for alkynes and conjugated dienes. Describe the physical properties of alkynes and conjugated dienes. Apply classical reaction and understand select mechanisms for the synthesis of and reaction of alkynes and conjugated dienes

1. Draw structures for and provide IUPAC names for alkynes.

2. Compare and contrast the physical properties of alkynes with alkanes and alkenes.

3. Discuss the causes for the unusual acidity of the hydrogen in terminal alkynes

4. Apply classical reactions of alkynes to prepare other functional groups, and understand select mechanisms, using the following reactions:
   - Halide elimination
5. Apply classical reactions of alkynes to prepare other functional groups using the following reactions:
   - Catalytic hydrogenation
   - Halohydrogenation
     - With discussion of resonance stabilization
   - Halogenation
   - Hydration
     - With discussion of tautomerism
   - Nucleophilic substitution
   - Birch-like reduction

6. Draw structures for and provide IUPAC names for dienes and polyenes

7. Differentiate between isolated, conjugated, cumulated polyenes and discuss their spatial orientation and chemical stability

8. Apply classical reactions of conjugated dienes to prepare other functional groups using the following reactions:
   - Halohydrogenation and halogenation
   - Diels Alder reaction
     - With discussion of stereospecificity, simple bridged bicyclics, and endo vs exo configuration

Unit 2: Aromatic Compounds and Aldehydes and Ketones

UNIT OBJECTIVE: Apply IUPAC rules to name and draw structures of aromatic compounds, aldehydes, and ketones. Analyze the chemical structure of aromatic compounds, aldehydes, and ketones to predict the physical properties. Apply classical reaction and understand select mechanisms for the synthesis of and reaction of aromatic compounds, aldehydes, and ketones

1. Describe the unique stability of certain cyclic conjugated systems.

2. Use the Hückel Rule and other factors to determine if a given monocyclic species is aromatic

3. Compare and contrast the physical properties of aromatic compounds with other hydrocarbons.

4. Draw structures for and provide IUPAC and common names for derivatives of benzene

5. Describe how resonance in benzene ring changes the pKa of certain functional groups including, but not limited to, alcohols and amines.

6. Understand how different functional groups direct, activate, and deactivate a benzene ring.

7. Apply classical reactions of benzene and its derivatives to prepare other functional groups, and understand select mechanisms, using the following reactions:
    - Electrophilic Aromatic Substitution
        - Halogenation
        - Nitration
        - Sulfonation
        - Friedel-Crafts alkylation
        - Friedel-Crafts acylation
    - Side chain reduction and oxidation
    - Birch reduction
    - Nucleophilic aromatic substitution

8. Introduce the concepts of multistep synthesis and retrosynthesis to prepare compounds.

9. Draw structures for and provide IUPAC and common names for aldehydes and ketones

10. Describe the physical properties of aldehydes and ketones.

11. Apply classical reactions for the preparation of aldehydes and ketones using
    - Oxidative cleavage of alkenes
    - Alcohol oxidation
    - Hydration of alkynes
    - Friedel Crafts acylation

12. Apply classical reactions of aldehydes and ketones to prepare other functional groups, and understand select mechanisms, using the following reactions:
    - Nucleophilic Addition
        - Hydration
        - Hemiacetal and acetal formation
        - Imine and enamine formation
        - Cyanohydrin formation
        - Grignard Reaction
        - Oxidation of aldehydes
            - Acidic and basic pathways
        - Reduction
            - Using hydrides
            - Wolff-Kischner reaction
            - Clemmensen reaction

Unit 3: Carboxylic Acids and Their Derivatives

UNIT OBJECTIVE: Apply IUPAC rules and draw structures for carboxylic acids and their derivatives. Describe the unique properties of carboxylic acids. Apply classical reaction and understand select mechanisms for the synthesis of and reaction of carboxylic acids and their derivatives.

1. Draw structures and provide IUPAC and common names for carboxylic acids and diacids

2. Describe the physical properties of carboxylic acids

3. Apply classical reactions for the preparation of carboxylic acids using
   - Oxidation of alcohols and aldehydes
   - Oxidation of alkylated arenes
   - Oxidative cleavage

4. Apply classical reactions of carboxylic acids to prepare other functional groups, and understand select mechanisms, using the following reactions:
   - Neutralization
   - Reduction
   - Nucleophilic acyl substitution

5. Draw structures and provide IUPAC and common names for acid halides, acid anhydrides, and esters

6. Apply classical reactions of carboxylic acid derivatives to prepare other functional groups, and understand select mechanisms, using the following reactions:
   - Nucleophilic acyl substitution
   - Fischer Esterification
   - Reduction
     - Using LAH and DIBAH
   - Grignard reaction

Unit 4: Alpha Substitution, Amines and Amides, and Introduction to Heterocycles

UNIT OBJECTIVE: Examine the variety of reactions that can occur at the alpha carbon of different carbonyl compounds. Draw structures and provide IUPAC and common names for amines and amides. Apply classical reactions of amines. Examine heterocyclic rings, general synthesis, their reactivity, and their prevalence in nature.

1. Identify alpha carbons and their hydrogens in a variety of carbonyl containing compounds.

2. Define enolates and explain what makes alpha hydrogens more acidic than other methylene hydrogens.

3. Apply classical reactions of alpha substitution to prepare other functional groups, and understand select mechanisms, using the following reactions:
   - Aldol reaction and condensation
   - Claisen reaction and condensation
   - Alpha bromination of CAs
   - Alpha alkylation
   - Malonic ester synthesis
   - Acetoacetic ester synthesis

4. Draw structures and provide IUPAC and common names for amines and amides

5. Classify amines and amides

6. Describe the physical properties of amines, amides, and nitriles

7. Apply classical reactions for the preparation of amines and amides using
   - Substitution reactions
   - Imine and enamine intermediates
   - Gabriel synthesis
   - Hoffman rearrangement
   - Reduction of nitro groups
   - Reductive amination

8. Apply classical reactions of amines and amides to prepare other functional groups, and understand select mechanisms, using the following reactions:
   - Exhaustive alkylation
   - Hoffman elimination
   - Acylation
   - Sandmeyer reactions
   - Diazonium coupling

9. Understand the IUPAC system of nomenclature for aliphatic and aromatic heterocycles

10. Recognize common nitrogen and oxygen containing heterocycles and their occurrence in nature.

11. Describe how aromaticity and electrophilic aromatic substitution for heterocycles is different from benzene