Syllabus

Course Code: Chem 203 **Title: Organic Chemistry I**

Institute: STEM **Department: Chemistry**

Course Description: Students will apply many concepts from general chemistry to a study of organic chemistry. They will be able to name, draw, predict products, interpret spectra for, synthesize and explain reaction mechanisms for hydrocarbons and halogenated hydrocarbons, alcohols, ethers and epoxides. The stereochemistry of compounds and reactions will be studied. Labs will emphasize preparation, isolation and identification of organic compounds using modern laboratory instrument techniques

Prerequisites: A grade of "C" or higher in CHEM 102 (General Chemistry II)

Corequisites: None

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

Required Textbook/Materials:

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

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 and reactions of the following functional groups: Alkanes, alkenes, alkyl halides, alcohols, ethers, and epoxides
- 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

Course Content:

Unit 1: General chemistry review with expanded concepts.
Unit 2: Alkanes and stereochemistry
Unit 3: Alkenes and alkyl halides
Unit 4: Substitution and elimination reactions, alcohols and thiols, ethers and epoxides

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: General Chemistry Review With Expanded Concepts.

UNIT OBJECTIVE: To review concepts learned in general chemistry that will be applied in organic chemistry including atomic structure, periodicity, Lewis dot structures, VSEPR, bond theory, intermolecular forces, kinetics, equilibrium, and thermochemistry. This unit will also expand on concepts from general chemistry applicable to the learning outcomes of future units of organic chemistry including resonance structures, formal charge, orbital box diagrams, and LeChatelier's Principle.

1. Describe the strong forces and provide examples of each.

2. Describe the parts of chemical reaction. Recognize reactions as addition, substitution, elimination, oxidation/reduction. Describe the factors that influence a chemical reaction

3. Draw atomic orbital box diagrams for light atoms. Describe an atom as paramagnetic or diamagnetic

4. Draw Lewis dot structures for simple covalent compounds and polyatomic ions. Use polyatomic ions as a basis to describe resonance. Be able to draw major and minor resonance contributors. Assign formal charges to each atom in any species

5. Demonstrate how atoms' orbitals combine to form sp, sp^2, and sp^3 hybrids. Explain the manifestation of these hybrids on the electron and molecular geometry of atoms

6. Draw molecular orbital diagrams for diatomic molecules. Describe bonding and antibonding orbitals and orbital symmetry

7. Determine the dipole moment for small molecules. Describe localized dipoles over large molecules. Describe the difference between the debye and the dielectric constant

8. Describe the weak forces and their impact on physical properties including, but not limited to, solubility, vapor pressure, and boiling point.

9. Describe the fundamentals of a rate law and the importance in the mechanism of a reaction.

10. Write equilibrium expressions for chemical reactions. Using LeChatelier's principle, describe how equilibrium is affected when the parameters of a reaction are changed

11. Describe the similarities and differences between Arrhenius, Bronsted-Lowry, and Lewis acids and bases. Illustrate acid-base reactions using curved arrow notation. Predict and indicate conjugates in acid base reactions.

12. Use inductive and resonance effect to explain the acidity of protons and the importance of pKa

13. Understand the importance of enthalpy and Gibbs' free energy in the progression of chemical reactions using reaction coordinates

UNIT 2: Alkanes and Stereochemistry

UNIT OBJECTIVE: Apply IUPAC rules to name and draw structures of alkanes. Analyze the structure of alkanes to describe their stability, physical, and chemical properties. Develop spatial reasoning skills by interconverting between two and three dimensional representations of chemical structures to describe their stereochemistry.

1. Recognize the difference between the four types of hydrocarbons.

2. Draw and interconvert between complete, condensed, and skeletal structural formulas of alkanes

3. Apply IUPAC rules to name straight chain, branched chain, and monocyclic alkanes

4. Recognize and classify carbons in an alkane as primary, secondary, tertiary, and quaternary

5. Predict products of alkanes as a result of the following types of reactions
    - Radical halogenation
    - Complete and incomplete combustions

6. Recognize the major functional groups

7. Perform conformation analysis using Newman and sawhorse projection for simple saturated chain organic compounds and cyclohexane derivatives.

8. Recognize chiral carbons given an organic structure. Use R/S system to note the stereochemistry of the molecule in its IUPAC name. Employ the dash/wedge system and Fischer projections to draw the structural formulas of stereoisomers

9. Determine if a compound is optically active and use the designations d, l, +, and – to indicate optical rotation.

10. Recognize stereoisomers as enantiomers, diastereomers, or meso compounds

11. Discuss the physical properties of stereoisomers and their resolution.

UNIT 3: Alkenes and Alkyl Halides

UNIT OBJECTIVE: The student will be able to recognize, draw structures, name and explain the physical properties of alkenes and alkyl halides (not including substitution and elimination reactions). Students will also learn some classical methods of preparing and reacting alkenes and alkyl halides.

1. Draw structures for and provide IUPAC names for monoalkenes including the use of the cis/trans and E/Z systems.

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

3. Describe the impact cis- and trans- isomerism has on the physical properties of alkenes.

4. Calculate the unsaturation number and draw constitutional isomers, given a compound's formula.

5. Apply classical reactions of alkenes to prepare other functional groups, and understand select mechanisms, using the following reactions:
   - Hydrogenation
   - Haloacid addition
     - Discuss the importance of regiochemistry and Markovnikov's rule
   - Bromine and Chlorine Halogenation
   - Oxymercuration
   - Hydroboration
   - Oxidative cleavage

6. Draw structures for and provide IUPAC names for halogenated alkanes

7. Compare and contrast the properties of alkanes and haloalkanes.

8. Apply classical reaction for the preparation of alkyl halides

9. Apply classical reactions of alkyl halides to prepare other functional groups using the following reactions:
   - Organolithium formation
   - Grignard reaction
   - Gilman reaction
   - Allylic substitution

Unit 4: Substitution and Elimination Reactions, Alcohols and Thiols, and Ethers and Epoxides

UNIT OBJECTIVE: A continuation from the previous unit, students will analyze the kinetics, competition, and reaction conditions required for alkyl halides to undergo substitution or elimination reactions. The student will be able to recognize, draw structures, name and explain the physical properties of alcohols, thiols, ethers, and epoxides. Students will also learn some classical methods of preparing and reacting alcohols, thiols, ethers, and epoxides.

1. Describe the rate equation and kinetics of a first and second order reaction. Draw a reaction coordinate that describes the progress of each type of reaction.

2. Predict the products of a substitution or elimination reactions given the following:
   - The nature of the nucleophile
   - The nature of the leaving group
   - The classification of the alkyl halide
   - The solvent effect
   - The temperature of the reaction

3. Draw the mechanisms for substitution and elimination reactions

4. Recognize any structural, regiochemical, and stereochemical consequences for substitution and elimination reactions

5. Discuss the parameters that are required to prevent competition between the different types of substitution and elimination reactions

6. Draw structures of and provide IUPAC names for alcohols, glycols, and basic thiols

7. Discuss the physical properties of alcohols and thiols

8. Classify alcohols

9. Apply classical reactions for the preparation of alcohols, glycols, and thiols using
   - Reduction of carboxylic acids, aldehydes, and ketones
   - Substitution of alkyl halides
   - Oxidative cleavage

10. Apply classical reactions of alcohols and thiols, and understand select mechanisms, to form other functional group products using the following reactions:
    - Dehydrogenation of alcohols
    - Oxidation of alcohols
    - Substitution and elimination via activation of C-O bond using sulfonate and phosphite esters, and acids to create
        - Alkyl halides
        - Thiols

- Ethers via Williamson ether synthesis
- Alkenes

- Disulfide formation

11. Draw structures and for epoxides and ethers.

12. Provide IUPAC names for simple ethers

13. Discuss the physical properties of ethers and epoxides

14. Apply classical reactions for the preparation of ethers and epoxides using
    - Thermal coupling of alcohols
    - Williamson ether synthesis
    - Alkoxymercuration
15. Apply classical reaction of ethers and epoxides to form other functional group products using the following reactions:
    - Substitution
    - Elimination
    - Acid catalyzed opening
    - Base catalyzed opening