Montgomery County Community College
CHE 261
Organic Chemistry I
4-3-3

COURSE DESCRIPTION:
This course covers the nomenclature, structure, properties and reactions of many important classes of organic compounds. Stereochemistry, reaction mechanism and syntheses are stressed. The laboratory demonstrates basic techniques and syntheses discussed during lecture. This course is subject to a course fee. Refer to http://mc3.edu/adm-fin-aid/paying/tuition/course-fees for current rates.

REQUISITE(S):
Previous Course Requirements
CHE 152 - Principles of Chemistry II

CO-REQUISITE(S):
None

Upon successful completion of this course, the student will be able to:

LEARNING OUTCOMES	LEARNING ACTIVITIES	EVALUATION METHODS
1. Describe atomic structure by using electron configuration, valence bond theory, hybridization and simple Molecular Orbital Theory.	Lectures Class Discussions Problem Solving	Section Exam and Comprehensive Final Exam
2. Predict the polarity of a covalent molecule; draw resonance structures; define acid and base and determine relative acid strength using pKa values.	Lectures Class Discussions Problem Solving Laboratory Activity and Report	Section Exam and Comprehensive Final Exam
3. Explain properties of organic compounds including alkanes and cycloalkanes and identify alkane isomers and cycloalkane cis-trans isomers.	Lectures Class Discussions Problem Solving Laboratory Activity and Report	Section Exam and Comprehensive Final Exam

LEARNING OUTCOMES	LEARNING ACTIVITIES	EVALUATION METHODS
4. Identify the conformations of small alkanes and cycloalkanes, with emphasis on cyclohexane chair conformation with mono, di and tri substitutions. Draw Newman projections and predict stability of molecules.	Lectures Class Discussions Problem Solving Molecular Models Activity	Section Exam and Comprehensive Final Exam
5. Identify and draw radical and polar reaction mechanisms and use energy diagrams to identify transition states, intermediates and reactant-product energy changes.	Lectures Class Discussions Problem Solving Emphasis on Reaction Mechanisms	Section Exam and Comprehensive Final Exam
6. Explain properties of alkenes and discuss electrophilic addition with the use of Markovnikov's Rule and carbocation rearrangement.	Lectures Class Discussions Problem Solving Emphasis on Reaction Mechanisms Laboratory Activity and Report	Section Exam and Comprehensive Final Exam
7. Discuss synthesis and reactions of alkenes: elimination, addition, reduction, oxidation and radical polymerization. Write and explain mechanisms for common reactions of alkenes.	Lectures Class Discussions Problem Solving Emphasis on Reaction Mechanisms Laboratory Activity and Report	Section Exam and Comprehensive Final Exam
8. Name alkynes and discuss synthesis and reactions of alkynes: elimination, addition, hydration, reduction, oxidative cleavage and alkylation of acetylide amions.	Lectures Class Discussions Problem Solving Emphasis on Reaction Mechanisms Laboratory Activity and Report	Section Exam and Comprehensive Final Exam

LEARNING OUTCOMES	LEARNING ACTIVITIES	EVALUATION METHODS
9. Identify enantiomers, with one or more chirality centers, R, S configuration, diastereomers, meso compounds and racemic mixtures.	Lectures Class Discussions Problem Solving Molecular Models Activity	Section Exam and Comprehensive Final Exam
10. Name alkyl halides and discuss synthesis: radical halogenation and allylic bromination and discuss reactions: use of Grignard Reagents and coupling Reactions.	Lectures Class Discussions Problem Solving Laboratory Activity and Report Emphasis on Reaction Mechanisms	Section Exam and Comprehensive Final Exam
11. Discuss the mechanisms of alkyl halides: Sn1, SN2, E1, E1cb and E2; plus their kinetics and the Zaitsev's Rule.	Lectures Class Discussions Problem Solving Emphasis on Reaction Mechanisms Laboratory Activity and Report	Section Exam and Comprehensive Final Exam
12. Interpret mass spectra using fragmentation patterns and infrared spectra using location of common functional groups.	Lectures Class Discussions Problem Solving Laboratory Activity and Report	Section Exam and Comprehensive Final Exam
13. Interpret ^{13}C, DEPT ^{13}C and ^{1}H NMR using chemical shifts, integration and spin-spin splitting techniques.	Lectures Class Discussions Problem Solving Laboratory Activity and Report	Section Exam and Comprehensive Final Exam
14. Discuss properties of conjugated dienes: addition reaction, electrophilic addition, kinetic vs. thermodynamic control, Diels-Alder reaction and ultraviolet spectroscopy.	Lectures Class Discussions Problem Solving Emphasis on Reaction Mechanisms	Section Exam and Comprehensive Final Exam

At the conclusion of each semester/session, assessment of the learning outcomes will be completed by course faculty using the listed evaluation method(s). Aggregated results will be submitted to the Associate Vice President of Academic Affairs. The benchmark for each learning outcome is that *70% of students will meet or exceed outcome criteria*.

SEQUENCE OF TOPICS:

I. Structure and Bonding
   A. Atomic Structure: Orbitals and Electron Configuration
   B. Valence Bond Theory
   C. Hybridization: sp, sp^2 and sp^3 Orbitals
   D. Molecular Orbital Theory

II. Polar Covalent Bonds; Acids and Bases
   A. Electronegativity
   B. Dipole Moments
   C. Formal Charges
   D. Rules and Drawing Resonance Structures
   E. Bronsted-Lowry Definition
   F. Using pKa Values in Looking at Acid Strength
   G. Organic Acids and Bases
   H. Lewis Definition
   I. Drawing Chemical Structures and Molecular Models

III. Alkanes and Cycloalkanes
   A. Functional Groups
   B. Isomers
   C. Alkyl Groups
   D. Nomenclature
   E. Properties
   F. cis-trans Isomers of Cycloalkanes

IV. Stereochemistry of Alkanes and Cycloalkanes
   A. Conformations of Ethane, Propane and Butane
   B. Baeyer Strain Theory
   C. Conformations of Cyclopropane, Cyclobutane, Cyclopentane and Cyclohexane
   D. Axial and Equatorial Bonds in Cyclohexane of Chair Conformation
   E. Monosubstituted Cyclohexane
   F. Conformational Analysis of di and tri Substituted Cyclohexane
   G. Boat Cyclohexane

V. Stereochemistry
   A. Enantiomers
   B. Chirality and Optical Activity
   C. R, S Configuration
   D. Diastereomers
   E. Meso Compounds
   F. Two Chirality Centers
   G. Physical Properties of Stereoiosomers
   H. Racemic Mixtures and their Resolution

VI. Organic Reactions
   A. Radical Reaction Mechanism
   B. Polar Reaction Mechanism
   C. Using arrows
   D. Reaction Equibilibria, Rates and Energy Changes
   E. Bond Dissociation Energies
   F. Energy Diagrams and Transition States
   G. Intermediates
VII. Alkenes
   A. Degree of Unsaturation
   B. Nomenclature
   C. Electronic Structure
   D. Cis-Trans Isomers
   E. E, Z Designation
   F. Electrophilic Addition of HX
   G. Markovnikov's Rule
   I. Carbocation Stability and Structure
   J. Hammond Postulate
   K. Carbocation Rearrangement
VIII. Alkenes Synthesis and Reactions
   A. Elimination Reactions
   B. Addition of Halogens
   C. Halohydrin Formation
   D. Addition of Water: Oxymercuration
   E. Addition of Water: Hydroboration
   F. Addition of Carbenes: Cyclopropane Synthesis
   G. Reduction: Hydrogenation
   H. Oxidation: Hydroxylation and Cleavage
   I. Addition of Radicals: Polymers
IX. Alkynes
   A. Structure
   B. Nomenclature
   C. Synthesis: Elimination of Dihalides
   D. Addition of HX and X_2
   E. Hydration
   F. Reduction
   G. Oxidative Cleavage
   H. Alkylation of Acetylide Anions
   I. Introduction to Organic Synthesis
X. Alkyl Halides
   A. Nomenclature
   B. Structure
   C. Radical Halogenation of Alkanes
   D. Allylic Bromination of Alkenes and Stability of Allyl Radical
   E. Synthesis from Alcohols
   F. Organohalides: Grignard Reagents
   G. Organometallic Coupling Reactions
   H. Oxidation and Reduction

XI. Reactions of Alkyl Halides
  A. Walden Inversion
  B. Nucleophilic Substitution and Kinetics
  C. S_N2 Reaction and Kinetics
  D. S_N1 Reaction Kinetics and Stereochemistry
  E. Eliminations Reactions and Zaitsev's Rule
  F. E_2 Reaction
  G. E_1 Reaction
XII. Structure Determination I
  A. Mass Spectrometry, Interpretation, and Behavior of Common Functional Groups
  B. Fragmentation Patterns
  C. Electromagnetic Spectrum
  D. Infrared Spectroscopy, Interpretation and Behavior of Common Functional Groups
XIII. Structure Determination II
  A. Nuclear Magnetic Resonance Spectroscopy
  B. Chemical Shifts
  C. ^{13}C NMR: Signal Averaging and FT-NMR
  D. DEPT ^{13}C NMR
  E. ^{1}H NMR and Proton Equivalence
  F. Integration of ^{1}H NMR
  G. Spin-Spin Splitting in 1H NMR: Simple and Complex
XIV. Conjugated Dienes and Ultraviolet Spectroscopy
  A. Conjugated Dienes: Preparation and Stability
  B. Molecular Orbital Description
  C. Electrophilic Addition: Allylic Carbocation
  D. Kinetic vs. Thermodynamic Control
  E. Diels-Alder Cycloaddition Reaction
  F. Ultraviolet Spectroscopy
  G. Effect of Conjugation and Color

SEQUENCE OF EXPERIMENTS:
1. Melting Points and Boiling Points
  a. Melting Points of Pure Urea and Cinnamic Acid
  b. Melting Points of Urea-Cinnamic Acid Mixtures
  c. Identify Unknowns Via Melting and Boiling Point
  d. Boiling Points Using a Digital Thermometer and a Reaction Tube
2. Simple Distillation of Ethanol & Water; Fractional Distillation of Ethanol & Water
3. Recrystallization of Naphthalene from a Mixed Solvent
4 Thin Layer Chromatography
  a. Identify Unknown Analgesics
5. Extraction of Caffeine from Tea Microscale
  a. Prepare Flowchart

6. Dehydration of Cyclohexanol
    a. Preparation of Cyclohexene Microscale
    b. Test for Alkanes and Alkenes. with Bromine Water
    c. Infrared Spectroscopy
7. Macroscale Addition of Bromine to Stilbene to Prepare Meso-Stilbene Dibromide
8. Microscale Nucleophilic Substitution Reactions
9. Infrared Spectroscopy; Nuclear Magnetic Resonance; Ultraviolet Spectroscopy and Mass Spectroscopy

LEARNING MATERIALS:

McMurry, J. (2024). *Organic Chemistry* (10^{th} ed.). OpenStax.

McMurry, S. (2024). *Study Guide and Student Solutions Manual* (10^{th} ed.). OpenStax.

Williamson, K., Masters, K. (2017). *Macroscale and Microscale Organic Experiments* (7^{th} ed.). Cengage.

Molecular Models

Other learning materials may be required and made available directly to the student and/or via the College's Libraries and/or course management system.

COURSE APPROVAL:

Prepared by: Dr. E. Martins, Assistant Professor of Chemistry Date: 10/9/2004

Revised by: Dr. L. McAtee, Assistant Professor of Chemistry Date: 2/5/2009

VPAA/Provost Compliance Verification: Dr. John C. Flynn, Jr. Date: 9/11/2009

Revised by: Dr. L. McAtee, Assistant Professor of Chemistry Date: 12/17/2012

VPAA/Provost or designee Compliance Verification:

Victoria L. Bastecki-Perez, Ed.D. Date: 2/13/2013

Revised by: Debbie Dalrymple Date: 6/27/2016

VPAA/Provost or designee Compliance Verification:

Victoria L. Bastecki-Perez, Ed.D. Date: 6/17/2016

Revised by: Margaret Bryans, Ph.D. Date: 11/5/2024

VPAA or designee Compliance Verification: Date: 11/13/2024

This course is consistent with Montgomery County Community College's mission. It was developed, approved and will be delivered in full compliance with the policies and procedures established by the College.