This course offers a study of the compounds of carbon and their reactions with emphasis upon structure/reactivity relationships and mechanisms. The laboratory emphasizes standard organic techniques, investigations, and spectroscopic methods for identification. C-ID CHEM 150, CHEM 160S
IGETC Area 5: Physical and Biological Sciences

5A: Physical Science

CSU GE Area B: Scientific Inquiry and Quantitative Reasoning

B1 - Physical Science
B3 - Laboratory Sciences

PROGRAM LEVEL LEARNING OUTCOME(S) Supported by this course:

improve problem-solving and critical thinking skills.

actively engage in hands-on experiences in both the classroom and the laboratory.

interpret experimental information, develop relationships, and correlate that experimental information with theory.

develop an understanding of how chemistry is applied in other fields.

COURSE LEVEL STUDENT LEARNING OUTCOME(S) Supported by this course:

1. predict the products, specify the reagents needed with correct stereochemistry and regiochemistry for reactions studied in this semester.

2. evaluate reactive sites within a molecule by locating them and drawing correct electron-pushing arrows for reactions based on electronic properties and structure instead of rote memorization of mechanisms.

3. Show how to synthesize a given compound, outlining the forward steps and reagents that are required using reactions learned in this semester.

4. Lab: Set up and conduct standard organic chemistry procedures such as melting point, distillation, extraction, crystallization, gas chromatography, polarimetry and thin layer chromatography.

5. Lab: draw conclusions from data obtained in lab, such as the identity of an unknown, purity of compounds, explaining the results of an experiment.

6. Lab: Obtain and interpret infrared and NMR spectra.

7. Lab: Operate in the organic chemistry lab demonstrating good technique, safety practices and notebook keeping.

8. use correct names for organic molecules containing alkyl, cycloalkyl, alkene, alkyne, alcohol, ether, halide and amine groups; draw the structures of such compounds from the names.

9. draw three-dimensional structures of organic compounds; determine hybridization, geometry, orbitals, and stereochemistry; and analyze stability of different conformations of alkanes and cycloalkanes.

COURSE OBJECTIVES:

1. Apply principles of electron configuration, Lewis structural theory, and Valence Shell Electron Pair Repulsion (VSEPR) theory, to predict the structure, bonding, and three-dimensional shape of organic species from the chemical formula.

2. Use IUPAC nomenclature rules to systematically name a chemical structure or draw a chemical structure from a name for alkanes, alkyl halides, alkenes, alkynes, alcohols, ethers and amines.
3. Predict the products, including stereo and regioisomers, and provide appropriate reagents for common reactions, including substitution, elimination, addition, oxidation, free radical and organometallic reactions.

4. Generate a mechanism that explains the regiochemistry and stereochemistry of reactions including nucleophilic substitution, elimination, alkene and alkyne additions, and free-radical halogenation.

5. Use learned reactions to create multi-step syntheses.

I. Lab Objectives

I.1. 1. Use and explain the common techniques of organic chemistry, such as melting point, recrystallization, extraction, distillation, chromatography, infrared and nuclear magnetic spectroscopy.

I.2. 2. Execute simple experiments using the common techniques of organic chemistry.

I.3. 3. Keep a proper laboratory notebook and use it to write lab reports.

COURSE CONTENT:

LECTURE CONTENT:

A. Review of Bonding
   1. Lewis structural theory
   2. Valence Shell Electron Pair Repulsion Theory (VSEPR)
   3. Orbital hybridization
   4. Bond angles and molecular shape
   5. Resonance structures

B. Review of Acid/Base Chemistry
   1. Bronsted-Lowry and Lewis acids and bases
   2. pKa
   3. Energy diagrams
   4. Bond and molecule polarity

C. Identify Functional Groups of Organic Compounds

D. Nomenclature
   1. Alkanes
   2. Cycloalkanes
   3. Alkenes
   4. Alkynes
   5. Alcohols
   6. Ethers
   7. Amines
   8. Alkyl halides

E. Structure of Alkanes and Cycloalkanes
   1. Conformations of alkanes and cycloalkanes
   2. Newman projections

F. Structure and Reactions of Alkenes and Alkynes
   1. Degree of unsaturation
   2. cis/trans and E/Z isomers
   3. Addition reactions, including mechanisms
   4. Carbocation stability and rearrangement
   5. Formation and use of acetylide ions

G. Stereochemistry
   1. R/S naming of stereocenters
   2. Enantiomers, diastereomers, and meso compounds
   3. Fischer projections

H. Substitution and Elimination Reactions
   1. Bimolecular nucleophilic substitution (SN2) reactions, including mechanism and stereochemistry
   2. Unimolecular nucleophilic substitution reactions (SN1), including mechanism, stereochemistry and rearrangements
3. Bimolecular elimination reactions (E2), including mechanism, regiochemistry, stereochemistry and conformational requirements
4. Unimolecular elimination reactions (E1), including mechanism, regiochemistry, stereochemistry and rearrangements
5. Competition between SN2/E2/SN1/E1
6. Factors affecting product distribution in substitution and elimination reactions
7. Synthesis of alkenes and alkynes
8. Conversion of alcohols to alkyl halides, sulfonates, alkenes

I. Free Radical Reactions
1. Stability of carbon radicals
2. Mechanism of free radical halogenation of alkanes
3. Product distribution of free radical halogenation
4. Free radical addition and substitution reactions

J. Oxidation and Reduction Reactions
1. Hydrogenation
2. Hydride reduction
3. Formation and reactions of epoxides
4. Alkene cleavage by oxidizing agents
5. Oxidation of alcohols

K. Organometallic Compounds
1. Grignard reaction
2. Formation and use of organolithium reagents
3. Formation and use of other organometallic reagents

L. Multi-step Synthesis
1. Retrosynthetic analysis
2. Formation of new carbon-carbon bonds
3. Functional group interconversions

LABORATORY CONTENT:

Lab Content:

A. Laboratory safety
B. Use and disposal of hazardous materials
C. Introduction to laboratory theory and techniques employed in the separation, purification, and identification of organic compounds
   1. Melting point
   2. Boiling point
   3. Crystallization
   4. Filtration
   5. Distillation
   6. Extraction
   7. Polarimetry
   8. Refractive index
   9. Thin layer chromatography
10. Gas Chromatography
11. Infrared spectroscopy
12. Nuclear Magnetic Resonance (NMR) spectroscopy

D. Proper maintenance of a laboratory notebook.

METHODS OF INSTRUCTION:

A. Lecture:
B. Lab:
C. Independent Study:
INSTRUCTIONAL TECHNIQUES:
A variety of techniques are used such as direct lecture, group problem solving, clicker questions and other active learning techniques.

COURSE ASSIGNMENTS:
Reading Assignments
textbook reading,

Out-of-class Assignments
Working problems in workbook and textbook, supplemental problem sets

Writing Assignments
Lab reports may include: Analysis of experimental data; synthesis of ideas; analysis of spectra or chromatograms; presentation of a well-written, logical argument based on facts given or observed.

METHODS OF STUDENT EVALUATION:
Midterm Exam
Final Exam
Short Quizzes
Written Assignments
Report
Problem Solving Exercises
Skills Demonstration

Demonstration of Critical Thinking:
Problem solving, essay, mechanism and synthesis questions on quizzes and exams, designing laboratory procedures, laboratory writeups requiring analysis of data and drawing sound conclusions from that data.

Required Writing, Problem Solving, Skills Demonstration:
Analysis of experimental data; synthesis of ideas; understanding of abstract concepts such as transition states, and effect of reactant structure and reaction conditions to predict reaction products; presentation of a well-written, logical argument based on facts given or observed; prediction of mechanisms based or acidity arguments and other similar reactions; use of learned reactions to synthesize moderately complex organic compounds.

TEXTS, READINGS, AND RESOURCES:
TextBooks:

Other:
1. Safety glasses or goggles, laboratory notebook.

LIBRARY:
Adequate library resources include:
Comments:

Attachments:
Attached Files