



### **Course Description**

#### **CHM2200 | Survey of Organic Chemistry | 3.00 credits**

This one-semester course briefly examines the structure, synthesis, nomenclature and reactivity of selected mono- and poly-functional organic compounds. Theories that relate the structure of organic molecules to their chemical reactivity will be presented as a unifying principle.

### **Course Competencies:**

**Competency 1:** The student will demonstrate knowledge of the structure, bonding, and acid-base properties of organic compounds by:

1. Using electronegativities to determine bond polarity.
2. Predicting the molecular geometry of organic compounds using Valence Shell Electron Pair Repulsion (VSEPR) Theory.
3. Predicting orbital hybridization using valence bond and molecular orbital theory.
4. Comparing and contrasting sigma ( $\sigma$ ) and pi ( $\pi$ ) bonding.
5. Predicting properties of organic compounds based on the type of intermolecular forces that are present.
6. Interpreting electrostatic potential maps.
7. Representing the structure of organic compounds using complete structural formulas, condensed structural formulas, and line angle formulas.
8. Calculating formal charges.
9. Drawing viable resonance structures.
10. Recognizing, identifying, and drawing structural/constitutional isomers.
11. Comparing and contrasting Brønsted-Lowry and Lewis acid-base theories.
12. Comparing and contrasting nucleophilicity and electrophilicity.
13. Completing acid-base reactions involving organic compounds.

**Competency 2:** The student will demonstrate knowledge of the nature and nomenclature of organic compounds by:

1. Distinguishing between functional groups (alkanes, alkenes, alkynes, arenes, halides, alcohols, phenols, ethers, amines, nitriles, sulfides, thiols, aldehydes, ketones, carboxylic acids, esters, amides, acid chlorides, and acid anhydrides).
2. Applying the International Union of Pure and Applied Chemistry (IUPAC) system of nomenclature to organic compounds (alkanes, alkenes, alkynes, arenes, halides, alcohols, phenols, ethers, amines, aldehydes, ketones, carboxylic acids, esters, and amides).

**Competency 3:** The student will demonstrate knowledge of the chemical behavior of alkanes by:

1. Identifying properties of alkanes and cycloalkanes.
2. Identifying and drawing conformational isomers of alkanes and cycloalkanes.
3. Identifying and drawing cis-trans isomers of cycloalkanes.
4. Identifying, writing, and applying reactions of alkanes (halogenation).
5. Illustrating methodologies for the synthesis of alkanes (hydrogenation of alkenes and alkynes).

**Competency 4:** The student will demonstrate knowledge of the chemical behavior of alkenes and alkynes by:

1. Identifying properties of alkenes and alkynes.
2. Identifying and drawing cis-trans and E, Z isomers of alkenes.
3. Drawing the mechanism for alkene addition reactions.
4. Summarizing the role that carbocation stability plays in product formation of hydration and hydrohalogenation reactions of alkenes.
5. Using Markovnikov's rule to predict the regioselectivity of several alkene addition reactions.

6. Identifying and illustrating reactions of alkenes (hydrogenation, halogenation, hydration, and hydroxylation).
7. Identifying and illustrating reactions of alkynes (hydrogenation, halogenation, hydration, and substitution reactions involving the alkynides).
8. Illustrating methodologies for the synthesis of alkenes (dehydrohalogenation and dehydration)

**Competency 5:** The student will demonstrate knowledge of the chemical behavior of aromatic compounds/arenes by:

1. Identifying properties of aromatic compounds.
2. Identifying the role that substituents play in the orientation of an incoming group during electrophilic aromatic substitutions.
3. Identifying and illustrating electrophilic reactions of aromatic compounds (halogenation, nitration, sulfonation, Friedel Crafts, alkylation, and acylation).

**Competency 6:** The student will demonstrate knowledge of stereochemistry (i.e., the three-dimensional structure of organic molecules) by:

1. Comparing and contrasting chirality and achirality.
2. Comparing and contrasting the physical and chemical properties of stereoisomers.
3. Identifying, comparing, and contrasting enantiomers, diastereomers, meso compounds, and racemic mixtures.
4. Applying sequencing rules for specifying R and S configurations.

**Competency 7:** The student will demonstrate knowledge of the chemical behavior of alkyl halides by:

1. Identifying properties of alkyl halides.
2. Identifying and illustrating reactions of alkyl halides (Grignard reagent formation; SN1, SN2, E1, and E2 reactions and stereochemistry).
3. Illustrating methodologies for the synthesis of alkyl halides (via substitution reaction of alcohols and hydrohalogenation and halogenation of alkenes).
4. Interpreting energy diagrams of SN1, SN2, E1, and E2 reactions of alkyl halides.

**Competency 8:** The student will demonstrate knowledge of the chemical behavior of alcohols, ethers, and phenols by:

1. Identifying properties of alcohols, ethers, and phenols.
2. Illustrating methodologies for synthesizing alcohols (via hydration of alkenes, reduction of aldehydes, ketones, esters, and carboxylic acids).
3. Illustrating methodologies for the synthesis of ethers (Williamson synthesis).
4. Illustrating methodologies for the synthesis of phenols from benzene.
5. Identifying and illustrating reactions of alcohols (dehydration, oxidation, and Williamson Synthesis).
6. Identifying and illustrating reactions of phenols (oxidation, bromination, nitration, and sulfonation).

**Competency 9:** The student will demonstrate knowledge of the chemical behavior of aldehydes and ketones by:

1. Identifying properties of aldehydes and ketones.
2. Illustrating methodologies for synthesizing aldehydes (via oxidation of primary alcohols and reduction of carboxylic acids and esters).
3. Illustrating methodologies for synthesizing ketones (via oxidation of secondary alcohols).
4. Identifying and illustrating reactions of aldehydes and ketones (nucleophilic addition reactions, hydration, acetal formation, Grignard reaction, conjugate addition,  $\alpha$ substitution reactions, nucleophilic acyl substitutions, and carbonyl condensations).

**Competency 10:** The student will demonstrate knowledge of the chemical behavior of carboxylic acids and their derivatives by:

1. Identifying properties of carboxylic acids and their derivatives.
2. Illustrating methodologies for synthesizing carboxylic acids (via oxidation of primary alcohols, aldehydes, and alkylbenzenes; via hydrolysis of esters, amides, and nitriles).
3. Identifying and illustrating reactions of carboxylic acids (reduction, Fischer esterification, and conversion to acid chlorides).
4. Identifying and illustrating reactions of acid/acyl chlorides (hydrolysis, esterification, and amidation).
5. Identifying and illustrating reactions of esters and amides (reduction, hydrolysis, and saponification).

**Competency 11:** The student will demonstrate knowledge of the chemical behavior of amines by:

1. Identifying properties of amines, heterocyclic amines, and quaternary ammonium salts.
2. Illustrating methodologies for the synthesis of amines (reduction of nitriles and amides; SN2 alkylation reactions of ammonia and alkylamines with alkyl halides).
3. Identifying and illustrating reactions of amines (nucleophilic acyl substitutions).

**Learning Outcomes:**

- Communicate effectively using listening, speaking, reading, and writing skills
- Solve problems using critical and creative thinking and scientific reasoning
- Describe how natural systems function and recognize the impact of humans on the environment