I. **OVERVIEW**
   The following information will appear in the 2009 - 2010 catalog

**CHEM-112 Organic Chemistry 1**  
5.33 Units

*Prerequisite: Satisfactory completion of CHEM 102.*

Nomenclature, structure, reactions and spectroscopy of carbon containing compounds. Laboratory emphasizes basic techniques of synthesis, purification, and identification of organic compounds. Field trips are not required. Course is applicable to the associate degree. General Education:  
  - CSU-GE - B1, B3
  - IGETC Category: IGETC - 5A

II. **LEARNING CONTEXT**
   Given the following learning context, the student who satisfactorily completes this course should be able to achieve the goals specified in Section III, Desired Learning:

A. **COURSE CONTENT**

1. **Required Content:**

   a. Electronic Structure and Bonding
      
      i. ionic vs. covalent bonding
      
      ii. hybridization

   b. Acids and Bases
      
      i. pH and pKa
      
      ii. Henderson-Hasselbalch equation
      
      iii. organic acids
      
      iv. buffer solutions

   c. Alkanes
      
      i. molecular formulae, structure and hybridization
      
      ii. nomenclature
      
      iii. Newman projections
      
      iv. cyclic alkanes
      
      v. molecular formulae
      
      vi. chair conformation of cyclohexane
d. Alkenes
   i. molecular formulae, structure and hybridization
   ii. nomenclature
      a. cis-trans convention
      b. E, Z system
   iii. electrophilic addition reactions
      a. sample reactions
      b. mechanism

e. Stereochemistry
   i. chirality
   ii. enantiomers
      a. drawing
      b. naming R, S system
   iii. diastereomers and meso compounds
      a. drawing
      b. naming R, S system
   iv. optical activity
      a. rotation
      b. calculation
   v. Effect of stereochemistry on product structure and distribution

f. Alkynes
   i. molecular formulae, structure and hybridization
   ii. nomenclature
   iii. reactions
   iv. alkynes as nucleophiles in synthesis

g. Electron Delocalization
   i. resonance structures
ii. chemical consequences, eg., pKa modification

iii. introduction to aromaticity

h. Alkyl halides
   i. molecular formulae, structure and hybridization
   ii. nomenclature
   iii. substitution reactions
      a. SN2
      b. SN1
   iv. elimination reactions
      a. E2
      b. E1
   v. stereochemical consequences of SN1, SN2, E1 and E2 reactions
   vi. competition between substitution and elimination reactions
   vii. alkyl halides in synthesis

i. Oxygen, nitrogen and sulfur containing compounds
   i. nomenclature
   ii. reactions
   iii. use in synthesis

j. Radical reactions
   i. reactivity vs. selectivity
   ii. stereochemical consequences
   iii. allylic and benzylic radicals

k. Mass Spectrometry
   i. fragmentation
   ii. isotopes
   iii. interpretation of spectra

l. Infrared Spectroscopy
   i. position and intensity of absorption bands
ii. effect of electron delocalization on absorption bands

iii. interpretation of spectra

m. Ultraviolet absorption
   i. Beer-Lambert Law
   ii. conjugated systems
   iii. effect of conjugation on wavelengths of absorption
   iv. color and applications
   v. interpretation of spectra

n. Nuclear Magnetic Resonance, emphasis on 1H NMR
   i. chemical shifts and shielding
   ii. splitting patterns
   iii. diamagnetic anisotropy
   iv. integration of signals
   v. deuterium and solvent choice
   vi. 13C NMR
   vii. DEPT, COSY and HETCOR
   viii. interpretation of spectra

2. Required Lab Content:

Lab Content (Typical Labs include)

a. Check-in and safety
b. Solubility and miscibility
c. Separation of an organic acid from a nonpolar compound
d. Crystallization of fluorene
e. Identification of an unknown analgesic by TLC
f. Sodium borohydride reduction of fluorenone to fluorenol followed by TLC
g. Column chromatography of spinach juice/UV-analysis
h. Hydrogenation of oleic acid
i. Bromination of cinnamic acid
j. A Diels-Alder reaction between alpha-phellandrene and maleic anhydride
k. Steam distillation of limonene from orange peel
l. Ethanol from sucrose/fractional distillation

B. ENROLLMENT RESTRICTIONS

1. Prerequisites

Satisfactory completion of CHEM 102.

2. Requisite Skills

Before entering the course, the student will be able to:

a. Identify and apply the vocabulary and basic principles of general chemistry.
b. Identify and use the techniques of measurement in general chemistry.
c. Demonstrate the proper use of laboratory instruments.
d. Demonstrate the graphics techniques of analyzing experimental data.
e. Design simple experiments to test chemical principles.
f. Demonstrate the proper use of chemical composition and molar ratios as applied to stoichiometric relationships within a chemical reaction.
g. Use the concepts of pH, equilibrium, Ka and pKa to describe the strength, form (ionized or unionized) and solubility of an organic acid.
h. Draw Lewis dot structures for sp, sp2 and sp3 hybridized atoms within a molecule.
i. Apply concepts of thermodynamics, equilibrium and kinetics to chemical reactions/systems.

C. HOURS AND UNITS

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D. METHODS OF INSTRUCTION (TYPICAL)

Instructors of the course might conduct the course using the following method:

1. Relevant material is presented through class lectures and lecture/laboratory demonstrations
2. Students perform laboratory experiments that reinforce and expand upon concepts discussed in lecture

E. ASSIGNMENTS (TYPICAL)

1. EVIDENCE OF APPROPRIATE WORKLOAD FOR COURSE UNITS

Time spent on coursework in addition to hours of instruction (lecture hours)
a. Reading assignments from lecture text approximately 50 pages per week

b. Chapter Review homework questions approximately 70 per week.

c. Weekly preparation of laboratory notebook which will include:
   i. physical properties and toxicity data for all reactant and product compounds as found in appropriate reference texts
   ii. a complete record of all experimental work performed, and analysis of results obtained

2. **EVIDENCE OF CRITICAL THINKING**
   *Assignments require the appropriate level of critical thinking*

   a. The student must demonstrate an understanding of spectroscopy as evidenced by the ability to deduce the structure of a compound given its spectra provided by mass spectrometry, ultraviolet-visible, infrared and 1H and 13C NMR spectroscopy. This is demonstrated on exam material and in the laboratory setting.

   b. The student must be able to apply a variety of chemical reactions as evidenced by an ability to synthesize small organic compounds in 2-5 steps given the structure of the product. The reagents must be specified and the reactions carried out in an appropriate order. This is demonstrated on exam material and in the laboratory setting.

   c. Sample exam question
   On the following pages you will find the MS, IR, 1H and 13C NMR spectra of compound A
   a. Write the molecular formula for compound A.
   b. Deduce the structure of compound A and draw it.
   c. Synthesize compound A starting from benzene, any alkyl or aryl halide of 4 carbons or less and any necessary inorganic reagents.

F. **TEXTS AND OTHER READINGS (TYPICAL)**


   4. Other: Student must purchase these items from MJC Bookstore:
      1. Goggles (Fog Gard Plus, ANSI Z87.1-1989, SEI Certified)
      2. Laboratory notebook with NCR pages
      3. Organic Chemistry Model Kit

   5. Other: Laboratory notebook with NCR pages
      Organic Chemistry Model kit

III. **DESIRED LEARNING**

A. **COURSE GOAL**
   *As a result of satisfactory completion of this course, the student should be prepared to:*

Division: Science, Math & Engineering
Name and write the formulas for carbon containing compounds, write and predict organic reactions and reaction mechanisms, describe stereochemical aspects of chirality centers, calculate kinetic parameters and interpret mass, infrared, ultraviolet-visible and nuclear magnetic resonance spectra of organic compounds. Upon satisfactory completion of the laboratory, students should be able to perform basic laboratory techniques to complete synthesis and purification of selected compounds.

B. **STUDENT LEARNING GOALS**

*Mastery of the following learning goals will enable the student to achieve the overall course goal.*

1. **Required Learning Goals**
   
   Upon satisfactory completion of this course, the student will be able to:

   a. Name various organic molecules using both common and IUPAC nomenclature rules.
   
   b. Determine the structure of an organic molecule when given its IUPAC name.
   
   c. Use the principles of thermodynamics and kinetic analysis to evaluate a set of reaction conditions and determine the resulting kinetic parameters at equilibrium.
   
   d. Determine the type of reaction mechanism operating in a given chemical reaction and describe the mechanism in detail using curved arrows to show movement of electrons. Special emphasis is placed on the mechanisms of electrophilic addition reactions, uni- and bimolecular nucleophilic substitution reactions and radical reactions.
   
   e. Predict the product of a given set of reactants under specified conditions as well as propose reactants and reaction conditions necessary for the production of a particular product. This includes reactions of alkanes, alkenes, alkynes, alkyl halides and alcohols.
   
   f. Devise multi-step synthetic schemes that will induce the production of a particular product molecule of some given complexity.
   
   g. Apply the principles of stereochemistry to the structure, function and reactions of molecules containing chirality centers.
   
   h. Interpret mass, ultraviolet-visible, infrared and nuclear magnetic resonance spectra as evidenced by the correct description of the structure of an unknown compound.
   
   i. Describe the physical characteristics of families of organic compounds including melting and boiling points, density, structure, polarity and solubility.
   
   j. Identify the hybridization of neutral atoms, carbocations and carbanions and the corresponding bond order, bond angles and molecular shapes.
   
   k. Write a procedure designed to separate an organic acid from a neutral molecule using the principles of solubility and pKa.

2. **Lab Learning Goals**

   Upon satisfactory completion of the lab portion of this course, the student will be able to:

   a. Demonstrate safe practice in the chemistry laboratory including measures to prevent/control chemical spills, fire, explosion, contact and/or intake of hazardous chemicals or fumes and injury due to broken glass or contact with hot glassware.
   
   b. Identify an unknown from a list of compounds based on its melting point.
   
   c. Demonstrate the capacity to determine the solubility of a compound based on its structure and effectively use this information to separate ionic/polar compounds from neutral compounds by extraction.
   
   d. Demonstrate the ability to isolate and purify organic compounds via gravity or vacuum filtration.
   
   e. Separate the components of a mixture via thin layer or column chromatography.
f. Follow the progress of a reaction by thin layer chromatography.

g. Hydrogenate a double bond by generating hydrogen gas from the reaction of zinc and sulfuric acid.

h. Brominate a double bond and determine the stereochemistry of the resulting product.

i. Perform a Diels-Alder reaction and build a model of the resulting adduct.

j. Perform steam, simple and fractional distillation of alcohols and/or oils.

k. Identify pertinent peaks on an infrared spectrum of an organic compound including (but not limited to) peaks for the following functional groups: carbonyl, alcohol, aldehydes, phenyl groups.

l. Separate organic compounds using gas chromatography.

m. Identify pertinent peaks on a mass spectrum due to fragmentation of an organic compound.

n. Prepare an NMR sample, run a 1H and 13C NMR and determine the structure of an unknown organic compound based on these spectra.

o. Determine the success of a chemical reaction based on IR, MS and NMR analysis.

IV. METHODS OF ASSESSMENT (TYPICAL)

A. FORMATIVE ASSESSMENT

1. Assigned homework and/or quizzes given throughout the semester

2. Examinations given at regular intervals throughout the semester

3. Identification of laboratory unknowns

4. Instructor's evaluation of yields and purity of compounds synthesized in the laboratory

5. Laboratory notebook maintained by the student will be graded after each experiment.

6. Observation of laboratory technique and safety

B. SUMMATIVE ASSESSMENT

1. A comprehensive final examination