GAVILAN COLLEGE
5055 Santa Teresa Blvd
Gilroy, CA 95023

Course Outline

COURSE: CHEM 12A DIVISION: 10 ALSO LISTED AS:

TERM EFFECTIVE: Fall 2016 CURRICULUM APPROVAL DATE: 03/14/2016

SHORT TITLE: ORGANIC CHEMISTRY

LONG TITLE: Organic Chemistry

Units	Number of Weeks	Type	Contact Hours/Week	Total Contact Hours
5	18	Lecture:	3	54
		Lab:	6	108
		Other:	0	0
		Total:	9	162

COURSE DESCRIPTION:

This is the first semester of a year-long organic chemistry course designed for chemistry majors, pre-professional medical, biology, and science majors. Topics include nomenclature, stereochemistry, mechanisms, reactions and spectroscopic studies of organic compounds. Lecture and laboratory methods will focus on synthesis, isolation, purification, elucidation, and identification of organic structures, as well as instrumental methods and data interpretation. (C-ID: CHEM 150, CHEM 160S) PREREQUISITE: Chemistry 1B

PREREQUISITES:

Completion of CHEM 1B, as UG, with a grade of C or better.

COREQUISITES:

CREDIT STATUS: D - Credit - Degree Applicable

GRADING MODES

L - Standard Letter Grade

REPEATABILITY: N - Course may not be repeated

SCHEDULE TYPES:

02 - Lecture and/or discussion
03 - Lecture/Laboratory
04 - Laboratory/Studio/Activity

STUDENT LEARNING OUTCOMES:

1. Use and discuss the concepts and theories for the structure and bonding in organic molecules, as well as the naming, interpretation and drawing of chemical structures.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2010 2. Be able to recognize and evaluate polar bonds and their consequence in organic molecules, as well as the theories behind acid-base reactions.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2010 3. Compare and contrast the structures, physical/chemical properties, preparation, and nomenclature of alkanes and cycloalkanes including isomers, stability and conformers.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2010 4. Be able to interpret how organic reactions occur through mechanistic diagrams, as well as describing an organic reaction via rates, equilibrium, energy, transition states and intermediates.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2010 5. Compare and contrast the structures, physical/chemical properties, preparation, and nomenclature of alkenes and cycloalkenes including unsaturation, electronic structure, ans isomers.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2015

6. Demonstrate knowledge of alkene reactions and synthesis including addition, elimination, oxidation and reduction, as well as carbocation structure and rearrangement.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2015

7. Compare and contrast the structures, physical/chemical properties, preparation, and nomenclature of alkynes including unsaturation, electronic structure, ans isomers.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2015

8. Demonstrate knowledge of alkyne reactions and synthesis including addition, elimination, oxidation and reduction, as well as introduction to organic synthesis.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2015

9. Demonstrate knowledge and analyze the stereochemistry of organic molecules, chirality, optical activity, specific rotation, and stereoisomers.

10. Be able to discuss Fischer Projections and the assignment of configuration, the stereochemistry of reactions resulting from addition reactions to alkenes and chiral alkenes, as well as chirality in atoms other than carbon.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2015 11. Compare and contrast the structures, physical/chemical properties, preparation, and nomenclature of alkyl halides, as well as their reactions including Grignard, organometallic, oxidation and reduction.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

12. Be able to discuss, compare and contrast nucleophilic substitution and elimination reactions including characteristics, stereochemistry, kinetics, inversion, reactivity, and usage in chemical synthesis.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

13. Demonstrate comprehension of mass spectrometry, infrared spectroscopy, and ultraviolet spectroscopy by the interpretation of spectra with respect to organic molecules and structure elucidation.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2010

14. Demonstrate comprehension of Carbon-13 and Hydrogen-1 nuclear magnetic resonance (NMR) by the interpretation of spectra with respect to organic molecules and structure elucidation.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2010

15. Compare and contrast the structure, stability, orbital descriptions, and nomenclature of conjugated dienes, as well as addition reactions to conjugated dienes including Diels-Alder and kinetic versus thermodynamic control of a chemical reaction.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

16. Be able to recognize and evaluate aromatic hydrocarbons including their structure, stability, orbital description, and nomenclature, as well as aromatic ions, heterocycles, and polyaromatic compounds.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

17. Demonstrate knowledge of the chemical reactions of benzene including electrophilic and nucleophilic aromatic substitutions, Friedel-Crafts alkylation and acylation, substituent effects in substituted aromatic rings, as well as the oxidation and reduction of aromatic compounds, and the synthesis of polysubstituted benzenes.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 7

GE-LO: B1, B3, B5, B6, A6

Year assessed or anticipated year of assessment: 2016

18. Employ laboratory procedures to: i) Characterize organic compounds based on physical/chemical properties including IR, UV, MS, and NMR spectroscopy. ii) Purify organic compounds by methods including recrystallization, solvent extraction, sublimation, and distillation. iii) Synthesize, derivatize and degrade organic compounds, and characterize their physical/chemical properties. iv) Isolate, purify, and characterize the structures of natural products. v) Examine chemical concepts through peer interaction and written laboratory reports. vi) Relate classroom and laboratory experiences to phenomena outside the classroom.

Measure: Homework, Group activities, Quizzes, and Exams.

PLO:

ILO: 2, 1, 4, 6

GE-LO: B4, B7, B8, A5

Year assessed or anticipated year of assessment: 2016

PROGRAM LEARNING OUTCOMES:

Employing the scientific method as a basis for evaluation theoretical and laboratory derived information, students will gain an understanding of the biological and/or physical worlds. Students will also gain a working familiarity with mathematics and an understanding of mathematics as it applies to modeling in the sciences.

CONTENT, STUDENT PERFORMANCE OBJECTIVES, OUT-OF-CLASS ASSIGNMENTS

Curriculum Approval Date: 03/14/2016

WEEK HOURS CONTENT:

1-2 6 Chapter-1 Structure and Bonding.

Atomic structure, orbitals and electron configuration.

Development of chemical bonding theory and the nature

of ionic and covalent bonds. Describing covalent bonds

using the Valence Bond and Molecular and Molecular

Orbital Theories. Hybridization concepts: sp. sp2

and sp3 orbitals.

Homework problems from text and instructure.

Chapter-2 Polar Bonds and Their Consequences.

Polar covalent bonds, electronegativity and the dipole

moment. Formal charges, chemical structures, and

resonance. Drawing and interpreting resonance forms.

Acids and bases, the Bronsted-Lowry definition.

Predicting acid-base reactions from pKa values. Acids and bases, the Lewis definition. Drawing chemical structures and molecular models.
Homework problems from text and instructor.
Laboratory Experiment: Recrystallization and Melting Point.

3-4 6 Chapter-3 Organic Compounds: Alkanes and Cycloalkanes.
Functional groups, alkanes, alkane isomers and alkyl groups. Naming alkanes and the properties of alkanes. Naming cycloalkanes and the properties of cycloalkanes. Cis-Trans isomerism in clycloalkanes.
Homework problems from text and instructure.
Chapter-4 Stereochemistry of Alkanes and Cycloalkanes.
Heats of combustion of alkanes and cycloalkanes. The nature of ring strain in cycloalkanes. Conformations of cyclohexane, the axial and equatorial bonds. Conformational mobility of cyclohexane. Conformations of monosubstituted cyclohexanes and analysis of disubstituted cyclohexanes. Conformations of polycyclic molecules.
Homework problems from text and instructor.
Exam #1, Laboratory Experiment: Extraction.

5-6 6 Chapter-5 An Overview of Organic Reactions.
Kinds of organic reactions. How organic reactions occur, mechanisms. Radical reactions and how they occur. Polar reactions and how they occur. Describing a reaction: rates, equilibria, bond dissociation energies, energy diagrams, transition states and intermediates.
Homework problems from text and instructor.
Chapter-6 Alkenes: Structure and Reactivity.
Calculating a molecule's degree of unsaturation. Naming alkenes. The electronic structure of alkenes. Cis-Trans isomerism in alkenes and sequence rules for the E, Z designation. Alkene stability and electrophilic addition reactions. Orientation of electrophilic addition: Markovnikov's Rule. Carbocation structure and stability. The Hammond Postulate. Mechanistic evidence and carbocation rearrangements.
Homework problems from text and instructor.
Laboratory Experiment: i) Separation and Purification of Organic Liquids. ii) Gas Chromatography.

7-8 6 Chapter-7 Alkenes: Reactions and Synthesis.
Preparation of alkenes and a preview of elimination reactions. Addition of halogens to alkenes and halohydrin formation. Hydration of alkenes by hydroboration and oxymercuration. Addition of carbenes to alkenes. Reduction of alkenes by

hydroxylation and cleavage. Biological alkene addition reactions. Radical addition to alkenes by HBr/Peroxides and radical polymerization of alkenes.
Homework problems from text and instructor.
Chapter-8 Alkynes: An Introduction to Organic Synthesis
The electronic structure of alkynes. Naming alkynes. Preparation of alkynes via elimination reactions of dihalides. Reactions of alkynes by the addition of HX and X2. The hydration and reduction of alkynes. Oxidative cleavage of alkynes. The formation and alkylation of acetylide anions. Introduction to organic synthesis problems.
Homework problems from text and instructor. Exam #2.
Laboratory Experiment: Thin-Layer Chromatography (TLC).
9-10 6 Chapter-9 Stereochmistry.
Enantiomers and the tetrahedral carbon. Chirality, optical activity and specific rotation. Sequence rules for specification of configuration. Diastereomers and molecules with more than two stereogenic centers. Meso compounds, racemic mixtures and their resolution. Physical properties of stereosomers. Assigning R, S configurations to Fischer Projections. Stereochemistry of reactions by addition of HBr and Br2 to alkenes. Stereochemistry of reactions by addition of HBr to a chiral alkene. Stereoisomerism and chirality in substituted cyclohexanes. Chirality of atoms other than carbon and chirality in nature.
Homework problems from text and instructor.
Chapter-10 Alkyl Halides.
The structure and naming of alkyl halides. Preparation of alkyl halides. Radical halogenation of alkenes and allylic bromination of alkenes. Stability of the allyl radical. Reactions of alkyl halides via Grignard reagents. Organometallic coupling reaction. Oxidation and reduction in Organic Chemistry.
Homework problems from text and instructor.
Laboratory Experiment: i) Refractometry and Polarimetry.
ii) Alcohols and Alkenes.
11-12 6 Chapter-11 Reactions of Alykl Halides: Nucleophilic Substitutions and Eliminations.
The Walden Inversion. Stereochemistry and kinetics of nucleophilic substitution. The SN2 reaction and its characteristics. The SN1 reaction and its characteristics. Stereochemistry and kinetics of the SN1 reaction. Elimination reactions of alykl halides. The E2 reaction. Elimination reactions and cyclohexane conformation. The E1 reaction and the deuterium isotope effect. Summary and comparison of reactivity

for the SN1, SN2, E1 and E2 reactions. Substitution reactions in synthesis as well as biological systems. Homework problems from text and instructor.
Chapter-12 Structure Determination: Mass Spectrometry and Infrared Spectroscopy.
Mass Spectrometry and interpreting mass spectra. Interpreting mass spectral fragmentation patterns as well as the behavior of common functional groups. Spectroscopy and the electromagnetic spectrum. Infrared Spectroscopy and interpreting infrared spectra. Infrared spectra of common functional groups. Homework problems from text and instructor.
Laboratory Experiment: i) Alykl Halide
ii) Acid-Base Extraction
13-14 6 Chapter-13 Structure Determination: Nuclear Magnetic Resonance Spectroscopy.
Nuclear Magnetic Resonance Spectroscopy and the nature of NMR absorptions. Carbon-13 NMR Spectroscopy, its characteristics and chemical shifts. Advanced Carbon-13 NMR Spectroscopy and its uses. Hydrogen-1 NMR Spectroscopy, its characteristics and chemical shifts. Advanced Hydrogen-1 NMR Spectroscopy and its uses. Homework problems from text and instructor. Exam #3.
Laboratory Experiment.
15 6 Chapter-14 Conjugated Dienes and Ultraviolet Spectroscopy. Preparation and stability of conjugated dienes. Molecular orbital description of dienes. Electrophilic additions to conjugated dienes. Kinetic versus thermodynamic control of reactions. Diene polymers. The Diels-Alder cycloadditon reaction and its characteristics. Structure determination in conjugated systems using Ultraviolet spectra. Colored organic compounds and the effect of conjugation. Homework problems from text and instructor.
Laboratory Experiment: Electrophilic Aromatic Substitution.
16-17 6 Chapter-15 Benzene and Aromaticity.
Aromatic hydrocarbons and naming aromatic compounds. Structure, stability and molecular orbital description of benzene. Aromaticity and the Huckel 4n+2 Rule. Aromatic ions, aromatic heterocycles and polyaromatic compounds. Spectroscopy of aromatic compounds. Homework problems from text and instructor.
Laboratory Experiment.
Chapter-16 Chemistry of Benzene: Electrophilic Aromatic Substitution. Bromination of aromatic rings and other aromatic substitutions. Alkylation of aromatics rings including the Friedel-Crafts reaction. Acylation of

aromatic rings. Substituent effects in substituted
aromatic rings. Trisubstituted benzenes and the
additivity effect. Nucleophilic aromatic substitution
Oxidation and reduction of aromatic compounds.
Synthesis of polysubstituted benzenes.
Homework problems from text and instructor.
Laboratory Experiment.
18 2 Final Exam (cumulative)
Comprehensive over the entire course with evaluation
of each of the areas previously encountered.
ASSIGNMENTS:
See content section of course outline.

METHODS OF INSTRUCTION:
Instruction is by lecture, class discussion, lecture demonstration, small group problem solving, laboratory work projects and homework.

METHODS OF EVALUATION:
CATEGORY 1 - The types of writing assignments required:
Percent range of total grade: 20 % to 30 %
Written Homework
Lab Reports
Other: Extra Credit report on an organic chemistry topic.

CATEGORY 2 -The problem-solving assignments required:
Percent range of total grade: 70 % to 80 %
Homework Problems
Lab Reports
Quizzes
Exams

CATEGORY 3 -The types of skill demonstrations required:
Percent range of total grade: 0 % to %
CATEGORY 4 - The types of objective examinations used in the course:
Percent range of total grade: 0 % to %

REPRESENTATIVE TEXTBOOKS:
Required:
1.) McMurry, J., "Organic Chemistry," 9th ed. , Cengage Learning Publishing, 2016
2.) Palleros, D.R., "Experimental Organic Chemistry", 2nd ed., J. Wiley Publishing, 2012
Recommended:
1.) McMurry, S. , Brady, A. Hyslop, "Study Guide & Solution Manual," 9th ed., Cengage Learning Publishing 1.) 2016
Or other appropriate college level text.
ISBN: 978-1-305-08048-5
978-0-471-28250-1

978-0-840-05445-6
Reading level of text, Grade: 13 Verified by: D. Clark
Other textbooks or materials to be purchased by the student: None

ARTICULATION and CERTIFICATE INFORMATION

Associate Degree:
- GAV B1, effective 201370
- GAV B3, effective 201370

CSU GE:
- CSU B1, effective 201370
- CSU B3, effective 201370

IGETC:
- IGETC 5A, effective 201370
- IGETC 5C, effective 201370

CSU TRANSFER:
- Transferable CSU, effective 201370

UC TRANSFER:
- Transferable UC, effective 201370

SUPPLEMENTAL DATA:

Basic Skills: N
Classification: Y
Noncredit Category: Y
Cooperative Education:
Program Status: 1 Program Applicable
Special Class Status: N
CAN:
CAN Sequence:
CSU Crosswalk Course Department: CHEM
CSU Crosswalk Course Number: 12A
Prior to College Level: Y
Non Credit Enhanced Funding: N
Funding Agency Code: Y
In-Service: N
Occupational Course: E
Maximum Hours:
Minimum Hours:
Course Control Number: CCC000251859
Sports/Physical Education Course: N
Taxonomy of Program: 190500