ILLINOIS VALLEY COMMUNITY COLLEGE

Course Syllabus

DIVISION: Natural Sciences Business

Course: CHM 2003

Date: December 2013

Semester Hours: 5

Prerequisite(s): Grade of C or Better in CHM 2002 or equivalent

Delivery Method:

☒	**Lecture**	**3 Credit Hours**
☒	**Seminar**	**1 Credit Hours**
☒	**Lab**	**1 Credit Hours**
☐	**Clinical**	**0 Credit Hours**

☐ **Online**

☐ **Blended**

Offered: ☐ **Fall** ☒ **Spring** ☐ **Summer**

IAI Equivalent –***Only for Transfer Courses***-go to *http://www.itransfer.org*: CHM 914

CATALOG DESCRIPTION:
This course is a continuation of Organic Chemistry I and including applications of mechanisms to synthetic reactions, the use of special data in the determination of structure and analysis, and natural products. Lab requirement is 3 clock hours per week in the open lab.

GENERAL EDUCATION GOALS ADDRESSED

[See the last page of this form for more information.]

Upon completion of the course, the student will be able:

[Choose those goals that apply to this course.]

☒ To apply analytical and problem solving skills to personal, social and professional issues and situations.
☒ To communicate orally and in writing, socially and interpersonally.
☐ To develop an awareness of the contributions made to civilization by the diverse cultures of the world.
☒ To understand and use contemporary technology effectively and to understand its impact on the individual and society.
☒ To work and study effectively both individually and in collaboration with others.
☒ To understand what it means to act ethically and responsibly as an individual in one's career and as a member of society.
☐ To develop and maintain a healthy lifestyle physically, mentally, and spiritually.
☒ To appreciate the ongoing values of learning, self-improvement, and career planning.

EXPECTED LEARNING OUTCOMES AND RELATED COMPETENCIES:

[Outcomes related to course specific goals.]

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

1. interpret spectral data in relation to the structure and functional groups of a compound.
2. explain the stability, reactions and reaction products of allylic and conjugated compounds.
3. explain the resonance energy of benzene, predict when aromatic stability prevails, give mechanisms and explain products of electrophilic aromatic substitutions and explain their orientation.
4. give mechanisms for the substitution of halogens in the production of halobenzenes and explain the reactivity of aromatic side chain halides.
5. give equations for the preparation of organometallic compounds and their reaction with water.
6. name or give the structure of aldehydes and ketones, give the equations and some mechanisms for the production and reactions of aldehydes and ketones giving special attention to oxidation-reduction reactions including the reagents involved.
7. give the IUPAC name, the common name and/or structure of carboxylic acids and their derivatives as well as the reactions and mechanisms which produce them or are undergone by them.
8. be able to give the name, structure, properties, biological importance and reactions of various amines and amides.
9. be able to give the four major biological molecules, their general structural and their properties.

COURSE TOPICS AND CONTENT REQUIREMENTS÷

Outcome 1 - Students will be able to interpret spectral data in relation to the structure and functional groups of a compound.

Competency 1.1 Given the names or structural formula of a hydrocarbon, students will be able to:

A. determine the numbers of non-equivalent protons that could possible give rise to NMR absorptions.
B. determine what the relative peak heights or areas would be for these protons.
C. using a table of Characteristic Proton Chemical Shifts, determine the approximate S values for the protons.

Competency 1.2 Students will be able to determine the structure of hydrocarbon given the NMR data for the compound using: a table of Characteristic Proton Chemical Shifts, a table of Characteristic Coupling Constants J.

Competency 1.3 Given an IR spectra and a table of characteristic group frequencies, students will be able to determine which of the following functional groups are present in a compound: alkanes, alkenes, alkynes, alcohols, ethers, alkyl halides, aldehydes, ketones, carboxylic acids.

Outcome 2 - Students will be able to explain the stability, reactions and reaction products of allylic and conjugated compounds.

Competency 2.1 Explain the stability and reaction products of allylic systems such as allylic cations, anions, and radicals and the reactions on conjugated dienes or trienes in terms of resonance structures and resonance theory.

Competency 2.2 Students will be able to explain the kinetic versus thermodynamic control of addition reactions of dienes (1,2 and 1.4 addition) by means of a reaction coordinate energy profile diagram and using the rules for carbonium stability (resonance theory) and alkene stability.

Competency 2.3 Students will be able to give the special reactions of unsaturated carbonyl compounds such as isomerization of the double bond and 1,2 and 1,4 additions.

Competency 2.4 Students will be able to give the reactants for preparing cyclohexane ring systems by reduction of benzene derivative and the Diels-Alder reaction.

Competency 2.5 Students will be able to recognize and identify the isoprene unit as it may exist in a terpene or steroid.

Outcome 3 - Students will be able to explain the resonance energy of benzene, predict when aromatic stability prevails, give mechanisms and name products of electriphilic aromatic substitutions and explain their orientation.

Competency 3.1 Students will be able to show how the resonance energy of benzene is calculated and explained.

Competency 3.2 Students will be able to apply the 4n + 2 rule to predict aromatic stability.

Competency 3.3 Students will be able to write the mechanisms for the following electrophillic substitution reactions on benzene:

A. Bromination
B. Prontonation
C. Nitration
D. Sulfonation
E. Friedel-Crafts Acylation

Competency 3.4 Students will be able to name substituted benzenes given structures or give structures if given the name.

Competency 3.5 Students will be able to give the orientation of substituted benzenes in electrophilic aromatic substitution reactions.

Competency 3.6 Students will be able to show how theory can explain the orientation effects in electrophilic aromatic substitutions.

Competency 3.7 Students will be able to give the mechanism for and explain the limitations of the Friedel-Crafts alkylation reaction.

Outcome 4 - Students will be able to give mechanisms for the substitution of halogens for the production of halobenzen and explain the reactivity of aromatic side chain halides.

Competency 4.1 Students will be able to give the two mechanisms of substitution of halogen on halobenzenes.

Competency 4.2 Students will be able to predict and explain the reactivity of different aromatic side chain halogen compounds.

Outcome 5 - Students will be able to give equations for the preparation of organometallic compounds and their reaction with water.

Competency 5.1 Students will be able to give the equations for the preparation of organometallic compounds from alkyl halides or metal exchange with other ogranometallics.

Competency 5.2 Students will be able to give the equations and products of reaction of the organometallic compounds with water for metals with an electronegativity of 1.7 or less.

Competency 5.3 Students will be able to predict the direction of an organmetallic - metal exchange reaction from a table of standard reduction potentials.

Outcome 6 - Students will be able to name or give the structure of aldehydes and ketones, give the equations and some mechanisms for the production and reactions of aldehydes and ketones giving special attention to oxidation-reduction reactions including the reagents involved.

Competency 6.1 Students will be able to name an aldehyde or ketone given its structures or give a correct structure given a name.

Competency 6.2 Students will be able to use the following methods to write equations for the transformation of groups into aldehydes or ketones.

A. Oxidation of alcohols
B. Oxidation of alkenes
C. Hydration of alkynes

Competency 6.3 Students will be able to give the equations for the reactions of aldehydes and ketones which are explained in terms of keto-enol equilibria or an enolate ion and give the theoretical explanation for the acidity of ochydrogens of aldehydes and ketones.

Competency 6.4 Student will be able to write a mechanism for the following kinds of carbonyl addition reactions:

A. formation of gem diols
B. hemiacetal and acetal formation
C. formation of imines and related compounds
D. simple additions such as actylide ions, hydrogen cyanide
E. the aldol condensation

Competency 6.5 Students will be able to write a mechanism for the following kinds of carbonyl addition reactions:

A. formation of gem diols
B. hemiacetal acetal formation
C. formation of imines and related compounds
D. simple additions such as actylide ions, hydrogen cyanide
E. the aldol condensation

Competency 6.6 Given the reagents and conditions, students will be able to give the products of the major addition reactions or carbonyl compounds.

Competency 6.7 Students will be able to give the reagents, conditions and the products for the following kinds of oxidation an reduction reactions of ketones and aldehydes.

A. Baeyer-Villiger oxidation

B. Cannizzaro reaction and crossed Canniccaro
C. Wolff-Kishner reduction
D. Clemmennsen reduction
E. metal hydride reduction

Competency 6.8 Students will be able to recognize the different oxidizing and reducing agents and their resultant reaction with aldehydes and ketones.

Outcome 7 - Students will be able to give the IUPAC name, the common name and/or structure of carboxylic acids and their derivatives as well as the reactions and mechanisms which produce them or are undergone by them.

Competency 7.1 Students will be able to give the IUPAC name for carboxylic acids and the common name for any acid containing up to 5 carbons, if given the structure; or give the structure if given the name.

Competency 7.2 Students will be able to predict the effect on acidity of a carboxylic acid with a change in structure. Predict which of two different carboxylic acids would be the more acidic.

Competency 7.3 Students will be able to give the equations and/or reagents for the preparations of carboxylic acids from alkyl halides or alcohols by the methods of:
A. hydrolysis of nitriles
B. carbonation of organometallics
C. oxidation of primary alcohols

Competency 7.4 Students will be able to give the equations and/or reagents for the following reactions of carboxylic acids:
A. with base or dizomethane
B. Hell, Volhard-Zelinsky reaction
C. formation of amides
D. reduction
E. formation of esters
F. formation of acyl halides

Competency 7.5 Students will be able to give the correct names for the following derivatives of carboxylic acids:
A. esters
B. amides
C. acyl halides
D. anhydrides
E. nitriles
and to give the correct structures of the above and also for sulfonates, sulfates, phosphates, phosphonates, phosphatidic acids.

Competency 7.6 Students will be able to give a correct mechanism for the nucleophilic substitution reactions of the carboxylic acid derivatives and to know the relative reactivities of these derivatives with nucleophiles.

Competency 7.7 Students will be able to give the correct products in the reactions of carboxylic acid and derivatives for the following reaction types:

A. hydrolysis
B. with alcohols
C. with amines or ammonia
D. with carboxylic acids or carboxylate salts
E. with organometallics
F. reducing agents

Competency 7.8 Students will be able to give correct products for the following:

A. Hofmann degradation
B. Pyrolytic eliminations of esters and xanthate esters

Outcome 8 - Students will be able to give the name, structure, properties, biological importance and reactions of various amines and amides.

Competency 8.1 Students will be able to give the IUPAC nomenclature of simple amines and amides; or given the name sketch the structure.

Competency 8.2 Students will be able to recognize the basicity properties and character of amines in chemical reactions.

Competency 8.3 Students will be able to give the general nucleophilic substitution reactions of amines.

Competency 8.4 Students will be able to write chemical equations for the following methods of preparation of amines:

A. reduction of nitro compounds
B. reduction of amides, oximes, and nitriles
C. Hofmann rearrangement or degradation

Competency 8.5 Students will be able to give the reactions of amines with nitrous acid and the coupling reactions of diazonium salts.

Outcome 9 - Students will be able to give the four major biological molecules, their general structure and their properties.

Competency 9.1 Students will be able to state the four major biomolecules: carbohydrates, lipids, amino acids, and nucleic acids.

Competency 9.2 Students will be able to give the general structure and properties for each of the above.

Competence 9.3 Students will be able to give the nomenclature of simple carbohydrates.

Competency 9.4 Students will be able to give the hydrolysis reactions and general synthesis of carbohydrates, lipids, and proteins.

INSTRUCTIONAL METHODS:
Instructional methods will vary depending on topics. Methods that will be utilized are Lecture, Direct demonstration, Independent Research, Inquiry-based classroom instruction, Inquiry-based laboratory instruction. Electronic resources such as on-line homework, quizzing, discussion boards, and live chat sessions will be utilized at the perview of the instructor. Web resources that utilize simulation software particularly with spectroscopic techniques will be extensively applied in class.

INSTRUCTIONAL MATERIALS:
Brown & Foote, 2014, Organic Chemistry, 7th ed. Cengage Learning (required purchase)

Williamson, K. L. (2004) Organic Experiments 9th ed. Boston. Houghton Mifflin Company. (required purchase)

Laboratory notebook (required purchase)

Visorgog safety goggles (required purchase)
UCLA. (2006) Web Spectra search engine. Downloaded on 3/31/06 from http://www.chem.ucla.edu/~webspectra/search.html. (faculty resource)

STUDENT REQUIREMENTS AND METHODS OF EVALUATION:
Evaluation will use a mixed method approach. It will combine the use of traditional assignments like tests, quizzes and homework with a more authentic approach in the laboratory section. The lab componant of the course will combine traditional synthetic organic chemistry experiments with a culminating project of qualitative organic analysis to give the students a real world approach to working with organic chemicals.
Evaluation may include but may not be limited to the follow:
Homework
Lab reports
Tests
Quizzes
Discussion both in class and on-line
Written Assignments
Oral Presentations

Grades are based on a standard scale of
90 - A
80 - B
70 - C
60 - D
below 60 - F

Specific grading policies are assigned by the instructor and are not defined by this document.

OTHER REFERENCES
CRC Handbook of Chemistry and Physics (Available in the Lab and the Library)

Aldrich Library of FTIR Spectra (Available in the Lab)

CRC Handbook of Organic Compounds (Available in the Lab)

Course Competency/Assessment Methods Matrix

Course Prefix, Number and Name	Assessment Options																																
For each competency/outcome place an "X" below the method of assessment to be used.	**Assessment of Student Learning**	Article Review	Case Studies	Group Projects	Lab Work	Oral Presentations	Pre-Post Tests	Quizzes	Written Exams	Artifact Self Reflection of Growth	Capstone Projects	Comprehensive Written Exit Exam	Course Embedded Questions	Multi-Media Projects	Observation	Writing Samples	Portfolio Evaluation	Real World Projects	Reflective Journals	Applied Application (skills) Test	Oral Exit Interviews	Accreditation Reviews/Reports	Advisory Council Feedback	Employer Surveys	Graduate Surveys	Internship/Practicum /Site Supervisor Evaluation	Licensing Exam	In Class Feedback	Simulation	Interview	Written Report	Assignment
Assessment Measures – Are direct or indirect as indicated. List competencies/outcomes below.	**Direct/ Indirect**	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	I	I	I	I	D	D							
1. Interpret spectral data in relation to the structure and functional groups of a compound.					X				X						X																X	
2. Explain the stability, reactions and reaction products of allylic and conjugated compounds								X	X																							
3. Explain the resonance energy of benzene, predict when aromatic stability prevails, give mechanisms and explain products of electrophilic aromatic substitutions and explain their orientation.								X	X																							X
4. Give mechanisms for the substitution of halogens in the production of halobenzenes and explain the reactivity of aromatic side chain halides								X	X																							X
5. Give equations for the preparation of organometallic compounds and their reaction with water					X			X	X																							X
6. Name or give the structure of						X		X	X						X																	X

aldehydes and ketones, give the equations and some mechanisms for the production and reactions of aldehydes and ketones giving special attention to oxidation-reduction reactions including the reagents involved.																																
7. Give the IUPAC name, the common name and/or structure of carboxylic acids and their derivatives as well as the reactions and mechanisms which produce them or are undergone by them							X	X																							
8. Be able to give the name, structure, properties, biological importance and reactions of various amines and amides							X	X																							
9. Be able to give the four major biological molecules, their general structural and their properties							X	X																							X