COURSE OUTLINE
Organic Chemistry 2

Course Description
CH 245. Organic Chemistry 2. 5 hours credit. Prerequisite: CH 240 with a C or better. This course will enable the student to study additional organic chemistry with emphasis on the structures, synthesis, and reactions of principle functional groups and compounds of biological interest. The student will study some advanced topics such as dyes, polymers, and heterocyclic chemistry. The student will participate in three hours of lecture/discussion and four hours of laboratory time per week.

Required Materials
For complete material(s) information, refer to https://bookstore.butlercc.edu

Butler-Assessed Outcomes
The intention is for the student to be able to
1. Demonstrate advanced scientific methods.
2. Demonstrate knowledge of basic math skills as they apply to organic chemistry.
3. Apply advanced scientific reasoning to real world problems in organic chemistry.

Learning PACT Skills that will be developed and documented in this course
Through involvement in this course, the student will develop ability in the following PACT skill area(s):

Communication Skills
- Creation and delivery of messages – Through the completion of lab reports, the student will identify purpose, procedure, observations, and analysis of experiments using scientific reasoning.

Technology Skills
- General computer use - Through the production of electronic-facilitated research, preparation of graphs, and manipulation of data, the student will develop basic computer skills.

Analytical Thinking Skills
- Critical thinking - Through the production of mathematical, graphical, experimental, and written assignments, the student will demonstrate scientific reasoning.

Major Summative Assessment Task(s)
These Butler-assessed Outcome(s) and Learning PACT skill(s) will be demonstrated by
1. Completing a portfolio of laboratory reports including using technology (T-skill) and scientific reasoning to identify purpose, procedures, observations, and analysis of the experiment.
2. Writing a research paper on a topic of the student’s choice related to organic chemistry (C-skill).
3. Completing a final assessment of the course using the American Chemical Society’s national standardized exam for Organic Chemistry I and II (A-skill).

Skills or Competencies
These actions are essential to achieve the course outcomes:
1. Use basic computer skills.
2. Solve basic mathematical problems related to the sciences.

Learning Units
Lecture
I. Spectroscopy
   A. State the relationship between wavelength, frequency, wave number, and energy of light photons
   B. Identify the general regions of the total electromagnetic spectrum
   C. Describe the fundamentals of light emission and absorption
   D. Describe the basic concepts of infrared spectrometry and the general molecular motion on which it is based
   E. Interpret the results of an infrared spectrum and state how that may be utilized
   F. Describe the principle behind nuclear magnetic resonance (NMR) spectra
   G. Interpret simple NMR spectra and determine a simple molecular structure
   H. Describe the principles and application of mass spectroscopy
   I. Describe the principles and application of gas chromatography
   J. Describe the principles and application of ultraviolet spectrum
   K. Describe the principles and application of C-nuclear magnetic resonance (CMR) spectroscopy
   L. Describe the principles and application of the high-performance liquid chromatography (HPLC)

II. Alcohols, Ethers, and Epoxides
   A. Describe the basic structural features of alcohols
   B. Name alcohols and draw structures using the International Union of Pure and Applied Chemistry (IUPAC) nomenclature system
   C. Explain the importance of hydrogen bonding in alcohols
   D. Predict what alcohol can be formed from various starting compounds and explain the mechanism
   E. Demonstrate how alcohols can react to form various compounds and the mechanism involved
   F. Describe the basic analysis for the identification for alcohols
   G. Describe the basic structural characteristics of steroids
   H. Identify important factors affecting cholesterol, its physiological action, and its relationship to other hormones
   I. Distinguish between androgens and estrogens by their physiological action
   J. Identify the general precursors of sex hormones in organisms
   K. Describe the physiological action of vitamin B3 in human beings
   L. Describe the basic structural features of ethers and epoxides
   M. Name ethers and epoxides and draw structures using the IUPAC method
N. Predict what ethers and epoxides can be formed from various starting compounds and explain the mechanism
O. Describe the test for peroxides in ethers

III. Aldehydes and ketones
A. Name and draw structures of aldehydes and ketones in the accepted manner
B. Draw the tautomeric forms of various aldehydes and ketones
C. Illustrate how aldehydes and ketones are synthesized from alcohols
D. Describe the reaction mechanism leading to the reduction of aldehydes and ketones to form alcohols
E. Describe the biologically induced oxidation of alcohol and reduction of ketones or aldehydes in living systems
F. Predict the products of a Grignard reaction, aldol condensation, and cyanohydrin synthesis
G. Describe how formalin is formed
H. Identify hemiacetals or hemiketals and acetals or ketals
I. Distinguish aldehydes from ketones by specific chemical test reactions
J. Explain what information is actually obtained from a Benedict test
K. Identify some examples of aldehydes and ketones found in nature

IV. Carboxylic acids and derivatives
A. Name and draw structures of organic acid and esters using the IUPAC method
B. Identify the primary methods of organic acid synthesis
C. Describe the general structure of fatty acids, and the number of carbons in the fatty acids
D. Explain why most fatty acids contain an even number of carbon atoms
E. Illustrate what is meant by the term “acid” derivative
F. Illustrate the synthesis of esters by esterification and another method
G. Show the accepted mechanism of esterification
H. Discuss the fundamental structure and use of glycerides
I. Identify factors that create rancidity in fat, and explain how rancidity can be prevented
J. Compare biological esterification with laboratory analogs
K. Show mechanisms of acid- and base- catalyzed ester hydrolysis
L. Predict the products of simple Claisen condensation hydrolysis
M. Identify the roles of pheromones in the insect world
N. Identify the physiological role of prostaglandins
O. Demonstrate how carboxylic acids and their derivatives react and are produced
P. Identify the physiological role of prostaglandins
Q. Demonstrate how carboxylic acids and their derivatives react and are produced

V. Enolates and Carbanions
A. Write, predict, and develop the mechanism of the Aldol Condensation reaction
B. Write, predict, and develop the mechanism of the Claisen Condensation reaction
C. Write, predict, and develop the mechanism of the Malonic Ester synthesis
D. Write, predict, and develop the mechanism of the Acetoacetic Ester synthesis

VI. Amines and derivatives
A. Name simple amines
B. Identify or classify amines as primary, secondary, or tertiary
C. Explain the importance of hydrogen bonding in amines with respect to the deoxyribonucleic acid (DNA)
D. Give products of neutralization reactions involving amines
E. State which is the most basic of various amines by examining their Kb values
F. List and explain the relative order of the basicity of amines
G. Draw the resonance forms or structures of aromatic amines
H. Identify alkaloids on the basis of certain characteristics inherent in all alkaloids
I. Describe the type of physiological activities that alkaloids can cause in an animal, especially a human
J. State the sequence of events in nerve impulse transmission and nerve paralysis
K. Describe the theory that shows why alkaloids act as poisons
L. Identify the general structural components in an alkaloid that cause it to act as structure similar to morphine
M. Name structural features of amines that can act as central nervous system stimulants

VII. Phenols
A. Describe the basic structural features of phenols
B. Identify some naturally occurring phenol based compounds
C. Demonstrate how phenols react and how that are synthesized, and explain the reaction mechanism

Laboratory
I. Laboratory practices
A. Dress in an appropriate manner as to promote safety in the laboratory, wearing a lab coat and goggles when anyone is working with chemicals in the laboratory
B. Follow written directions accurately
C. Work safely and effectively, using equipment and chemicals carefully and correctly
D. Demonstrate use of required safety and common laboratory techniques
E. Dispose of waste products in a proper manner

II. Qualitative and quantitative data gathering and recording
A. Acquire data using balances and volumetric glassware
B. Make and record visual observations
C. Use computers, when appropriate, as data acquisition tools
D. List or describe experimental assumptions made and any deviations from the written experimental procedures

III. Data handling and evaluation
A. Create notebooks and laboratory reports that are clear, understandable, and accurately represent the data collected
B. Display computer data in a spreadsheet or graphically, as appropriate
C. Correlate observations with chemical or physical processes
D. Carry out suitable calculations with quantitative data, recognizing when data and calculations are within a reasonable range
E. Use observations of experimental data to present relevant conclusions pertaining to the experimental procedure

IV. Laboratory work correlation with principal topics in Organic II lecture

Learning Activities
Learning activities will be assigned to assist the student to achieve the intended learning outcome(s) through lecture, instructor-led class discussion, guest speakers, group activities, drills/skill practice, labs, and other activities at the discretion of the instructor. These activities may be either face-to-face or online.

Grade Determination
The student will be graded on learning activities and assessment tasks. Grade determinants may include the following: daily work, lab reports, research papers, quizzes, chapter or unit tests, comprehensive examinations, projects, presentations, class participation, and other methods of evaluation at the discretion of the instructor.