1. CURRENT DATE: Spring 2015
   Please indicate whether this is a NEW COURSE or a REVISION: Revision
   
   DATE OF PRIOR REVISION: Spring 2012

2. NAME OF REVISE R: Dr. Jason Polisar & Dr. Martin Epstein

3. COURSE #: CHEM 205

4. NAME OF COURSE: Organic Chemistry 2 - Lecture & Lab

5. COURSE DESCRIPTION:
   CHEM 205 Organic Chemistry 2 - Lecture & Lab
   5 credits

   Continuation of Organic Chemistry 1. In-depth study of the structure, synthesis and reactivity (including detailed mechanisms) of conjugated, aromatic, carbonyl and nitrogen compounds. Multi-step syntheses is emphasized. Additional topics may include heterocycles, pericyclic reactions, biochemical molecules/pathways and/or polymers. Laboratory experiments are related to topics covered in lecture and build upon the organic laboratory techniques learned in first semester, featuring more complex syntheses and spectroscopic methods of analysis.

   Notes: Organic Chemistry 2 is the second semester of a one-year (two-semester) comprehensive organic chemistry course designed for science or engineering majors transferring to a four-year college or for students fulfilling prerequisites for medical school or related programs. Class Hours: 4; Lab Hours: 3; Prerequisites: CHEM 201 (Organic Chemistry 1 - Lecture & Lab); Offered in Fall and Spring semesters and Summer Session 2.

6. NUMBER OF CREDITS: 5

7. NUMBER OF CONTACT HOURS PER WEEK
   a. Lab hours: 4       b. Lecture hours: 3

8. APPROXIMATE FREQUENCY OF OFFERING THIS COURSE: Fall, Spring & Summer Session 2

9. PREREQUISITES or PLACEMENT SCORES: CHEM 201 (Organic Chemistry 1 - Lecture & Lab)

10. COREQUISITES: None

11. ASSOCIATED COURSES (such as field courses): None

12. PLACE OF THIS COURSE IN CURRICULUM:
   Required for Curriculum: Liberal Arts/Math & Science;
   Part of required/recommended sequence with CHEM 201.

13. ADDITIONAL COMMENTS/CLASS NOTES: Students must register for both a lecture and a lab section.
14. REQUIRED TEXTS AND/OR MATERIALS ¹:

¹Textbooks are subject to change each semester. For updated textbook requirements, please contact the WCC Bookstore.

15. STUDENT LEARNING OUTCOMES (SLOs) and COURSE OBJECTIVES

<table>
<thead>
<tr>
<th>SLO/Objectives* - Upon successful completion, the student will be able to:</th>
<th>This outcome will be measured* by one or more of the following instruments (exercises, tools, observations):</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SLO 1:</strong> demonstrate an understanding of delocalized pi-systems.</td>
<td><strong>Measure: Exam 1, Final Exam.</strong></td>
</tr>
<tr>
<td>Objective 1: describe and draw out the bonding/orbital overlap within a compound containing more than one pi-bond.</td>
<td></td>
</tr>
<tr>
<td>Objective 2: use the concept of aromaticity and antiaromaticity in predicting the stability, structure and properties of cyclic compounds and ions containing pi-electrons.</td>
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<tr>
<td>Objective 3: predict the product(s) of electrophilic addition to conjugated dienes under thermodynamic OR kinetic control.</td>
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<tr>
<td><strong>SLO 2:</strong> demonstrate an understanding of aromatic, amine, carbonyl and conjugated compound synthesis and reactions.</td>
<td><strong>Measure: Exam 1, Exam 2, Exam 3, Final Exam.</strong></td>
</tr>
<tr>
<td>Objective 1: predict the product(s) given a set of reaction conditions.</td>
<td></td>
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<tr>
<td>Objective 2: recall the reagents needed to carry out a functional group transformation.</td>
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<tr>
<td>Objective 3: solve multi-step synthesis sequences.</td>
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<tr>
<td><strong>SLO 3:</strong> demonstrate a mechanistic understanding of aromatic, amine, carbonyl and conjugated compound reactivity.</td>
<td><strong>Measure: Exam 1, Exam 2, Exam 3, Final Exam.</strong></td>
</tr>
<tr>
<td>Objective 1: provide arrow (electron)-pushing mechanisms for most of the reactions encountered in the course and related transformations.</td>
<td></td>
</tr>
<tr>
<td>Objective 2: apply mechanistic and structural principles, such as steric and electronic effects, to explain the observed regio- and/or stereoselectivity of a reaction.</td>
<td></td>
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<tr>
<td><strong>SLO 4:</strong> demonstrate the ability to conduct organic chemistry experiments and to analyze data &amp; results.</td>
<td><strong>Measure: Class observation, laboratory reports and/or homework assignments, lab quizzes.</strong></td>
</tr>
<tr>
<td>Objective 1: perform short reaction sequences.</td>
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<tr>
<td>Objective 2: interpret spectroscopic data.</td>
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</table>

*Variations from this basic plan may occur depending on the individual instructor teaching the course and/or the time constraints of a given semester.
SUNY General Education Outcomes (Appendix A)

<table>
<thead>
<tr>
<th>Natural Sciences- Students will demonstrate:</th>
<th>Related Course SLO &amp; Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>understanding of the methods scientists use to explore natural phenomena, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence, and employment of mathematical analysis.</td>
<td>SLO 4 and Measure 4</td>
</tr>
<tr>
<td>application of scientific data, concepts, and models in one of the natural (or physical) sciences.</td>
<td>SLOs 1, 2 &amp; 3 and Measures 1, 2 &amp; 3</td>
</tr>
</tbody>
</table>

16. COURSE GRADING CRITERIA:
Lecture $^1 = 75$
3 Exams (50% combined)
Cumulative Final Exam (25%)
(On the occasion of significant improvement on the final exam, more weight will be placed on the final exam.)

Lab $^{1, 2} = 25$

$^1$Variations from this basic plan may occur depending on the instructor. Instructors will state their grading procedures at the start of the term.
$^2$Exception: Students who fail the lab will fail the course regardless of their lecture average.

17. INSTRUCTIONAL METHODS: List the different instructional methods you might use, in the course of the semester.
List supplementary learning options, if any:
- Traditional lecture with use of chalkboard
- Computer assisted diagrams and graphics
- Molecular Models
- Team work in the laboratory
- Homework assignments
- Solving specific questions related to content studied
- Written exams and distribution of study questions/previous exams
- Use of the Internet

18. TOPIC OUTLINE: Please see below.

19. UNIQUE ASPECTS OF COURSE (such as equipment, specified software, space requirements, etc.):
Organic chemistry laboratories and their associated equipment, instruments and chemicals.

CHEM 205 Lecture Topic Outline *

Ch. 12 Structure Determination: Mass Spectrometry
Interpreting Mass Spectra

Ch. 13 Structure Determination: Nuclear Magnetic Resonance Spectroscopy (In Lab)
Chemical Shifts; $^{13}$C NMR and $^1$H NMR; Proton Counting, and Spin-Spin Splitting Patterns

Ch. 14 Conjugated Compounds and Ultraviolet Spectroscopy
Conjugated Dienes; Electrophilic Additions to Conjugated Dienes and Allylic Carbocations; Kinetic versus Thermodynamic Control; Diels-Alder Cycloaddition; Diene Polymers; Ultraviolet Spectroscopy.
Ch. 15 **Benzene and Aromaticity**
Structure and Stability of Benzene; Aromaticity, the Huckel Rule, and Aromatic Ions; Aromatic Heterocycles and Polycycles

Ch. 16 **Chemistry of Benzene**
Electrophilic Aromatic Substitutions (Halogenation, Alkylation, Acylation, Nitration, Sulfonation); Substituent Effects; Nucleophilic Aromatic Substitution; Benzyne; Oxidation and Reduction.

Ch. 17/Ch. 18 **Review of Alcohols, Epoxides and Organometallic Reagents**
Preview of Carbonyl Compounds

Ch. 19 **Aldehydes and Ketones: Nucleophilic Addition Reactions**
Preparation of Aldehydes and Ketones; Nucleophilic Addition Reactions of Aldehydes and Ketones; Conjugate additions.

Ch. 20 **Carboxylic Acids and Nitriles**
Structure and Properties; Preparation and Reactions of Carboxylic Acids; Nitriles

Ch. 21 **Carboxylic Acid Derivatives: Nucleophilic Acyl Substitution Reactions**
Nucleophilic Acyl Substitution Reactions: Acid Halides, Acid Anhydrides, Esters, Amides, Thioesters.

Ch. 22 **Carbonyl Alpha-Substitution Reactions**
Keto-Enol Tautomerization; Reactivity of Enols; Alpha Halogenation of Aldehydes, Ketones, and Carboxylic Acids; Formation and Reactions of Enolates.

Ch. 23 **Carbonyl Condensation Reactions**
Carbonyl Condensations and Alpha Substitutions; Aldol/Claisen Condensations; Michael Reactions.

Ch. 24 **Amines and Heterocycles**
Structure and Properties of Amines; Basicity of Amines; Synthesis and Reactions of Amines; Reactions of Aryl amines.

If time permits additional topics may include: reactions of heterocycles, polymers, pericyclic reactions or a survey of biomolecule structure.

*Exact topic content and time allotted to topics will depend on the individual instructor and/or the time constraints of a given semester.

**CHEM 205 Lab Topic Outline**

1. Check-In; Safety; Review of Organic Laboratory Practices including Distillation, Reflux; Nomenclature of Carbonyl Compounds
2. The Diels Alder Reaction (small scale)
3. Spectroscopy Dry Lab: Introduction to NMR/Review of IR
4. Nitration (EAS) of Methyl Benzoate and Phenylacetonitrile
5. Friedel-Crafts Acylation Anisole and Succinic Anhydride
6. Sodium Borohydride Reduction of Benzil.
7. Cannizzaro Reaction.
8. Aldol Condensation – Dibenzalacetone
9. Wittig Reaction
10. Esterification: Preparation of Isoamyl Acetate
11. Synthesis of Aspirin

1 Some experiments require more than one lab period to complete.
2 Based on an instructor’s preference, availability of equipment/supplies or constraints within a given semester, this laboratory schedule is subject to change, including but not limited to, the addition or replacement of one or more of the above experiments with the following experiments: Preparation of Benzilic Acid from Benzil
   Reaction of Benzonitrile with t-Butyl Alcohol
   Benzamide with Bromine and Sodium Hydroxide
APPENDIX A
SUNY GENERAL EDUCATION KNOWLEDGE AND SKILL AREAS

1. MATHEMATICS - Students will demonstrate the ability to:
   • interpret and draw inferences from mathematical models such as formulas, graphs, tables and schematics;
   • represent mathematical information symbolically, visually, numerically and verbally;
   • employ quantitative methods such as, arithmetic, algebra, geometry, or statistics to solve problems;
   • estimate and check mathematical results for reasonableness; and
   • recognize the limits of mathematical and statistical methods.

2. NATURAL SCIENCES - Students will demonstrate:
   • understanding of the methods scientists use to explore natural phenomena, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence, and employment of mathematical analysis; and
   • application of scientific data, concepts, and models in one of the natural (or physical) sciences.

3. SOCIAL SCIENCES - Students will demonstrate:
   • understanding of the methods social scientists use to explore social phenomena, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence, and employment of mathematical and interpretive analysis; and
   • knowledge of major concepts, models and issues of at least one discipline in the social sciences.

4. AMERICAN HISTORY - Students will demonstrate:
   • knowledge of a basic narrative of American history: political, economic, social, and cultural, including knowledge of unity and diversity in American society;
   • knowledge of common institutions in American society and how they have affected different groups; and
   • understanding of America’s evolving relationship with the rest of the world.

5. WESTERN CIVILIZATION - Students will:
   • demonstrate knowledge of the development of the distinctive features of the history, institutions, economy, society, culture, etc., of Western civilization; and
   • relate the development of Western civilization to that of other regions of the world.

6. OTHER WORLD CIVILIZATIONS - Students will demonstrate:
   • knowledge of either a broad outline of world history, or
   • the distinctive features of the history, institutions, economy, society, culture, etc., of one non-Western civilization.

7. HUMANITIES - Students will demonstrate:
   • knowledge of the conventions and methods of at least one of the humanities in addition to those encompassed by other knowledge areas required by the General Education program.

8. THE ARTS - Students will demonstrate:
   • understanding of at least one principal form of artistic expression and the creative process inherent therein.

9. FOREIGN LANGUAGE - Students will demonstrate:
   • basic proficiency in the understanding and use of a foreign language; and knowledge of the distinctive features of culture(s) associated with the language they are studying.

10. BASIC COMMUNICATION - Students will:
    • produce coherent texts within common college-level written forms;
    • demonstrate the ability to revise and improve such texts;
    • research a topic, develop an argument, and organize supporting details;
    • develop proficiency in oral discourse; and
    • evaluate an oral presentation according to established criteria.