Agenda Item #06-94
Effective Spring 2008
Effective Spring 2010, with revisions

Eastern Illinois University
New Course Proposal
CHM 4915, Advanced Laboratory

This format is to be used for all courses submitted to the Council on Academic Affairs and/or the Council on Graduate Studies.

Gray boxes (except check boxes) will expand as you type in them.

Please check one: **x** New course ☐ Revised course

PART I: CATALOG DESCRIPTION

1. Course prefix and number, such as ART 1000: CHM 4915
2. Title (may not exceed 30 characters, including spaces): Advanced Laboratory
3. Long title, if any:
4. Class hours per week, lab hours per week, and credit [e.g., (3-0-3)]:1, 6, 3
5. Term(s) to be offered: ☐ Fall x Spring ☐ Summer ☐ On demand
6. Initial term of offering: ☐ Fall x Spring ☐ Summer x Year 2008
7. Course description (not to exceed four lines): An interdisciplinary laboratory course featuring experiments in inorganic, organic, and organometallic chemistry. Experiments will emphasize advanced techniques of chemical research, including the synthesis and characterization of important classes of inorganic, organic, and organometallic compounds. WI
8. Registration restrictions:
   a. Identify any equivalent courses (e.g., cross-listed course, non-honors version of an honors course).
   b. Prerequisite(s), including required test scores, courses, grades in courses, and technical skills. Indicate whether any prerequisite course(s) MAY be taken concurrently with the proposed/revised course.
      CHM 2840, 2845, 3780, and 4900. Prior completion of CHM 3915 recommended.
   c. Who can waive the prerequisite(s)?
      ☐ No one x Chair ☐ Instructor ☐ Advisor ☐ Program Coordinator ☐ Other (Please specify)
   d. Co-requisites (course(s) which MUST be taken concurrently with this one):
   e. Repeat status: x Course may not be repeated.
      ☐ Course may be repeated to a maximum of hours or times.
   f. Degree, college, major(s), level, or class to which registration in the course is restricted, if any:
      Chemistry
   g. Degree, college, major(s), level, or class to be excluded from the course, if any:
9. Special course attributes [cultural diversity, general education (indicate component), honors, remedial, writing centered or writing intensive] WI
10. Grading methods (check all that apply): x Standard letter ☐ C/NC ☐ Audit ☐ ABC/NC ("Standard letter"—i.e., ABCDF--is assumed to be the default grading method unless the course description indicates otherwise.)
11. Instructional delivery method: lecture lab combined (This is a drop-down menu.)

PART II: ASSURANCE OF STUDENT LEARNING
(See the CAA website for examples of items 1, 2, and 3.)

1. List the student learning objectives of this course:
   Students will:
   1) Identify (acquire) and describe information pertaining to substances, reactions, characterization methods or other specialized methods needed for each experiment from various chemistry resources. (graduate goals: depth of content knowledge; effective oral and written communication)

   2) Collect and record data and apply techniques relevant to experiment objectives.

   3) Describe chemical principles that underlie each experiment. (graduate goals: depth of content knowledge, effective critical thinking and problem solving, effective oral and written communication)

   4) Apply physical methods of analysis to determine structural, electronic, magnetic or other properties of substances.

   5) Analyze (collected) data for the purpose of characterizing substances, testing hypotheses, or interpreting experimental results. (graduate goals: depth of content knowledge, effective critical thinking and problem solving, effective oral and written communication)

2. Identify the assignments/activities the instructor will use to determine how well students attained the learning objectives:

Objective	Reports	Exams/Assignments	Performance
1	X		X
2			X
3	X	X	
4	X	X	
5	X	X	

3. Undergraduate: 1) written laboratory reports, 60%; 2) exams or assignments, 30%; 3) laboratory performance grade (includes proper maintenance of a laboratory notebook, working safely/proficiently in laboratory), 10%.

4. NA

5a. Integrate chemical literature research and laboratory experiences in a research proposal format (graduate goals: depth of content knowledge, effective critical thinking and problem solving, effective oral and written communication, advanced scholarship through research or creative activity).

b. Synthesize a research proposal based on a comprehensive review of journal articles on a topic relevant to course materials. In addition to a description of the proposed research, the proposal will include detailed documentation that places the proposed research in the context of related chemistry research.

c. Graduate: 1) written laboratory reports, 50%; 2) exams or assignments, 30%; 3) research proposal, 10%; 4) laboratory performance grade (includes proper maintenance of a laboratory notebook, working safely/proficiently in laboratory), 10%.

Written reports will be held to a higher standard with respect to data analysis and interpretation than those produced by undergraduates.

6. This is a writing-intensive course, as detailed laboratory reports are required for each experiment and comments will be made on each report. At least one revision of a laboratory report is allowed.

PART III: OUTLINE OF THE COURSE

General Overview:

The class will meet for 7 hours each week for 15 weeks. Six of the seven hours will be devoted to laboratory work in the form of two 3-hour lab meetings per week. The remaining hour will be utilized for lecture. Lectures will be used to: 1) describe and discuss details of upcoming experiments; 2) discuss and analyze the outcomes of completed experiments; 3) teach experiment specific units in spectroscopy or other physical methods; 4) administer exams. Students will maintain a laboratory notebook, write formal laboratory reports for each experiment, complete assignments based on experiments, and take exams covering the experiments. In addition, students will be expected to perform experiments efficiently and in accordance with all applicable safety protocols.

A detailed outline is attached.

PART IV: PURPOSE AND NEED

1. This course proposal is the result of a chemistry curriculum restructuring designed to provide chemistry majors with a senior-level lab experience with a significant (~50%) organic chemistry component.

   The restructuring has two parts: 1) reduce Organic Chemistry Laboratory II, CHM 2845, from 2 to 1 credit hour (approved by CAA in Fall 2004 and implemented in Fall 2005); 2) develop an Advanced Laboratory Course that combines material from the former CHM 2845 (before the credit reduction) and CHM 4905 while simultaneously taking advantage of the natural synergies between inorganic and organic chemistry to create new lab experiences that transcend these chemistry sub-disciplines. (The current proposal). CHM 4905 will be dropped from the chemistry curriculum as a result of this restructuring.

   Like the two predecessor courses, the new course will include a series of challenging experiments featuring advanced protocols and methods of analysis. Students will take this course after completing CHM 4900 and the following lab-based courses: CHM 2845, CHM 3780, and CHM 3915. Thus, there are opportunities to apply elements from these courses in this new course. While this is currently done in CHM 4905, there are two key differences between the new course and CHM 4905: 1) CHM 4905 does not include experiments in organic chemistry; 2) CHM 4900 is taken concurrently with CHM 4905.

2. Knowledge and skills learned in the pre-requisite courses CHM 2845 (Organic Chemistry Laboratory II), CHM 3780 (Instrumental Analysis), CHM 3915 (Physical Chemistry Laboratory) and CHM 4900 (Inorganic Chemistry II) is essential for understanding the chemical principles and physical methods of analysis that underlie each experiment as well as for successfully performing each experiment.

3. There are no similar courses.
   a. As noted above in IV.1, CHM 4905 is to be dropped once this course is approved and CHM 2845 has already been reduced from 2 to 1 credit hour.

4. Impact on Program(s):
    a. The course is required for chemistry majors in the Chemistry concentration.
    b. This course will serve as an approved elective for chemistry graduate students.

PART V: IMPLEMENTATION

1. The course will be team-taught. The faculty assigned to teach this course will have expertise in inorganic (Drs. McGuire, Sheeran) or organic (Drs. Treadwell, Wheeler) chemistry. Other qualified faculty may be assigned to teach this course. The team will be comprised of at least one faculty member from each area of expertise.

2. $20 Course Fee pending approval by the President's Council

3. "Synthesis and Technique in Inorganic Chemistry: A laboratory Manual", 3rd edition, by G. S. Girolami, T. B. Rauchfuss, and R. J. Angelici, University Science Books, 1999.

   "Microscale and Macroscale Techniques in the Organic Laboratory", D. L. Pavia, G. M. Lampman, G. S. Kriz, and R. G. Emgel, Brooks/Cole—Thomson Learning, 2002.

   "Introduction to Spectroscopy", 3rd edition by D. L. Pavia, G. S. Kriz, G. M. Lampman. Harcourt College Publishers, 2001.

   Reference Texts: Textbooks used in CHM 2840 and CHM 4900.

PART VI: COMMUNITY COLLEGE TRANSFER

A community college course will not be judged equivalent to this course.

PART VII: APPROVALS

Date approved by the Department of Chemistry: August 22, 2006

Date approved by the college curriculum committee
October 20, 2006

Date approved by the Honors Council (if this is an honors course) _____

Date approved by CAA November 2, 2006 **CGS** December 5, 2006

*In **writing-active courses**, frequent, brief writing activities and assignments are required. Such activities -- some of which are to be graded – might include five-minute in-class writing assignments, journal keeping, lab reports, essay examinations, short papers, longer papers, or a variety of other writing-to-learn activities of the instructor's invention. Writing assignments and activities in writing-active courses are designed primarily to assist students in mastering course content, secondarily to strengthen students' writing skills. In **writing-intensive courses**, several writing assignments and writing activities are required. These assignments and activities, which are to be spread over the course of the semester, serve the dual purpose of strengthening writing skills and deepening understanding of course content. At least one writing assignment is to be revised by the student after it has been read and commented on by the instructor. In writing-intensive courses, students' writing should constitute no less than 35% of the final course grade. In **writing-centered courses** (English 1001G, English 1002G, and their honors equivalents), students learn the principles and the process of writing in all of its stages, from inception to completion. The quality of students' writing is the principal determinant of the course grade. The minimum writing requirement is 20 pages (5,000 words).

Week 1

Lecture:

1. Introduction to and overview of course.
2. Experiment 1 pre-lab discussion: crystals, crystal growth, and structure determination by x-ray crystallography.

Lab:

Experiment 1 (part 1): Growth and Isolation of Sulfamic Acid Crystals Suitable for X-ray Crystallography. (1 period)
Experiment 1 (part 2): The Structure of Sulfamic Acid by X-ray Crystallography. (1 period)

Week 2

Lecture:

1. Experiment 1 post-lab discussion: results and lab report details.
2. Experiment 2 pre-lab discussion: Kinetic versus thermodynamic control; enolate geometry; stereoselectivity in Aldol-type reactions; determination of regio/stereo-isomers by GC and ^{1}H NMR.

Lab:

Experiment 2: Kinetic vs Thermodynamic Control in Enolate Formation. (2 periods)

Experiment 1 lab report due.

Week 3

Lecture:

1. Return Experiment 1 lab report. Discuss opportunity to submit revised report.
2. Experiment 2 post-lab discussion: results and lab report details.
3. Experiment 3 pre-lab discussion: coordination compounds, magnetic properties, magnetic susceptibility measurements.

Lab:

Experiment 3: Synthesis and Characterization of the Paramagnetic Compound $Mn(acac)_3$. (2 periods)

Experiment 1 re-write due. (May be used for EWP.)

Week 4

Lecture:

1. Experiment 3 post-lab discussion: results and lab report details.
2. Experiment 4 pre-lab discussion: resolution of stereoisomers, ligand synthesis, and metallation reactions.

Lab:

Experiment 4 (part 1): Resolution of 1,2-Cylohexanediamine. (1 period)
Experiment 4 (part 2): Synthesis and Characterization of a Chiral Ligand. (1 period)

Experiment 2 report due.

Week 5

Lecture:

1. Experiment 4 discussion continued: catalysis, epoxidation reactions, stereochemical control in chemical synthesis, spectral characterization of stereoisomers.

Lab:

Experiment 4 (part 2 continued). (1 period)
Experiment 4 (part 3): Metallation of the Chiral Ligand Using $Mn(acac)_3$. (1 period)

Experiment 3 report due.

Week 6

Lecture:

1. Experiment 4 discussion continued.

Lab:

Experiment 4 (part 4): Application of a Homogeneous Chiral Transition Metal Based Epoxidation Catalyst.

- Epoxidation using the prepared catalyst. (1 period)
- Characterization of the epoxidation products including a stereochemical assessment. (1 period)

Week 7

Lecture:

1. Experiment 4 post-lab discussion: results and lab report details.
2. Experiment 5 pre-lab discussion: Solid state synthesis, structures of solids, Meissner effect, and titrametric analysis.

Lab:

- Experiment 5 (part 1): Synthesis of the 1-2-3 Superconductor $YBa_2Cu_3O_7$. (1 period)
- Experiment 5 (part 2): Characterization and Properties of the Superconductor. (1 period)

Experiment 4 report due.

Week 8

Lecture:

1. Experiment 6 pre-lab discussion: synthesis of organometallic compounds, structure determination using IR spectroscopy and Group Theory, elucidation of a reaction path via isolation of reactive intermediates, characterization of transition metal hydrides by ^{1}H and ^{31}P NMR.

Lab:

- Experiment 5 (part 2 continued): Characterization and Properties of the Superconductor. (1 period)
- Experiment 6 (part 1): Synthesis and Characterization of trans-$Fe(PPh_3)_2(CO)_3$. (1 period)

Week 9

Lecture:

1. Experiment 5 post-lab discussion: results and report details.
2. Exam 1.

Lab:

Experiment 6 (part 2): Isolation and Characterization of the Intermediate Species in the Synthesis of trans-$Fe(PPh_3)_2(CO)_3$. (2 periods).

Experiment 5 report due.

Week 10

Lecture:

1. Experiment 6 post-lab discussion: results and report details.
2. Experiment 7 pre-lab discussion: multi-step synthesis, use of protecting groups in multi-step synthesis, enzymatic resolution, and column chromatography.

Lab:

Experiment 7 (part 1): Synthesis and Characterization of Flavanols (2 periods)

Experiment 6 report due.

Week 11

Lecture:

1. Experiment 7 pre-lab discussion continued.

Lab:

Experiment 7 (part 1 continued). (2 periods)

Week 12

Lecture:

1. Experiment 7 discussion continued: biologicial activity and tests for biological activitiy.

Lab:

Experiment 7 (part 2): Biological Activity of Flavanols (2 periods)

Week 13

Lecture:

1. Experiment 7 post-lab discussion: results and report details.
2. Experiment 8 pre-lab discussion: metallocenes, structure-property relationships.

Lab:

Experiment 8 (part 1): Synthesis of a Series of (η^6-arene)$Cr(CO)_3$ compounds. (2 periods)

Experiment 7 report due.

Week 14

Lecture:

1. Experiment 8 pre-lab discussion: electrochemical methods of analysis.

Lab:

Experiment 8 (part 2): Spectral and Electrochemical Characterization and Structure-Property Relationships of a Series of (η^6-arene)$Cr(CO)_3$ compounds. (2 periods)

Week 15

Lecture:

1. Experiment 8 post-lab discussion: results and report details.
2. Experiment 9 pre-lab discussion: heterogeneous catalysis, hydrogenation, chemoselectivity and regioselectivity.

Lab:

Experiment 9: Catalytic Hydrogenation (2 periods).

Experiment 8 report due.

Week 16 (finals week)

Exam 2.

Experiment 9 report due.