Engineering Faculty Document 8-04
October 1, 2004

MEMORANDUM

To: The Faculty of the Schools of Engineering
From: The Faculty of the School of Civil Engineering
Re: New 500 Level Course

The Faculty of the School of Civil Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

CE 556 **Instrumental Methods in Environmental Chemistry**
This course is cross listed with EAS 591

Sem. 2 or SS, Class 2, lab 3, cr 3

Prerequisites: General chemistry (Chem 111 or equivalent), analytical chemistry (CE 353 or equivalent), or equivalent lab experience with consent of instructor.

Theory and operation of analytical instruments for quantitative chemical analysis of elements and chemicals of interest in environmental engineering and environmental geochemistry. Instrumental methods covered include: gas, liquid, and ion chromatography, gas chromatography-mass spectrometry, stable isotope mass spectrometry, atomic absorption spectroscopy, and inductively coupled plasma emission spectrometry.

Reason: Graduate student research in environmental sciences and engineering very often relies on the ability to measure trace concentrations of elements and chemicals in environmental samples. These measurements are made to properly characterize engineered, disturbed, and natural environments, and to test the design and function of engineered unit operations and other treatment processes. This course is primarily designed for advanced under graduate students and first and second year graduate students for their basic proficiency in several common advanced analytical methods: (1) that are commonly used in scientific research and may be of use in their own graduate research, and (2) that are currently used in industry to generate chemical data that environmental engineers and other decision makers must act upon.

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Fred L. Mannering, Head
School of Civil Engineering

Supporting Documentation

1. Justification: CE 556 is a new 3 credit-hour course. Since 1999, it has been offered annually as a special topic course. The enrollments during last three years it was taught were 11, 7 and 8 in 2002, 2003, and 2004, respectively. The course has evolved and matured into a highly successful course, primarily designed for advanced undergraduate and first and second year graduate students in environmental engineering and related programs. The course was not taught in 2005 or 2006. The class covers both the theory and use of advanced analytical instruments for chemical and elemental analysis. Course topics and materials directly benefit advanced undergraduate and graduate students by providing them with fundamental understanding of and hands-on experience with instrumentation that is available for use in graduate research education.

2. Level: Primarily advanced undergraduate and graduate level

3. Prerequisites: General chemistry, analytical chemistry or lab experience

4. Instructors: Changhe Xiao and Chad Jafvert

5. Course Objectives: At the conclusion of this course, students will be able to:

- Perform independent elemental or chemical analyses by means of gas chromatography, liquid chromatography, ion chromatography, mass spectrometry, atomic absorption spectroscopy, and inductively coupled plasma emission spectrometry
- Develop methods and protocols for operation and use of all instruments covered in the course
- Calculate experimental error, define error sources, and identify error reducing procedures.
- Interpret quantitatively results of analyses.
- Apply analytical principles and techniques to research projects.

6. Course outline:

Lectures cover the following topics:

- 1 week: Wet chemistry preparation for instrumental analysis
- 1 week: Instrumental errors, noise, and error handling
- 1 week: Lambert-Beer's Law, qualitative and quantitative analyses by UV/Vis spectrometry
- 1 week: Principles of atomic absorption (AA)
- 1 week: Principles of atomic fluorescence and elemental analysis
- 1 week: Chromatography separation theory and method development
- 2 weeks: Gas chromatography analysis
- 1 week: Liquid chromatography analysis
- 1 week: Ion chromatography sample analysis
- 1 week: Mass spectrometry
- 2 weeks: Basic principles of structural (EI, CI) GC-MS
- 1 week: Basic principles of LC-MS
- 1 week: Integrated consideration of analytical methods design and sample analysis

Lab Sessions will cover the following experiments:

- Wet chemistry lab review, safety
- UV-Vis spectrophotometry and extinction coefficient measurements
- Trace amounts of metal analysis of drinking water on Graphite Furnace Atomic Absorption Spectrometer (GFAAS)
- Analysis of heavy metal ions by inductively coupled plasma (ICP) emission spectroscopy
- Gas chromatographic (GC) analysis of organic samples
- High performance liquid chromatographic (HPLC) analysis of environmental samples
- Identification and analysis of contaminants by GC-MS
- Anion analysis of drinking water by Ion Chromatography (IC)
- LC-MS analysis of environmental samples

7. Text: *Principles of Instrumental Analysis*, 5th Ed., Saunders College Publishing, 1998, ISBN 0-03-002078-6**,** by Douglas A. Skoog, F. James Holler, and Timothy A. Nieman

8. Special Notes: The analytical methods employed to measure trace concentrations of compounds, metals, and metalloids in samples taken from natural and engineered environments are common across many academic disciplines. In recognition of this fact, this course will be cross-listed in Civil Engineering and Earth and Atmospheric Sciences and will meet with EAS 591 with participation from Professor Tim Filley of the Earth and Atmospheric Sciences Department**.** This interaction further will illustrate to students in these disciplines the range of measurement applications.