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

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

Prerequisites: General chemistry, analytical chemistry or lab experience

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 designed to impart to students 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 decisions makers, must act upon.

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. Since this time, the course has evolved and matured into a highly successful course, primarily designed for first and second year graduate students in environmental engineering and related programs. The class covers both the theory and use of advanced analytical instruments for chemical and elemental analysis. Course topics and materials directly benefit 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 graduate level

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

4. Instructor: 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:

- Wet chemistry preparation for instrumental analysis
- Instrumental errors, noise, and error handling
- Lambert-Beer's Law, qualitative and quantitative analyses by UV/Vis spectrometry
- Principles of Atomic Absorption (AA)
- Principles of atomic fluorescence and elemental analysis
- Chromatography separation theory and method development
- Gas Chromatography analysis
- Liquid Chromatography analysis
- Ion Chromatography sample analysis
- Mass Spectrometry
- Basic principles of structural (EI, CI) GC-MS
- Basic principles of LC-MS and ions introduction.
- Integrated consideration of sample analysis and design of analytical methods Summary of the method development

Lab Sessions will cover the following experiments:

- Wet chemistry lab review
- UV-Vis Spectrophotometer and extinction coefficient measurements
- Trace amount metal analysis of drinking water on Graphite Furnace Atomic Absorption Spectrometer (GFAAS)
- Analysis of heavy metal ions on Inductively Coupled Plasma (ICP)
- Gas Chromatography (GC) analysis of organic samples
- High Performance Liquid Chromatography (HPLC) analysis of environmental samples
- GC-MS direct analysis of contaminants
- Anion analysis of drinking water on Ion Chromatography (IC)
- LC-MS analysis of environmental contaminants

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 organic species, metals and metalloids in samples taken from natural and engineered environments are common across several academic disciplines. This course is cross-listed in Civil Engineering and Earth and Atmospheric Sciences in recognition of this fact, and to illustrate to students in these disciplines the range of measurement applications. This course may meet with EAS 591, which is taught by Professor Tim Filley of the Earth and Atmospheric Sciences Department.