STUDENT COURSE SYLLABUS - SPRING 2003
CHEM 4630: DETECTION OF CHEMICAL POLLUTANTS

Instructor: Dr. Ngee-Sing Chong. Office phone: 898-5487. Office: Room 231, Davis Science Building. Office hours: MWF 9:30-11:00, R 1:00-2:00, other hours by appointment.

Description: This course covers the theory and practice of analytical chemistry as applied to the identification and quantitation of pollutants in environmental samples ranging from trace to major levels. Classical analytical methods and selected instrumental techniques based on chromatography, spectroscopy, and microscopy as well as sample preparation techniques, statistical data treatment, and quality assurance of data will be discussed. Methods development for metals and organic pollutants in the environmental media of soil, water, air, and waste will be emphasized primarily. The prerequisite is CHEM 222 or 2230 (Quantitative Analysis) or the equivalent.


Netlibrary Reference Titles:
Analytical Instrumentation Handbook; Ewing, G. W.; Marcel Dekker; 1997.
Extraction Methods For Environmental Analysis; Dean, John R.; John Wiley; 1998.
Introduction To Analytical Gas Chromatography; Scott, R. P. W.; Marcel Dekker; 1998.
Liquid Chromatography-mass Spectrometry; Niessen, W. M. A.; Marcel Dekker; 1999.

Laboratory: There will be about 8 experiments for this course depending on the rate of class progress and instrument service requirements. A printed lab report should be turned in by the due date announced in class for each experiment. A floppy disk containing all the report files including any spreadsheet or graphics files should be turned in at the end of the semester. Each report is worth 50 points and will be graded on the basis of adherence to experimental procedures, demonstrated analytical proficiency, accuracy and precision of data, meaningful or logical interpretation of results, and answers to questions relevant to the experiments. Experimental data should be well organized and written in a lab notebook with numbered pages and the raw data in the notebook should be photocopied to accompany the lab reports.

The laboratory will be in DSB 206 and 207. These rooms are available to you during the scheduled laboratory periods plus other hours by prior arrangement with the instructor. Please confine all wet chemistry to Room 206. Be cautious with the operation of analytical instruments and do not change the instrumental parameters without permission. You may be held responsible for replacing any equipment or accessories that you break. Since some of the analytical instruments are shared by faculty and students in research and instructional projects, you have to sign-up for the use of instruments such as GC-MS, AA, and FTIR as directed.

Safety rules must be adhered to and goggles are required in the laboratory during sample preparation. A bound laboratory notebook and a calculator are required for recording raw data and calculating lab measurements, respectively.
Project: Participation in one environmental analysis project is required for each group of 2 or 3 students with subsequent presentation of results in class and in a written report. The project must emphasize the design of sampling methods, the development of analytical procedures, the interpretation of data, and the application of quality control protocols. Students are expected to integrate the knowledge and experience gained throughout the course to complete the project for the analysis of pollutants in air, water, soil, or hazardous wastes. More information will be provided in class.

Grading: Three 100-point exams 300 points
Final exam (May 2, 2003 at 12-2pm) 200 points
Eight 50-point lab reports 400 points
Environmental analysis project 100 points

The grading scale for your total score is as follows: A for >= 850; B for 725-849; C for 600-724; D for 475-599; and F for <475. **Plus/minus grading scheme will be used** for the “B” and “C” grades as follows; the plus and minus grades will be given to the top 3% and bottom 3%, respectively, of the 12.5% range for each grade interval. For instance, a score of 820-849 will be assigned a “B+” and 600-629 will be assigned a “C-“. The exam dates will be announced in class at least one week ahead of the scheduled time.

Attendance: Regular attendance of class lectures is expected due to the coverage of materials beyond the textbook and the regular discussions of laboratory procedures and data pertaining to the experiments. You are responsible for all lecture materials and timely submission of lab reports regardless of the nature of your class absences.

Lecture outline: Jan. 6 – Jan. 20 Introduction and Basics of Environmental Analysis: Legislation for pollution control and monitoring; pollutant types and sources; sample manipulation techniques such as solid phase extraction, purge-and-trap method, thermal desorption, and sample digestion methods; measurement terms; statistics.

Jan. 22 - Mar. 3 Analysis of Organic Pollutants: Gas chromatography (GC) with flame ionization detector (FID), electron capture detector (ECD), photoionization detector (PID), and mass spectrometry (MS) detectors; high pressure liquid chromatography (HPLC) with electrochemical, UV-Vis and MS detectors; ion chromatography with conductivity detector; environmental applications of Fourier Transform infrared spectrometry (FTIR) and mass spectrometry (MS).

Mar. 5 - Apr. 7 Analysis of Inorganic Pollutants: Ultraviolet-visible (UV-Vis) spectrophotometry of metal complexes and anions, elemental analysis by atomic absorption spectroscopy (AAS), inductively coupled plasma-atomic emission spectrometry (ICP-AES), inductively coupled plasma-mass spectrometry (ICP-MS), X-ray fluorescence spectrometry (XRF); stripping voltammetry; radioactivity detectors; scanning electron microscopy (SEM) of particulate pollutants and X-ray microanalysis..
Methods Development and Data Analysis:
Overview of EPA methods for air, water, waste, and soil analyses; onsite field monitoring; quality assurance/quality control (QA/QC) protocols; data analysis with internal standardization, isotope dilution, multiple linear regression, and least squares analyses; classical techniques for acidity & alkalinity; biochemical oxygen demand (BOD) and chemical oxygen demand (COD); titrimetry; potentiometry; toxicity bioassay and biomonitoring.

Experiments:
Eight of the following ten labs will be performed by each group of 2 or 3 students.
- Survey of environmental pollution data using Internet resources
- Gasoline contaminants in water by GC-FID with solid phase microextraction
- Characterization of automobile exhausts by GC-MS with sorbent tube sampling
- Determination of polycyclic aromatic hydrocarbons by HPLC-UV diode array
- Speciation of trivalent and hexavalent chromium by UV-Vis spectrophotometry
- Analysis of cigarette smoke by FTIR spectrometry
- Quantitation of metals in particulate matter by AAS and/or AES
- Measurement of water alkalinity by potentiometric titration
- Fluoride determination by ion selective electrode analysis
- Gravimetric determination of inhalable airborne particulate matter

Important Dates:
- Feb. 3 - Last day to drop without a grade
- Mar. 3 - Last day to drop with a “W” grade

Disabilities:
If you have a disability that may require assistance or accommodation, or you have questions related to any accommodations for testing, note takers, readers, etc., you MUST contact the Office of Disabled Students Services (898-2783) and then speak with me as soon as possible.

Lab Safety Rules

1. Wear safety goggles and gloves when working with hazardous chemicals
2. Never keep or consume food or drink in a chemistry laboratory.
3. Never pipet by mouth to avoid accidental ingestion.
4. Be cautious when working with instruments that have high voltage or heated components such as the GC injector, quadrupole analyzer in MS, and spectrometer lamps.
5. Use proper care in dispensing, mixing, and handling chemicals to avoid skin contact.
6. Know the location of emergency equipment such as first aid kit, eyewash fountain, fire extinguisher, fire alarm, and the nearest telephone.
7. Read the Material Safety Data Sheets of chemicals encountered in the lab and follow the proper precautions and handling instructions.
8. Use the fume hood when working with volatile chemicals or solvents to avoid inhalation.
9. Ask for instructor’s assistance when gas cylinders for any instruments need to be changed.
10. Be aware of waste disposal options for organic wastes (halogenated versus non-halogenated), metal-containing wastes, and broken glassware.

THIS SYLLABUS IS SUBJECT TO CHANGE AT THE DISCRETION OF THE INSTRUCTOR.