Chemistry 7600 Analytical Separations (3 Credits)

Dr. Brown's Portion of The Class

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General Course Overview

Prerequisites: Although there are no formal prerequisites for this class, student will preferably have taken (or are taking concurrently) most of the following undergraduate courses or their equivalent: undergraduate instrumental (CHEM 5640/5650), quantitative analysis (CHEM 3000/3005) and physical chemistry (CHEM 3060/3070).

Chem 7600 will be divided into two sections. The first half of the class will be taught by Professor Brown and will deal with spectroscopic theory and instrumentation. The second half of the class will be taught by Professor Chen and will involve spectroscopic applications with particular emphasis on applications to biological problems.

This course is intended for chemistry graduate students (Ph.D., MS) or advanced undergraduate or graduate students from a science discipline who meet the above prerequisites. The class will be structured with both formal lectures on the material covered in the attached syllabus as well as a less formal aspect where students will be encouraged to discuss aspects of analytical spectroscopy as it relates to their research problems or general interest areas. Because of the diversity of the material to be covered, there will be no assigned text for the class. Appropriate handouts on particular topics will supplement lectures. Beyond the basic material in the attached syllabus, additional material may be covered in an attempt to accommodate particular interests of students in the class, within the framework of the attached course outline. This may include discussions of specific analytical applications of a particular spectroscopy. The course will be primarily concerned with spectroscopic and mass spectrometric methods applied to organic based compounds, but the basic theory discussed is equally important for all spectroscopic applications. This course will assist the student in implementing various spectroscopies in their individual research areas. It will also provide important fundamental knowledge of spectroscopic methods that should facilitate the future use of analytical spectroscopies in academics or industry.

Grading

Grading for Dr. Brown's section of the course will be based upon successful completion of the following:

(a) Two written take home exams (occurring about week 4 and 7 of the semester).
(b) Class participation (i.e., regular attendance and interaction).

Final course grades will be determined based upon the average of a student's performance in both sections of the course and in consultation with both Professor Brown and Professor Chen.
Course Withdrawal: Students may withdraw from Chemistry 5640 as outlined in the current on-line edition of the Utah State University General Catalog (web link: http://catalog.usu.edu/content.php?catoid=7&navoid=1259 - Dropping_Courses).

Additional Provisions: The administration of Chemistry 5640 will adhere strictly to the USU Academic Policies outlined in the current on-line edition of the Utah State University General Catalog. The complete code of Policies and Procedures for Students can also be viewed online at: http://www.usu.edu/studentservices/studentcode/.

Spring Holidays: Because of the two spring semester Monday holidays (Martin Luther King, Jr. Day, January 20 and President’s Day, February 17), students will attend their Monday schedule of classes on Tuesday, February 18.

Final Note: In accordance with the Americans with Disabilities Act, reasonable accommodation will be provided for all persons with disabilities in order to ensure equal participation in Chemistry 7600. A student who requires an accommodation must contact the Instructor. The disability must be documented by the Disability Resource Center. In cooperation with the Disability Resource Center, reasonable accommodation will be provided for students with Disabilities. Course material may be requested in alternate formats through the Disability Resource Center (phone number 797-2444).

New Course Evaluation System

Categories for Primary Course Learning Objectives:

I. Basic Cognitive Background
   • Gaining factual knowledge (terminology, classifications, methods, trends)
   • Learning fundamental principles, generalizations, or theories

II. Application of Learning
   • Learning to apply course materials (to improve rational thinking, problem solving and decisions)
Developing specific skills, competencies and points of view needed by professionals in the field most closely related to this course
Tentative First Section (Spectroscopic Theory) Course Outline

Analytical Spectroscopy Topics

Electronic Spectroscopy
(1) Fundamental theory relating to Ultraviolet, Visible and Fluorescence Spectroscopy
   a) Light absorption; light emission, singlet vs. triplet states; measurement aspects of
      light absorption; forbidden vs. allowed transitions
(2) UV-Vis molecular chromophores, estimation of UV-Vis absorption wavelength
    maxima (Woodward-Frieser rules)

Vibrational Spectroscopy
(1) Fundamental theory of Fourier transform infrared spectrometry (FTIR) and aspects
    of data processing
(2) Instrumental aspects of FTIR and review of optics
(3) Novel sampling techniques employed in FTIR and computer methods for data
    analysis
(4) Fundamental theory of Raman spectroscopy
   a) Conventional Raman spectroscopy
   b) FT-Raman spectroscopy

Mass Spectrometry Topics
(1) Introduction to mass spectrometry (MS)
   a) Classical mass analyzers including: magnetic/electric sector, quadrupole, ion
      traps (magnetic and electric sector), time-of-flight
   b) Newer hybrid instrument designs and the new “orbitrap” mass spectrometer
(2) "Standard" ionization sources (organic) for MS (EI and CI)
(3) Ionization techniques for higher molecular weight (or thermally labile) molecules
   a) Electrospray Ionization (ESI) theory and applications
   b) Matrix-Assisted Laser Desorption/Ionization (MALDI) theory and applications
(4) MS/MS experiments: collision and photon induced decompositions; new electron
    capture dissociation (ECD) and electron transfer dissociation (ETD) methods. In-
    Source and Post-Source Decay in MALDI