Chem 7640 - Special Topics: Mass Spectrometry
Instructor: Bob Brown
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Office Hours: Tu 3:00-4:00 PM, W 3:00-4:00 PM and by appointment

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: instrumental analysis (Chem 5640/5650), quantitative analysis (Chem 3600/3610) and physical chemistry (Chem 3060/3070).

This course is intended for chemistry graduate (Ph.D., MS) and advanced undergraduate students or for graduate students from a science discipline who meet the course 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 separation science as it relates to their research problems or general interest areas. There will be no formal textbook for the class. Students will be given access to a printed copy of the text: "Mass Spectrometry, A Textbook" (1st edition) by Jurgen H. Gross to supplement class lecture material. In addition, an electronic version of the same text (2nd Edition) will be made available via the classes Canvas web site. The class will discuss the basic ideas that are fundamental to all types of mass spectrometry: ionization methods, ion m/z separation methods, ion detection processes and mass soectra data analysis. The course will also discuss the large range of mass spectrometers available to researchers. Additional material to be covered in the class will attempt to be geared, as much as possible, to specific interests of students in the class, within the framework of the attached course outline. The course is primarily concerned with various mass spectrometry applications to both small organic compounds and large and complex biomolecules (peptides and proteins), but the basic mass spectrometry principles are useful to a variety of other compound classes. This course should prepare the student for utilizing mass spectrometry data in their individual research areas as well as providing a solid fundamental background in mass spectrometrry for future use in academics or industry.

Grading

Grading will be based upon successful completion of the following:

(a) Two graded take home assignments (occurring about week 3 and 6 of the second 7-week semester). Specific dates will be announced in class.

(b) A class project as the final exam to be chosen from either:
(i) A written (typed) report on an approved (by the instructor) mass spectrometry topic (typically 10-12 double space pages using a 12-point font).

Or

(ii) A practical lab experience based upon being trained on and subsequent use of the departmental LC-MS or LC-MS and GC-MS, to solve a chemical problem.

(c) Class participation (i.e., regular attendance and interaction).

Course Withdrawal: Students may withdraw from Chemistry 7640 as outlined in the most recent Utah State University General Catalog and the most recently revised semester calendar.

Additional Final Provisions: The administration of Chemistry 7640 will adhere strictly to the regulations outlined in the most recent Utah State University Fall Schedule of Classes. Missed exams will be handled on a case-by-case basis and may require written documentation of a medical or family emergency, at my discretion.

Course Learning Objectives:

1) Gain an understanding of the basic instrumentation used in mass spectrometry.
2) Gain an understanding of the chemistry and physics of ion formation and fragmentation.
3) Gain an improved understanding of the various ionization processes used in mass spectrometry and their advantages and limitations for specific classes of molecules.
4) Understand the difference between mass resolution and mass accuracy of mass spectra and when each is important in an analysis.
5) Understand the underlying principles used to separate ions by m/z (electric fields vs. magnetic fields; static versus dynamic fields; continuous versuses pulsed instruments.
6) Gain an understanding of why chromatographic processes are often coupled to mass spectrometry for important modern chemistry and biochemistry analyses.

Tentative 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 high molecular weight (or thermally labile) molecules
   a) Early desorption ionization methods (Field Ionization, Field Desorption, SIMS, FAB, plasma desorption, thermospray)
   b) Electrospray Ionization (ESI) theory and applications
   c) 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
(5) Separation techniques coupled to MS
(6) Selected environmental and biomolecule applications.

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 Chem. 7610. Any student that 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.