

SYLLABUS**CHEMISTRY 514****Fall 2015**

Credits: 2.0 hours
Schedule: Monday 8:10-9:00 PM, Wednesday 8:10-9:00 PM Fulmer 150
Instructor: Prof. Peter Reilly
Office: Fulmer 128 Phone: 335-0042 Email: pete.reilly@wsu.edu
Office hours: by appointment

Grading: 3 midterm exams 100 points each
Exams will be take home. There is no comprehensive final exam. Any resource except another human being may be used on the exams. Please be aware that just because you can find something by merely “googling” does not mean that what you find is correct. Not everything on the internet has been vetted. Grades are curved up (never down) to a B⁺ average. Because the exams are not given in class, 3 class room days will be returned at the discretion of the instructor.

Prerequisites: 1. Undergraduate physical chemistry and/or
2. Undergraduate physics

Note: It is necessary to introduced several 2nd order linear differential equations to define the motions of ions in the various traps; however, you will not be asked to solve them nor will you be responsible for solving them on the exams. Undergraduate analytical chemistry is also helpful but not necessary. Any graduate student in chemistry, biochemistry, engineering or physics should already have enough background to be able to comprehend any of the material presented.

Synopsis:

This course thoroughly covers the fundamentals of mass spectrometer instrumentation. It does not cover any of the specific applications of mass spectrometry such as any topic with the “-omics” suffix or biological or organic mass spectrometry. Each of these specific applications would require their own separate course to be covered at the graduate level. This course demystifies the mass spectrometer so that it is not seen as a black box. It teaches students how each type of mass analyzer, source and detector operates and how they can be combined and used in any application. It teaches the student how ions are created and moved into vacuum from the atmosphere and how they are manipulated in vacuum. Students learn cutting edge uses for mass spectrometers and obtain a vision of where the field is heading. The ion handling portion of this course will contain the rudiments of high resolution MS in the ultra high mass range. This course teaches the student to use, adapt and know which type of mass spectrometer is needed for their purpose. Fundamental knowledge of mass spectrometer instrumentation is crucial for students that will eventually set up and operate an analytical laboratory where a large portion of the budget is allocated for mass spectrometer instrumentation and maintenance.

This is an advanced course. It is not a prerequisite for the analytical preliminary exams. Mass spectrometry topics covered on the preliminary exams can be found in Harris.

Reading:

All required reading will be sent as pdf files through email at least a week before it is covered in class. The material in these pdfs is introductory and can be understood at the first year graduate

student level. They were produced by the leading experts in the fields to be primers. The slides that are covered in class will be sent out in advance before they are covered in class so that the student can print them and annotate them during class. Class participation is encouraged and expected.

Course Outline

- Week 1-3: Topics: Introduction and Ion Source Fundamentals
Required reading: Marvin L. Vestal, *Chemical Reviews*, 2001, 101,361-375, "Methods of Ion Generation" and Nadja B. Cech and Christie G. Enke, *Mass Spectrometry Reviews*, 2001, 20, 362– 387, "Practical Implications of Some Recent Studies in Electrospray Ionization Fundamentals"
- Week 4-5: Topics: Time-of-Flight Mass Spectrometry
Required reading: Michael Guilhaus, *Journal of Mass Spectrometry*, Vol. 30, 1519-1532 (1995), "Principles and Instrumentation in Time-of-Fight Mass Spectrometry: Physical and Instrumental Concepts"
- Week 6-7: Topics: Ion Trap and Guides in Mass Spectrometry
Required reading: Raymond E. March, *Journal of Mass Spectrometry*, Vol. 32, 351-369 (1997), "An Introduction to Quadrupole Ion Trap Mass Spectrometry"
- Week 8-10: Exam I: ion sources and time-of-flight analysis
Topic: FT-ICR
Required reading: Alan G. Marshall, Christopher L. Hendrickson, and George S. Jackson, *Mass Spectrometry Reviews*, 1998, 17, 1–35, "Fourier Transform Ion Cyclotron Resonance Mass Spectrometry: A Primer"
- Week 11-12: Topic: Orbitrap mass spectrometry
Required reading: Richard H. Perry, R. Graham Cooks, and Robert J. Noll, *Mass Spectrometry Reviews*, 2008, 27, 661– 699, "Orbitrap Mass Spectrometry Instrumentation, Ion Motion and Applications"
- Week 13-14 Exam II: Ion traps and FTICR
Topics: Sector Instruments and Accelerator Mass Spectrometry
Reading: Material derived from the lectures
- Week 15-16 Detectors and Ion Handling and Ultra High Mass Spectrometry
Reading: Material derived from the lectures
- Week 17 Exam III—covers orbitraps, sector and accelerator instruments and ion handling and UHMS

The precise schedule and reading material are subject to change at the discretion of the instructor

Students with Disabilities: Students with Disabilities: Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217; 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center.

Attendance Policy: None. However, students are responsible for the material that is covered in class even if it is not present in the reading. Exams are take home. It is assumed that you have access to email even when absent. Makeup exams will be considered only in extreme circumstances at the discretion of the instructor.

WSU Reasonable Accommodation Statement:

“Students with Disabilities: Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building 217; 509-335-3417) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information contact a Disability Specialist on your home campus:

Pullman or WSU Online: 509-335-

3417 <http://accesscenter.wsu.edu>, Access.Center@wsu.edu

Spokane: <http://spokane.wsu.edu/students/current/studentaffairs/disability/>

Tri-Cities: <http://www.tricity.wsu.edu/disability/>

Vancouver: 360-546-9138 <http://studentaffairs.vancouver.wsu.edu/student-resource-center/disability-services>

Graduate-level courses: Faculty may also use the statement available on the GSC website: <http://gradschool.wsu.edu/FacultyStaff/Committee/>

WSU’s Academic Integrity Statement

“As an institution of higher education, Washington State University is committed to principles of truth and academic honesty. All members of the University community share the responsibility for maintaining and supporting these principles. When a student enrolls in Washington State University, the student assumes an obligation to pursue academic endeavors in a manner consistent with the standards of academic integrity adopted by the University. To maintain the academic integrity of the community, the University cannot tolerate acts of academic dishonesty including any forms of cheating, plagiarism, or fabrication. Washington State University reserves the right and the power to discipline or to exclude students who engage in academic dishonesty.” Students found responsible for academic integrity violations may receive an F on the particular assignment or exam, as well as an F for the course. Repeated and/or serious offenses may result in referral to the conduct board and expulsion from WSU. For graduate students, academic integrity violations may also result in the loss of teaching and/or research assistantships.

Academic Integrity Statement and link to WSU’s policy:

<http://www.wsulibs.wsu.edu/plagiarism/main.html>

<http://conduct.wsu.edu/academic-integrity-policies-and-resources/>