# CHEMICAL INSTRUMENTATION [CHEM 524]

*Spring 2018*

## Department of Chemistry
## University of Wisconsin, Madison

**Instructor:** Associate Professor Timothy H. Bertram
**E-mail:** tbertram@chem.wisc.edu
**Phone:** 608.890.3422
**Location of Instructor Office Hours:** Chemistry 4355
**Instructor Office Hours:** 11-12 TR
**Course Website**: https://canvas.wisc.edu/courses/76131

**Lecture:** 9:55 AM TR; Room 2373 Chemistry
**Laboratory:** MTWR 1:20 PM to 4:20 PM, W 5:45 to 8:45 PM or F 2:25 to 5:25 PM; Room 2330 Chemistry
All modes of instruction (lecture and laboratory) are face-to-face

**Laboratory Director:** Dr. Rob McClain mcclain@chem.wisc.edu
**Teaching Assistants:** Ann Lindberg aelindberg@wisc.edu; Michael Vermeuel mvermeuel@wisc.edu
**Teaching Assistant Office Hours:** After laboratory

**Credits:** 3, based on the traditional Carnegie definition. Chem 524 has two 50 minute lectures per week and one 3 hour laboratory each week. Laboratory meets every week of the semester.

**Course Designation:** Breadth – Physical Sci. counts toward the Natural Sci. requirement. Level – Advanced. L&S Credit – Counts as Liberal Arts and Science credit in L&S.

## COURSE INFORMATION

**Course Description:** Instrumental methods of measurements, as applied to modern chemical analysis; lecture and lab.

**Course Requisites:** Chemistry 343, Chemistry 329 or 327, and Physics 208 or 202.

**Learning Outcomes:** The purpose of this course is to teach the principles of chemical instrumentation design, development, and use. The course will consist of two lecture/discussion sessions and one laboratory session per week, along with problem sets and exams. The laboratory for Chemistry 524 is intended to provide you with hands on experiences with the design, development, and use of different types of chemical instrumentation. We want to facilitate a laboratory environment where you learn important physical concepts while practicing useful experimental laboratory skills.

**Lecture/Discussion:** There are two 50 minute lecture/discussion sessions each week covering the theory and applications of various analytical instrumentation topics. During lectures I will introduce principles and illustrate concepts with example questions. Lectures will provide an opportunity for discussion as well as tackling problems in a group. As a result, participation is central in class. Topics to be explored include separations, spectroscopy, mass spectrometry, and electronics.

**Laboratories:** There is a three hour laboratory each week. In the laboratory, practical experience building and using chemical instrumentation will be provided. More details on the laboratory can be found below.

**Problem Sets:** Problem sets will be assigned to cover the course material and will be discussed during lecture/discussions. Some of the problems will require the use of MatLab or other mathematical modelling software. Assignments will be made available at least 7 days before they are due.

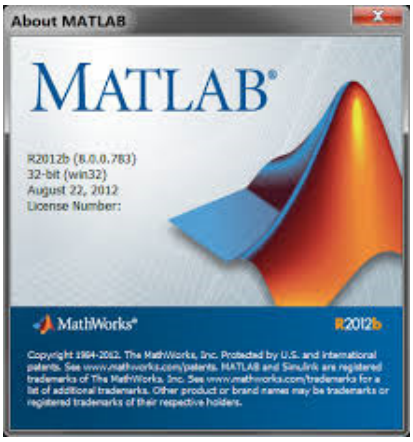
**Midterm Exam and Final Project:** There will be one midterm exam in this course. The midterm exam will be given in the middle of the semester and will cover the material up to that time. The final project, in the form of a poster presentation, will occur during exam week.

**Grades:** Your final grade will be computed with the following scheme:

| | Percent | Notes |
|---|---|---|
| **Midterm Exam** | 15% | No make-up exams |
| **Laboratory** | 40% | More details below |
| **Problem Sets** | 30% | P.S. are not equally weighted |
| **Final Project** | 15% | |

Your scores are available to you on Canvas, with a 3-5 day time delay. There are no opportunities for extra credit.

## RESOURCES AND MATERIALS:




1. There is no single, formal textbook for Chem 524. Instead, select book chapters are posted on Canvas for each of the topics discussed in class and laboratory.

2. Numerous problem sets will require the use of mathematically modelling software. Mathworks MatLab is recommended for this. MatLab is available at no charge to students at UW Madison through a site license. Installation instructions for MatLab can be found at the campus software library: https://www.doit.wisc.edu/services/software/

   If you have any questions or concerned regarding access to MatLab for your personal computer or to university computer labs that have MatLab installed, please contact us. It is important that you find a reliable mechanism for using MatLab early in the class.

## RULES, RIGHTS & RESPONSIBILITIES

- See the Guide's to Rules, Rights and Responsibilities

## ACADEMIC INTEGRITY

By enrolling in this course, each student assumes the responsibilities of an active participant in UW-Madison's community of scholars in which everyone's academic work and behavior are held to the highest academic integrity standards. Academic misconduct compromises the integrity of the university. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these acts are examples of academic misconduct, which can result in disciplinary action. This includes but is not limited to failure on the assignment/course, disciplinary probation, or suspension. Substantial or repeated cases of misconduct will be forwarded to the Office of Student Conduct & Community Standards for additional review. For more information, refer to studentconduct.wiscweb.wisc.edu/academic-integrity/.

## ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

**McBurney Disability Resource Center syllabus statement:** "The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (Faculty Document 1071) require that students with disabilities be reasonably accommodated in instruction and campus life. Reasonable accommodations for students with disabilities is a shared faculty and student responsibility. Students are expected to inform faculty [me] of their need for instructional accommodations by the end of the third week of the semester, or as soon as possible after a disability has been incurred or recognized. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to identify and provide reasonable instructional accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA." http://mcburney.wisc.edu/facstaffother/faculty/syllabus.php

## DIVERSITY & INCLUSION

**Institutional statement on diversity:** "Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals.

The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world." https://diversity.wisc.edu/

## LECTURE OUTLINE

Content covered in lecture will closely follow that of the laboratory. The tentative schedule for lecture is:

1. Separations
    - A. Liquid Chromatography
    - B. Gas Chromatography
    - C. Electrophoretic Methods
2. Spectroscopic Measurements
    - A. Types of Spectroscopy
    - B. Frequency Domain Measurements (e.g. absorption and emission)
    - C. Instrumental Parameters (e.g. sensitivity, resolution, dynamic range)
    - D. Instrumental Components (light sources, wavelength selectors, detectors)
3. Electronics
    - A. Passive Measurements
    - B. Operational Amplifiers
    - C. Conversion between Analog and Digital Domains
    - D. Signal to Noise Optimization
4. Mass Spectrometry
    - A. General Introduction
    - B. Types of Mass Spectrometers

**LABORATORY SYLLABUS AND SCHEDULE**

**Laboratory Philosophy:** The laboratory for Chemistry 524 is intended to provide you with hands on experiences with the design, development, and use of different types of chemical instrumentation. We want to facilitate a laboratory environment where you learn important physical concepts while practicing useful experimental laboratory skills. We expect you to bring active hands and an active mind to each laboratory period. The lab sections are kept small to encourage discussion with the instructors and other students. No formal laboratory reports will be required. All observations, data, results and discussions will be completed, recorded and collected during the laboratory period. This will give you practice with **thinking while doing** which is an essential skill for any laboratory scientist.

**Laboratory Grading:** To be consistent with our laboratory philosophy, the lab grading will reflect the quality of your lab work and not necessarily the quantity. For example, if you are faced with a technical problem during an experiment, and this problem prevents you from completing all of the day's activities, you will be graded only on the activities that you had time to complete. And if you worked diligently on the problem you faced, you would receive high marks in the category of lab work. The following point totals reflect the maximum points for each aspect of the laboratory activities. Throughout the semester, the report sheets may be corrected and resubmitted in order to obtain the maximum points for accuracy and presentation.

**Lab Work:** Present during the entire lab period and worked thoughtfully and diligently on the lab activities. [5 pts $day^{-1}$]

**Report Sheet:** Of the activities completed, calculations, plots, results, and conclusions are correct and accurate, and the report sheet is organized and readable, i.e. plots are of appropriate size, important calculations are highlighted, and conclusions are written in a precise and concise manner. [10 pts $day^{-1}$]

**Laboratory Schedule:**

| | |
|---|---|
| Week 1 1/23 – 1/29 | Introduction to MatLab |
| Week 2 1/30 – 2/5 | Lab 1: Introduction to Chromatography |
| Week 3 2/6 – 2/12 | Lab 2: HPLC |
| Week 4 2/13 - 2/19 | Lab 2: HPLC |
| Week 5 2/20 – 2/26 | Lab 3: Introduction to Electrophoresis |
| Week 6 2/27 – 3/5 | Lab 4: Spectroscopic Measurements-The Monochromator |
| Week 7 3/6 – 3/12 | Lab 4: Spectroscopic Measurements- The Monochromator |
| Week 8 3/13 – 3/18 | Lab 5: Spectroscopic Measurements- Absorption and Signal to Noise |
| Week 9 3/19 – 3/26 | Lab 6: Spectroscopic Measurements-Fluorescence |
| Spring Break | No Labs during week of 3/26 |
| Week 10 4/3 – 4/9 | Lab 7: Electronics |
| Week 11 4/10 – 4/16 | Lab 7: Electronics |
| Week 12 4/17- 4/23 | Lab 7: Electronics |
| Week 13 4/24– 5/1 | Lab 7: Electronics |

**Group Work:** The ability to work with others is an important skill and collaboration with other students, TAs, and instructors is encouraged in the instrumental laboratory. For the laboratory activities you will work with a partner and only submit a single report sheet. Both partners need to make significant contributions to the collection of data and the writing of the report sheet in order to receive full points.

**Academic Misconduct**: The small laboratory with close interactions with TAs and instructors should be enough to prevent any academic misconduct. However, you should be aware that any of the following actions will be considered academic misconduct and will result in disciplinary action according to UWS 14 (link below): creating false data, presenting other persons data as your own, cutting and pasting information from the web without citation, and intentionally damaging equipment or contaminating reagents and glassware.

UWS 14: http://students.wisc.edu/saja/misconduct/UWS14.html

**Laboratory Safety:** Potential safety risks are usually minimal in the instrumental laboratory, but chemicals and glassware are used routinely, and adequate eye protection and clothing should be worn. Safety glasses are required and are available in the laboratory. You must wear shoes that completely cover your feet; no sandals or other open toed shoes are allowed. In general you should wear clothing that protects your skin as much as possible. Shorts are not allowed in the laboratory. Gloves are not used for routine work in this laboratory. In some cases, additional personal protection may be required for special procedures, and the extra personal protective equipment will be provided for you. Examples might include gloves, fume hoods, goggles, lab coats, and face shields. You will occasionally work with high voltage power supplies and class III lasers. Make sure your TA reviews appropriate safety procedures before working with these items.