# Chemistry 329: Fundamentals of Analytical Science
## SYLLABUS

**Course Description**
Fundamentals of chemical measurement in chemistry, biology, engineering, geology, and the medical sciences. Topics include acid-base, complexation, and oxidation-reduction equilibria of complex systems, spectroscopy, electrochemistry, separations, statistics, and quantitative laboratory technique. For chemistry majors, chemical engineering majors, and related majors. Lecture, lab, and discussion.

**Course Credit:** CHEM 329 is a 4-credit class that meets each week for two 50-minute lectures, one 50-minute discussion, and two 4-hour laboratories. Over the course of the semester, students are expected to do at least 180 hours of learning activities, which includes class attendance, reading, studying, preparation, problem sets, laboratory reports, and other learning activities.

**Course Designations:** Intermediate level; physical science breadth; counts as L&S credit.

**Instructional Mode:** Face-to-face

**Requisites**
CHEM 104 or CHEM 109.

Lecture time: MW 8:50 – 9:40 AM
Lab time: MW 1:20 -5:25 PM
Disc time: F 8:50-9:40 AM

Lecture location: Chem B371
Lab location: MSC 5360 & 5385
Disc location: Chem B379, 2307 or Sterling Hall, 2029, 2319, 2333 (depending on your section assignment)

**Instructor:**
Professor John Wright
PM office: Chem 3209
e-mail: wright@chem.wisc.edu
Course webpage: https://learnuw.wisc.edu

Office hours: M 10:00 – 11:00
Tues 10-11 AM phone: 2-0351
or by appt. (Room 3209) (

**Teaching Assistants:**
*TA Office hours listed on the course Moodle page.*

| | | |
|---|---|---|
| Section 321/621 | Matthew Griffin | mjgriffin4@wisc.edu |
| Section 322/622 | Yasmin Alverez Garcia | yasmin.alverezgarcia@wisc.edu |
| Section 323/623 | Cody Schilling | cschilling2@wisc.edu |
| Section 324/624 | Christopher Roy | crroy@wisc.edu |
| Section 315/615 | Hongyuan Sheng | hsheng7@wisc.edu |

**Textbook:** Harris, Daniel C. *"Quantitative Chemical Analysis"* 9th Ed.

**Other Required Material:** Lab manual (available in the Mills Street lobby of Chemistry building), Bound laboratory notebook with carbon copy, safety goggles, a USB or flash drive, and a lab coat.

**Learning Objectives for Chem 329:**
Students will be able to

a) Apply the statistical methods for the evaluation of laboratory data
b) Use calibration and sampling methods important to quantitative analysis
c) Model chemical systems and experimental data using relevant quantitative, mathematical, and computational methods.
d) Learn analytical methods based on titrations, separations, electrochemical measurements, and spectroscopy and interpret the results for chemical analysis
e) Identify, formulate, and solve integrative problems using appropriate information and approaches.
f) Develop skills in working collaboratively with others, both chemists and those from other disciplines, to solve problems and create new knowledge.
g) Communicate chemical knowledge effectively through written reports, oral presentations, and visual aids.
h) Locate, evaluate, and use information in the chemical literature.

**Grades:**
The point distribution is as follows:

| | | | |
|---|---|---|---|
| Exams: | 2 exams | | 20% (alternatively 62%) |
| Homework: | 11 assignments | | 42% (alternatively 0%) |
| Laboratory: | | | total 38% |
| | 12 labs | 12 X 1.4% | |
| | 12 pre-lab quizzes | 12 X 0.5% | |
| | 1 project | 12% | |
| | lab exit survey | 0.5% | |
| | TA evaluation | 2.7% | |
| *Total:* | | | *100%* |

The intended grading scale is:

| | |
|---|---|
| A | 90-100% |
| A/B | 84-89.9% |
| B | 79-83.9% |
| B/C | 74-78.9% |
| C | 68-73.9% |
| D | 60-67.9% |
| F | <60% |

However, the scale may be shifted to reflect overall class performance. You will be updated changes to the scale twice during the semester.

**Exams:**
There will be three exams this semester. The exams are not cumulative; however, most of the material is inherently pedagogical. Therefore, in general you must have a firm understanding of previous material in order to fully comprehend new material. Conscientious attention to the homework is central to exam performance. If you have conflicts with the examinations, please arrange makeup exam sessions with your TA in advance.

Mid-Term Exam: March 25
Final Exam: May 6, 7:45-9:45

**Homework:**
This course focuses on developing your mental problem solving skills using challenging laboratory and homework problems. Working together is a powerful way to develop these skills because you can share thought patterns, ideas, and strategies. This course is designed to insure your mastery of course concepts by providing homework problems that will develop your thinking skills and a forum for analyzing your work and cementing concepts using grading sessions. The grading sessions are intended as a forum for discussion, arguments, alternatives, etc. You will be in-charge of arriving at an understanding of the problem sets. The format for homework and grading is defined below.

You may work on these assignments with other people, but the homework that you turn in must be your own work, not a copy of the group. You will upload your homework to the web site before the time it is due and you will bring a hard-copy of your homework to the grading session. One or more of you will present your answers to the rest of your section and the rest of your section will grade their own homework on the hard copy. You will turn in your homework at the end of the grading session. Your grading will be done on a scale of 0-3; 3 points for the correct answer and correct strategy, 2 points if you made a careless mistake, 1 point for a flaw in the strategy, and 0 points if you could not develop a strategy. Often, a homework question will have multiple parts and you will grade each part. The reason for having multiple parts to a question is for guiding your strategy to reach the final answer. If your final answer is wrong, you can only receive 2 points for each part of the question. This policy reflects the importance of the conscientious work demanded of a professional. Your teaching assistant and perhaps the professor will check your grading to insure you understand the grading policy. If you don't understand or ignore the intent, your grade will be determined only by the examinations.

**Laboratory:**
The laboratory grade is divided into three main categories: standard experiments, lab quizzes, and project. The schedule is posted on the course website. Our first lab will meet January 23 at 1:20 PM.

There will be 11 graded standard experiments, and your grade will be based on the accuracy and precision of your results. The class will presented some choices on experiments to perform in order to learn and practice techniques important to analytical chemistry and specifically important to the project for the course. The results from these experiments are to be turned in no later than the start of the laboratory period one week after you have completed the experiment. You will lose 4 pts/day if the result is turned in late.

The primary goal of the pre-lab quizzes is to prompt you to prepare for the labs beforehand and to test your knowledge and understanding of the concepts behind the standard experiments. Overall, being "prepared" for a lab means you are familiar with the: overall concepts and goals of the experiment, methods used in the experiment to accomplish the goals, procedure (enough so that you understand the impact of each step on the chemistry and the calculations, e.g. dilutions, stoichiometry, etc), and calculations (enough so that you understand how to perform the calculation required for the experiment given a set of raw data). You can have two attempts at each quiz, the higher grade will be the final grade. It is advised that you make your first attempt for each quiz at least 1 day before the lab so that you have time to ask questions before your second attempt, in case you encounter any difficulties. The quiz for each lab becomes unavailable when that lab starts.

The lab project could be the most challenging and also most rewarding part of this course. We will discuss the project in more details as we go into the semester.

**Course Outline:**
The tentative course schedule appears at the end of this document. It is also available on our web site. Lecture notes and the PowerPoint presentationsare also provided on the web site. This schedule may change depending on the progress of the lectures. The text book is meant to supplement what you learn in lecture. The textbook chapters that correspond to each part of the course are defined in the course schedule. Although we will not explicitly cover chapters 0, 2, and 2, they provide detailed information on analytical laboratory practices that may help you in the laboratory portion of the course.

## 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-integrit

## 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."

## 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/

| Date | Lecture Topic | Chapter |
|---|---|---|
| **1/23/19** | Spectroscopy | 17 |
| **1/28/19** | Absorption Spectroscopy and equilibria | 6 |
| **1/30/19** | Error Analysis | |
| **2/4/19** | Statistics | |
| **2/6/19** | Student t test | |
| **2/11/19** | Introduction to Acid-Base Chemistry | |
| **2/13/19** | Monoprotic Acid-Bases | 8 |
| **2/18/19** | Buffers | 8 |
| **2/20/19** | Polyprotic Acid-Bases | 9 |
| **2/25/19** | Ampholytes and Zwitterions | 9 |
| **2/27/19** | Complex Polyprotic Equilibria and Titrations | 10 |
| **3/4/19** | Proteins, Electrophoresis- Complexation Equilibria | 25.6, 11 |
| **3/6/19** | Complexation and Chelation | 11 |
| **3/11/19** | Complex Solubility Equilibria | 11 |
| **3/13/19** | pH and Complexation Control of Chelation Equilibria | 11 |
| **3/18/19** | Spring Break | |
| **3/20/19** | Spring Break | |
| **3/25/19** | **Mid-Tem Examination** | |
| **3/27/19** | Metal Ion Indicators and Ca Fluorescence Probes | 12 |
| **4/1/19** | Chelation Titrations and Buffers | 12 |
| **4/3/19** | Introduction to Oxidation Reduction Equilibria | 13 |
| **4/8/19** | Relationship between Potential and Concentration | 13 |
| **4/10/19** | Relationship between Capacity and Concentration | 13 |
| **4/15/19** | Redox Equilibria and Titrations | 15 |
| **4/17/19** | Batteries and Fuel Cells | |
| **4/22/19** | Potentiometry | 14 |
| **4/24/19** | Amperometry | 16 |
| **4/29/19** | Mass Spectroscopy | 21 |
| **5/1/19** | Chromatography | 22 |
| **5/6/19** | **FINAL EXAM- 7:45 AM** | |