

Chemistry 61. Instrumental Analysis

INSTRUCTOR: Prof. Keith T. Kuwata, Olin-Rice 318, 696-6768, kuwata@macalester.edu
Web page: www.macalester.edu/~kuwata (for class handouts and answer keys)

REQUIRED TEXT: Douglas A. Skoog, F. James Holler, and Timothy A. Nieman, *Principles of Instrumental Analysis*, 5th ed., Saunders, 1998. In addition, I will hand out copies of selections from *A Guide to Lasers in Chemistry* (referred to as “Lasers” in the course schedule), Gerald R. Van Hecke and Kerry K. Karukstis, Jones and Bartlett, 1998.

DESCRIPTION: This course explores the principles of using instrumentation to make measurements of chemical species. The first unit of the course focuses on the electronics used in all instrumental methods, and quantifies the noise associated with these electronics. The second unit examines in detail the components of optical and X-ray spectrometers (including lasers), and explores time-domain (Fourier transform) approaches to chemical measurement. The third unit will cover other common instrumental methods; possible topics include mass spectrometry and electrochemistry.

Instrumental analysis is distinct from both physical chemistry (Chemistry 55 and 56) and quantitative chemical analysis (Chemistry 23), the prerequisites for this course. With respect to the former, we will focus on the physics and physical chemistry of instrumentation and measurement, rather than on the physico-chemical properties of analytes *per se*. With respect to the latter, our interest is not in the numerical results of chemical analyses, but rather how we obtain these numbers and evaluate their reliability.

LECTURES: MWF from 8:30 -9:30 a.m. in Olin-Rice 370.

LABS: Thursdays from 8:30-11:40 a.m. in Olin-Rice 364. You will work in pairs (or groups of three, if necessary). For the first unit, we will go through a workbook on electronics. For the second unit, we will construct and test a diode array spectrometer. (More details to come.)

PROBLEM SETS: Assignments will be handed out a week before they are due (see course schedule for the due dates). Work with me and each other on them!

OFFICE HOURS: I will be available M 12:00 noon-1:00 p.m., T 9:00-10:00 a.m., W 1:00-2:00 p.m., and Th 5:00-6:00 p.m. If you can't make one of these office hours, please make an appointment with me, or just come by—I'll usually be somewhere in Olin-Rice.

TESTS: There will be three exams administered during the Thursday morning lab periods of **October 3**, **November 7**, and **December 5**. (Note that some Unit 2 material will be on the first test.) There will be no final exam. Instead you get to write a...

PAPER: Each of you will have the opportunity (and obligation!) to choose a topic in analytical chemistry that interests you, explore the literature (both journals and books), give an oral presentation (20 to 25 minutes) on what you have learned, and write a paper of 1500 to 2000 words due by **December 16**. You may focus either on a specific instrumental technique we have not discussed in class, or an analytical problem to be solved. (Much of analytical research today address biological or environmental concerns.) To help you make progress on this project, you will turn in a paper proposal (including a preliminary bibliography) on or before **November 18**. Please talk with me before you commit yourself to a particular

topic. Note that if more than one person happens to be interested in the same topic, the first one to turn in his/her proposal gets exclusive claim to that topic!

GRADING: Homework: 10% Three Tests: 50% Lab Work: 20% Paper: 20%

Final grades will be based on your cumulative score; the median grade for Chemistry 61 is typically B+.

COURSE SCHEDULE (timing of lecture topics may vary)

Date	Day	Due	Lecture Topics/Other Activity	Reading (in Skoog unless noted)
9/4	W		Overview, Statistics, Electronics basics	1-3, 11-14, 22-26
9/5	Th		<i>NO LAB</i>	
9/6	F		DC circuits	26-28
9/9	M		AC circuits	28-38
9/11	W		Non-linear devices	38-44
9/12	Th		<i>Lab: Electronics</i>	
9/13	F	PS 1	Operational amplifiers: fundamentals	Chapter 3
9/16	M		Operational amplifiers: applications	Chapter 3
9/18	W		Operational amplifiers: applications	Chapter 3
9/19	Th		<i>Lab: Electronics</i>	
9/20	F	PS 2	Signals and noise	Chapter 5
9/23	M		Noise and Beer's law	300-310
9/25	W		Optical sources	143-147, 196-199, 313-314, 389-390
9/26	Th		<i>Lab: Electronics</i>	
9/27	F	PS 3	Wavelength selectors	116-128, 154-166, 311-312
9/30	M		Wavelength selectors	116-128, 154-166, 311-312
10/2	W	PS 4	Lasers: Quantum fundamentals	147-150, Lasers Chapter 2
10/3	Th		TEST 1: Classes thru 9/30; PS 1, 2, 3, 4	
10/4	F		Lasers: Optical fundamentals	Lasers Chapter 2
10/7	M		Laser distinctives	Lasers Chapter 1
10/9	W		Tunable lasers	Lasers 48-50, 65-67
10/10	Th		<i>Lab: Diode Array Spectrometer</i>	
10/11	F		Detectors	128-130, 167-178
10/14	M	PS 5	Detectors	128-130, 167-178
10/16	W		UV/Vis/IR instruments: overview	314-325, 397-399
10/17	Th		<i>Lab: Diode Array Spectrometer</i>	
10/18	F		Time domain spectroscopy	57-58, 473-474
10/21	M		Fourier transform methods	120-121, 182-189, 392-396
10/23	W		Fourier transform methods	120-121, 182-189, 392-396
10/24	Th		Fall Break—no class	
10/25	F		Fall Break—no class	
10/28	M	PS 6	X-rays: Physical fundamentals	272-275
10/30	W		Atomic X-ray spectroscopy	276-289
10/31	Th		<i>Lab: Diode Array Spectrometer</i>	
11/1	F		Atomic X-ray spectroscopy	276-289
11/4	M		Atomic X-ray spectroscopy	276-289
11/6	W	PS 7	Tour Keck Lab (Jeff Thole)	276-289
11/7	Th		TEST 2: Classes thru 11/6; PS 5, 6, 7	

COURSE SCHEDULE (timing of lecture topics may vary)

Date	Day	Due	Lecture Topics/Other Activity	Reading (in Skoog unless noted)
11/9	F		Topics to be announced	
11/11	M	LAB	Topics to be announced	
11/13	W		Topics to be announced	
11/14	Th		Topics to be announced	
11/15	F		Topics to be announced	
11/18	M	Prop	Topics to be announced	
11/20	W		Topics to be announced	
11/21	Th		Topics to be announced	
11/22	F		Topics to be announced	
11/25	M		Topics to be announced	
11/27	W		Topics to be announced	
11/28	Th		Thanksgiving Holiday—no class	
11/29	F		Thanksgiving Holiday—no class	
12/2	M		Topics to be announced	
12/4	W		Topics to be announced	
12/5	Th		TEST 3: Scope to be announced	
12/6	F		Oral reports in class	
12/9	M		Oral reports in class	
12/11	W		Oral reports in class	
12/12	Th		<i>NO LAB</i>	
12/13	F		Oral report in class; course evaluations	

Your final paper is due Monday, December 16