Chemistry 434
Fall 2016
Advanced Analytical Chemistry - Instrumental Methods of Analysis

Course Organization, Lecture Syllabus and Other Important Information

Lectures: Monday, Wednesday, Friday 1:50 to 2:40 pm,

Location: 136 CEM

Recitation: Friday, 9:10-10:00 AM, 183 CEM
Friday, 3:00-3:50 PM, 136 CEM

Course Website: **http://www2.chemistry.msu.edu/courses/cem434/**

Required Text: D.A. Skoog, F.J. Holler and S.R. Crouch, Principles of Instrumental Analysis, 6th Edition, Thomson Brooks/Cole Publishers, 2007.

Instructor: Professor Greg M. Swain
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Instructor Office Hours: Wednesday, 1:00 to 2:00 pm, 314 Chemistry, or by appointment.

TA: Stephen Baumler
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TA Office Hour: TBA

Course Description

This in-depth course covers the design, operational principles and practical application of modern instrumental methods used in chemical analysis. Instrumental methods are commonly used for the separation, identification and quantification of the chemical components of natural and artificial materials. Using a combination of problem-based learning approaches, case studies and traditional lectures, the student will develop critical thinking skills in the areas of instrument design and selection, method development, and data analysis/interpretation.

Course Objectives

1. Understand the basic design and operating principles of some modern instruments used in chemical analysis, specifically separations, optical spectroscopy, electroanalytical

methods, material characterization and surface analysis techniques, and analytical mass spectrometry.

2. Understand the basics of experimental design and the use of statistical analysis to evaluate measurement data.
3. Understand how to design experiments using these instruments to solve problems in chemical analysis.
4. Learn how to use databases to search for scientific literature and how to read a scientific paper.
5. Improvement of written communication skills through the preparation of a literature-based research paper on a current topic in analytical chemistry.
6. Improvement of oral communication skills through delivering an oral presentation, as part of a team, on an assigned case study.

Course Organization

Section A: Foundations (Analytical Chemist's Toolbox)
Chapter 1 – Method selection, detection figures of merit and response calibration
Chapter 5 – Instrumental electronics and signal processing
Experimental design and sample preparation (lecture notes only)
Statistical data analysis (lecture notes only)

Section B: Separations
Chapter 26 – Theory of separations
Chapter 27 – Gas chromatography (environmental analysis)
Chapter 29 – Normal- and Reversed-phase liquid chromatography (bioanalysis)
Chapter 30 – Capillary electrophoresis (single cell analysis)

Section C: Spectroscopy
Chapter 8 – Atomic absorption spectroscopy
Chapter 9 – Atomic emission spectroscopy – ICP (water quality analysis)
Chapter 13,14 – Molecular UV/Vis spectroscopy
Chapter 15 – Molecular luminescence spectroscopy (bioanalysis)
Chapter 16, 17 – Infrared spectroscopy (tissue imaging)
Chapter 18 – Raman spectroscopy (polymer characterization)

Section D: Electroanalytical Chemistry
Chapter 23 – Potentiometry and probes (biomedical analysis)
Chapter 25 – Analytical voltammetry (chemical sensing)

Section E: Additional Topics
Chapter 21 - Material and surface analysis techniques (polymers and nanoscale materials)
Chapter 20 – Advanced topics in MS: understanding the experiment (biomolecules)
Chapter 19 – Advanced topics in NMR: understanding the experiment (biomolecules)

Exam Schedule

October 5th (Exam 1 – in class)
October 31st (Exam 2 – in class)

November 30th (Exam 3 – in class)
December 12th (Final Exam – 12:45-2:45 PM, Room 136)

Grading

There are a total of 800 points available for this course:

Ten weekly quizzes **Given during Recitation**	(10 pts. each, 100 points total)
Three 1-h exams worth 100 points each	(300 points total)
Final Exam **Comprehensive**	(200 points total)
Term Paper	(100 points total)
Oral presentation – Case Study	(100 points total)

Grading Scale

The scale indicated below is based on the number of total points accrued being converted to a percentage of the total points available. These grade cut-offs are based on historical experience with this course and they may be relaxed by a small amount, at the instructor's discretion, based on the class exam results. In no event shall the grade levels be made more stringent than indicated below.

Raw score (1000 max)	Percentile score	Course grade
720 – 800	90.0 – 100%	4.0
680 – 719	85.0 – 89.9%	3.5
640 – 679	80.0 – 84.9%	3.0
600 – 639	75.0 – 79.9%	2.5
560 – 599	70.0 – 74.9%	2.0
520 – 559	65.0 – 69.9%	1.5
480 – 519	60.0 – 64.9%	1.0
< 480	< 60%	0

Homework

Problems will be assigned but **not** collected for any credit or grade. Answer keys will be posted on the course website. The Friday recitation section will be a place to ask any questions you have about the homework for that week. The Recitation period will be used to work selected problems from time to time. Questions can also be addressed to the Instructor after class, during the scheduled office hour or a scheduled meeting.

Lecture Schedule

Lecture notes will be posted on the course website.

It is expected that the Required Reading for each week will be completed *prior* to the start of that week's class. *All exams will cover material in the text, some of which may not be extensively discussed in the lectures, case study material, assigned problems and lecture notes!!*

Week	Lecture Topic	Chapter	Problems	Case Study (Friday class)
Aug. 31 and Sept. 2	Method selection, detection figures of merit and calibration	1	C1 – 1,7,8,9,10	None
Sept. 7 and 9	Instrumental electronics and signal processing/Experimental design	5	C5 – 1,2,4-10	None
Sept. 12-16	Sample preparation/Statistical analysis of data	Appendix 1	None	Group 1
Sept. 19-23	Theory of separations/Gas phase chromatography	26 and 27	C26 – 2,5,6,7,10 C27 – 1,3,6,13,15,20	Group 2
Sept. 26-30	Normal- and Reversed-phase liquid chromatography	28	C28 – 2,5,13,20,22	Group 3
Oct. 3-7	Capillary electrophoresis **EXAM 1…Oct. 5th**	30	C30 – 1,2,5,6,7,9	None
Oct. 10-14	Atomic absorption/Atomic emission spectroscopy - ICP	9 and 10	C9 – 2,3,5,6,8 C10 – 2,5,6	Group 5
Oct. 17-21	Molecular UV/Vis/Molecular fluorescence spectroscopy	13, 14 and 15	C13 – 1,5,8,9, 15 C14 – 1,2,8 C15 – 1,3,7	Group 5
Oct. 24-28	Infrared spectroscopy/Raman spectroscopy	16, 17 and 18	C16 – 1,2,4,7,8	Group 6
Oct. 31- Nov. 4	**Exam II…Oct. 31st** Potentiometry and probes	22 and 23	C22 – 2,3,8,9 C23- 2,4,7,13,14	None
Nov. 7-11	Potentiometry and probes/Analytical voltammetry	25	C25 – 5,9,10	Group 7
Nov. 14-18	Analytical voltammetry/Materials characterization	12		Group 8
Nov. 21 and 23	Material characterization		C21 – 1-5	None
Nov. 28-Dec. 2	**Exam III…Nov. 30th** Advanced topics: analytical mass spectrometry			Group 9
Dec. 5-9	Advanced topics: NMR and Final Review		C19 – 3-7, 21,27	Group 10
Dec. 12 (Mon.)	**Final Exam 12:45-2:45 pm**			

Research Paper

Your first task will be to select a topic of interest to write about. You can get ideas from the literature, for example, a feature or review article in the journal, *Analytical Chemistry*, or a related analytical measurement journal. One you have identified a current topic in analytical measurement science, you will need to search the literature for articles on that topic to use to develop your paper. DO NOT SEARCH GOOGLE!! Search the scientific literature databases (Scifinder, Scopus, Web of Science and or Pubmed) through MSU Libraries for important articles on your topic. The main article for the paper should be one published within the past three years. However, there may be background literature on the topic that dates back more than the three years. Use of this material is fine.

After gathering and reading the appropriate literature, you will need to do some critical thinking and write your thesis statement down in one sentence. Your thesis statement is like a declaration of your belief. What is the purpose for the report? The main portion of your report will consist of arguments to support and defend this belief or position.

You will then prepare an outline for the paper and have this reviewed by me before **Oct. 3rd.** The purpose of an outline is to help you think through your topic carefully and organize it logically before you start writing. A good outline is the most important step in writing a good paper. The outline should include: (i) Introduction – brief comment leading into the subject matter, (ii) Body of the paper – (a) experimental approach and instrument design, (b) experiments performed, (c) data analysis, and (iii) Conclusions – summary of key points from the main paper.

You will then write a 10-page literature-based research paper (Times Roman, 11 point, 1.5 line spacing) on the topic. The paper should utilize at least five references. The term paper should have the following sections: Motivations for the Instrumental Method (what is it good for, what types of analyses are possible, and how does having the method benefit science?), Basics of the Instrument Design and Theory of Operation, Example Data and Interpretation, and Conclusions and Future Prospects. All figures are to be scanned and embedded into the text. All text used in your paper and written by another author should be appropriately cited. All papers are due on or before **October 28th**.

Oral Presentation (Case Study)

You will be assigned to a team of students (group of 3) and the group will prepare and present a lecture on a case study you will be assigned. The case study will focus on one paper but you will have to search the literature for associated and background articles needed to understand the work presented in the main paper. Go to MSU Libraries and search the scientific literature databases (Scopus, Scifinder, Web of Science and or Pubmed)

In this Case Study, you will discuss the purpose for the work, the design of the instrumental method used and its operational principles, the data presented and the conclusions reached. See the syllabus for your presentation date.

Religious Observances/ Other Absences from Class

It is the responsibility of students who plan to be absent from class at certain times throughout the semester, due to religious holidays or other reasons, to make arrangements ***in advance*** with

the instructor. Course notes or handouts may be obtained from the instructor if these conditions are met. If a make-up exam is required, the instructor retains the right to determine the content of the exam and the conditions of administration, giving due consideration to equitable treatment.

Academic Honesty

Academic dishonesty at Michigan State University is defined by the General Student Regulations as conduct that violates the fundamental principles of truth, honesty, and integrity. The following conduct is specifically cited:

- Supplying or using work or answers that are not one's own.
- Providing or accepting assistance with completing assignments or examinations.
- Interfering through any means with another's academic work.
- Faking data or results.

You are expected to complete all course assignments, including homework, quizzes, tests and exams, without assistance from any source. You may work together with your classmates on course material but submit your own work. You are expected to develop original work for this course; therefore, you may not submit course work you completed for another course to satisfy the requirements for this course. Also, you are not authorized to use the www.allmsu.com or similar websites to complete any course work in this course.

Students who violate these rules WILL be assigned a failing grade for the course.

Social Media Policy

As members of a learning community, students are expected to respect the intellectual property of course instructors. All course materials presented to students are the copyrighted property of the course instructor and are subject to the following conditions of use:

1. Students may not record lectures or any other classroom activities and use the recordings only for their own course-related purposes without permission from the instructor.

2. If granted permission, students may share the recordings with other students enrolled in the class. Sharing is limited to using the recordings only for their own course-related purposes.

3. Students may not post the recordings or other course materials online or distribute them to anyone not enrolled in the class without the advance written permission of the course instructor and, if applicable, any students whose voice or image is included in the recordings.

4. Any student violating the conditions described above may face academic disciplinary sanctions.

Special Requests

https://www.rcpd.msu.edu/

Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at the link shown above. Once your eligibility for an accommodation has been determined, you will be issued a verified individual services accommodation ("VISA") form. Please present this form to me at the start of the term and/or two weeks prior to the accommodation date (first test date). Requests received after this date will be honored whenever possible.