Neuroscience 417
Chemistry 417
Spring 2017
Instrumental Methods of Analysis in Neurosciene

Course Organization, Lecture Syllabus and Other Important Information

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

Location: 323 CEM

Course Website: **Course materials will be available through D2L.**

Required Text: *Instrumental Analysis*, Robert M. Granger II, Hank M. Yochum, Jill N. Granger and Karl D. Sienerth, Oxford University Press, 2017, 1st ed. ISBN: 978-0-19-994231-2

Instructor: Professor Greg M. Swain
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Instructor Office Hours: Thursday, 2:00 to 3:00 pm, 314 Chemistry, or by appointment.

Course Description

Neurochemistry is the specific study of chemicals, including neurotransmitters and other molecules, that influence the function of neurons. Instrumental methods of chemical analysis have become the principal means of obtaining qualitative and quantitative information about analytes in diverse areas of science and technology. The speed, high sensitivity, low limits of detection, simultaneous detection capabilities, and automated operation of modern instruments have created new opportunities in neuroanalysis.

The course will review the design and principles of operation of several instrumental methods of analysis used in neuroscience. High performing analytical tools allow discovery and verification of basic neurosignaling processes, neurosignaling abnormalities, biomarkers of neurological diseases and local neuropharmacology. The course will be taught through examples of how these techniques are used to address key measurement challenges in neuroscience. In addition to traditional lectures, case studies, an oral presentation, and a researched term paper will be part of the course.

The topics to be covered include:

- Detection figures of merit and analytical response curves
- Signals and noise, and basic measurement statistics
- *In vitro* and *in vivo* electrochemistry and biosensors

- High performance liquid chromatography
- Capillary electrophoresis
- Microdialysis sampling
- UV/Vis and fluorescence spectroscopy
- Biological and imaging mass spectrometry

Course Objectives

1. Understand the basic design and operating principles of modern instrumental methods of analysis used in neuroscience, specifically electrochemistry, separations, optical spectroscopy and 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 neurochemical analysis.
4. Learn how to use databases to search for scientific literature and how to critically evaluate scientific papers.
5. Improvement of written communication skills through the preparation of (i) short critical reviews of the case study papers and (ii) a literature-based research paper on a current topic in neuroanalytical chemistry.
6. Improvement of oral communication skills through delivering a presentation on an assigned case study.

Exam Schedule

February 6th (Exam 1 – in class)
March 3rd (Exam 2 – in class)
April 10th (Exam 3 – in class)
May 1st (Final Exam – 3:00-5:00 PM, Room 323)

Grading

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

Weekly Quizzes worth 10 points 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 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 (800 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 from time to time but **not** collected for any credit or grade. Answer keys will be posted on the course website. Each student will prepare a 1-2 page critical review of the case study papers due the day the case study is presented. These reviews will be evaluated for writing style and quality but not used for any credit towards a grade.

Weekly Quizzes

There will be a short weekly quiz administered each week, usually Monday, on the prior week's lecture notes and course material. There will be 10 quizzes for a total of 100 points.

Lecture Schedule

Lecture notes will generally be provided ahead of 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)
Jan. 9-13	Course Overview, Analytical Detection Figures of Merit and Calibration Methods	None		
Jan. 16-20	Signals and Noise, Basic Measurement Statistics	5 (pp. 132-157) 22 (pp. 779-800)	1,2,3,5,9 Example Problems	
Jan. 23-27	Introduction to Analytical Electrochemistry and Biosensors	18 (pp. 633-660) 19 (pp. 663-700)	1,2,5,8 1,2,3,4,7,8	
Jan. 30 - Feb. 3	Single Cell and *In Vivo* Electrochemistry (Neurotransmitter detection)		Review	Case Study 1
Feb. 6-10	**Exam 1 (2/6)** Introduction to Chromatography	15 (pp. 501-544)	2,6,8,9	

Feb. 20-24	Analysis of Neurotransmitters by Liquid Chromatography		Review	Case Study 2
Feb. 27 – Mar. 3	Introduction to Capillary Electrophoresis **Exam 2 (3/3)**	17 (pp. 591-628)	3,4,13,16	
Mar. 6-10	SPRING BREAK (NO CLASS)			
Mar. 13-17	Analysis of Single Cells by Capillary Electrophoresis		Review	Case Study 3
Mar. 20-24	Molecular Absorption and Fluorescence Spectroscopy	6 (pp. 161-198) 7 (pp. 244-270)	1,3,5,6,7,17	
Mar. 27-31	NO CLASS – Work on paper			
April 3-7	Microdialysis for *In Vivo* Neurotransmitter Detection		Review	Case Study 4
April 10-14	**Exam 3 (4/10)** Introduction to Mass Spectrometry	13 (pp. 424-459)	1,2,8,9,14	
April 17-21	Mass Spectrometry Imaging of Neurons and *In Vitro* Neurotransmitter Detection			
April 24-28	Course Review		Review	Case Study 5
May 1st	**FINAL EXAM 3:00-5:00 pm**			

Research Paper

You will be assigned a topic to conduct a literature review on. The review will cover the most recent three years (2013-present). A literature review is an account of what has been published on a topic mainly in peer-reviewed scientific journals. In writing the literature review, your purpose is to convey to your reader what knowledge and ideas have been established on a topic, and what their strengths and weaknesses are. As a piece of writing, the literature review must be defined by a guiding concept (*e.g.*, your research objective, the problem or issue you are discussing, or your argumentative thesis). It is **not** just a descriptive list of the material available, or a set of summaries.

Besides increasing your knowledge about the topic, writing a literature review lets you gain and demonstrate skills in two areas:

1. **information seeking**: the ability to scan the literature efficiently, using manual or computerized methods, to identify a set of useful articles (and books).
2. **critical appraisal**: the ability to apply principles of analysis to identify unbiased and valid studies.

Your literature review must do these things:

1. be organized around and related directly to the thesis or research question you are developing
2. synthesize results into a summary of what is and is not known
3. identify areas of controversy in the literature

4. formulate questions that need further research

Ask yourself if you have **critically analyzed** the literature selected when preparing the review. Do I follow through a set of concepts and questions, comparing items to each other in the ways they deal with them? Instead of just listing and summarizing items, do I assess them, discussing strengths and weaknesses?

Your first task will be to perform a literature search on an assigned topic. You will prepare a 1-2 page review (annotated bibliography) of the key literature articles on your assigned topic over the past three years with a brief description of what the article was about and the key findings. Search engines such PubMed, Web of Science and or SciFinder Scholar will be very useful. DO NOT SEARCH GOOGLE!!

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 paper? The main portion of your report will consist of arguments to support and defend this belief or position.

The outline is due on or before March **1st.**

You will then write a 10-page literature review paper (Times Roman, 11 point, 1.5 line spacing) on the topic. A literature review is a piece of **discursive prose**, not a list describing or summarizing one piece of literature after another. It's usually a bad sign to see every paragraph beginning with the name of a researcher. Instead, organize the literature review into sections that present themes or identify trends, including relevant theory. **You are not trying to list all the material published, but to synthesize and evaluate it according to the guiding concept of your thesis or research question.**

The term paper should have the following sections: Statement of the Problem, Motivations and Background, Measurement Approach 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 **April 3rd**.

Oral Presentation (Case Study)

You will be assigned to a partner (group of 2) and your team will prepare and present a lecture on an assigned case study. 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.