Electrochemical Methods: Fundamentals and Applications (Credit: 3)

Academic Semester: 2026 Spring

Lectures: Mon 09:00-09:50 am; Wed 10:10 am-noon/week at R326

Lecturer	Wang, Yu-Heng (王育恒)
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Office Location	R401
Office Hour	By appointment

A. Course Description

This course is designed to provide an introductory yet thorough foundation in electrochemistry. Fundamentals, methods, and applications of electrochemistry will be covered, providing a foundation for independent research.

Lecture. Lectures organize the material, outline goals, and cover the basic principles of each topic. The lecture is not intended to describe or explain everything you will learn in the course; rather, it will indicate important topics to study and allow you to think about these topics and see if you understand them. Take notes during the lecture that accurately reflect your understanding of the material. Students are expected to read the textbook and work on the assigned problems as needed to supplement the material presented in class.

Final Exam. There will be an open-book, take-home final exam scheduled as in this syllabus. If you have any conflicts, please notify me promptly. The final exam will focus on material covered in the entire course, but you may have to use concepts from past courses (i.e., organic and inorganic courses at the undergraduate level), but no direct questions.

Problem Sets. Problem sets will be distributed on Friday and are due on the specified date (see syllabus). You may collaborate with your classmates on problem sets. Study groups reflect the teamwork inherent in the way modern science is done. It is important to realize that although you may collaborate with other classmates on assignments, the work you turn in must be your own. Thus, you must turn in an individual write-up (not a copy of the study group's work) of homework. You will also create your own problem set (problem set 2) with different topics and provide the solutions. The last problem sets will be assigned based on the collection of students' problem sets.

Presentation: You will work individually to study an electrochemical topic of your choice (e.g., cyclic voltammetry, differential pulse voltammetry), prepare PowerPoint slides, and present them in class. Each student will have 20 minutes to present their study to the class, and the presentation should be prepared in Microsoft PowerPoint format. Presentations and discussions will take place in week 13. Everyone must participate in these discussions. More details will be given to you as the semester proceeds.

Minireview. The ACS Style Guide: A Manual for Authors and Editors, 2nd edition, states that "Reviews integrate, correlate, and evaluate results from published literature on a particular

subject. … Effective review articles have a well-defined theme, are usually critical, and present novel theoretical interpretations. … An important function of reviews is to serve as a guide to the original literature; for this reason, accuracy and completeness of references cited are essential." The minireview paper for this course should cover an electrochemistry topic, which can be based on your expertise or your area of interest. The length of the paper is less important than the content. A lengthy, rambling review will be graded more severely than a short, concise one that covers all the bases. A template of this assignment and more details will be given to you as the semester proceeds.

B. Goals, Objectives, and Core Learning Outcomes

The course is designed as an introductory graduate-level course on electrochemistry and electrochemical methods. This course will blend the theory of electrochemistry with electrochemical characterization methods and applications of electrochemistry in research.

1. The basic theory of potentiometric and dynamic voltammetric measurement (30%).
2. The electrical double-layer structure and the theoretical description of the kinetics of chemical and electrochemical processes occurring at the electrode surface (30%).
3. Applications of electrochemical methods in independent research (40%).

Keywords: Butler-Volmer Equation (巴特勒-福爾默方程), Tafel Plots (塔菲爾圖), Cyclic Voltammetry (循環伏安法), Bulk Electrolysis (整批電解法), Hydrodynamic Voltammetry (流體動力學伏安法)

C. Required Knowledge

Basic knowledge of analytical chemistry, organic chemistry, and inorganic chemistry at the undergraduate level.

D. Required Materials

Calculator: An inexpensive calculator with logarithmic/exponential/scientific notation capabilities is required. The calculator will be permitted for use on quizzes and exams.

Class Handouts: You should obtain an electronic copy of each handout before the lecture.

E. Recommended Textbooks

1. *Zoski, C. Handbook of Electrochemistry (1st edition)*; Elsevier: Oxford, 2006 [Electronic Resource].
2. Compton, R. G. *Understanding voltammetry (2nd edition)*; World Scientific: Singapore, 2009 [Reserved in the Chem Library].
3. Scholz, F. Electroanalytical methods: guide to experiments and applications; Springer-Verlag: Berlin, 2010 [Electronic Resource].
4. Bard A. J.; Faulkner, L. R. *Electrochemical Methods (2nd edition)*; Wiley: New York, NY, 2009.
5. Pletcher, D. *A First Course in Electrode Processes (2nd edition)*; RSC: Cambridge, 2009.

F. Method of Evaluation

Assignment	*Each Point*	*Total Points*
Problem Set 1	1 × 100	100
Problem Set 2	1 × 100	100
Minireview Draft: 150 Review: 150 Final & Response: 200	1 × 500	500
Presentation	1 × 200	200
Final Exam	1 × 200	200
		Total Points: 1100

Letter grades will be assigned at the end of the semester based on the following scale:

Total Points	*Letter Grade (GPA)*
≥900	A+
850–899	A
800–849	A–
770–799	B+
730–769	B
700–729	B–
670–699	C+
630–669	C
550–629	C–
500–549	D
< 500	E

*Final grades will be based on an absolute scale. For example, if you earn a total of 950 points, you are guaranteed an A+, no matter how many other students earn that number of points. You are competing against this scale, not against other students, and it is to your benefit to help each other.

Tentative Course Outline

Week	*Date*	*Topic*	*Note*
1	2/22–2/28	Electron-Transfer Reactions and Electrode Processes (Section I, Lecture 1)	Minireview Rule
2	3/1–3/7	Electrochemical Potentials and Mass Transport (Section I, Lecture 2)	
3	3/8–3/14	The Interfacial Region: Electrode Kinetics and Double Layer (Section I, Lecture 3)	
4	3/15–3/21	The Interfacial Region: Butler-Volmer Equation and Tafel Plots (Section I, Lecture 4)	
5	3/22–3/28	Potential Scan Voltammetry: Linear Sweep Voltammetry and Cyclic Voltammetry (Section II, Lecture 5)	
6	3/29–4/4		Problem Set 1 (due by 3/30)
7	4/5–4/11	Bulk Electrolysis: Controlled-current Electrolysis and Controlled-potential Electrolysis (Section II, Lecture 6)	
8	4/12–4/18		Minireview Draft (due by 4/18)
9	4/19–4/25	Hydrodynamic Voltammetry: Rotating (Ring) Disk Voltammetry (Section II, Lecture 7)	Peer Review Rule Oral Presentation Rule
10	4/26–5/2		
11	5/3–5/9	Voltammetric Techniques for Studying Reaction Mechanisms I & II (Section III, Lectures 8 and 9)	Peer Review (due by 5/9)
12	5/10–5/16		How to Respond to Reviewers
13	5/17–5/23	Oral Presentation	Problem Set 2 (due by 5/23)
14	5/24–5/30	No Lecture	
15	5/31–6/6	No Lecture	
16	6/7–6/13	Final Exam (6/8, 9 am to 6/10, noon)	Final Minireview (due by 6/13)