

# Chemistry 459/549 – Fall 2022

## Electroanalytical Chemistry

### COURSE INFORMATION

Course Website: via Canvas at <https://canvas.rutgers.edu>

Course Instructor: Dr. Kate M. Waldie, [kate.waldie@rutgers.edu](mailto:kate.waldie@rutgers.edu)

Office: CCB 3220

Office hours: By Appointment, via Zoom or in-person

Lectures: Monday & Thursday 12:10 – 1:30pm, CCB 1203

#### Required Resources:

1. Pine and BASi Potentiostat Operation Manuals, available via Canvas
2. REHS Lab Safety / Biosafety / BBP Course
3. Lab specific training

#### Optional Resources:

1. Electrochemical Methods: Fundamentals and Applications, 2<sup>nd</sup> Edition  
Allen J. Bard, Larry R. Faulkner     **HIGHLY RECOMMENDED!**
2. Electrochemistry, 2<sup>nd</sup> Edition  
Carl H. Hamann, Andrew Hamnett, Wolf Vielstich
3. Laboratory Techniques in Electroanalytical Chemistry, 2<sup>nd</sup> Edition  
Peter T. Kissinger, William R. Heineman
4. Analytical Electrochemistry, 3<sup>rd</sup> Edition  
Joseph Wang
5. Pine and BASi Potentiostat Software (PC only), available via Canvas

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### COURSE SYNOPSIS

This one-semester course serves as an introduction to the principles of electrochemistry and their application to the analytical study of redox systems. Topics will include coulometry, potentiometry, chronoamperometry, voltammetry, hydrodynamic methods, bulk electrolysis, coupled chemical processes, and electrochemical impedance methods. Practical considerations for electrochemical experiments and specific examples of applications in the recent literature will also be covered.

#### **Learning Goals Met by this Course:**

- Apply the Nernst equation to different electrochemical systems
  - Understand and explain the roles of key components in an electrochemical cell
  - Describe physical phenomena occurring in different electrochemical systems and be able to relate mathematical equations to these physical models
  - Apply common electrochemical techniques to different electrochemical systems to obtain qualitative and quantitative information
  - Perform some basic electrochemical experiments, data analysis, and presentation
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## COURSE FORMAT

This course will consist of lectures on Monday and Thursday afternoons. Lectures will primarily be traditional directed instruction that incorporates material from *Electrochemical Methods: Fundamentals and Applications* (Bard and Faulkner) and the recent scientific literature. Lecture slides will be made available on Canvas prior to the class time. Additionally, four class sessions will be set aside for short laboratory modules where you will work in groups to apply some of the theoretical concepts from the lecture material to analyze electrochemical systems. In these hands-on modules, you will gain experience with constructing and handling simple electrodes, setting up three-electrode electrochemical cells, running electroanalytical experiments, and data analysis.

Six problem sets will be assigned throughout the course according to the schedule below. Questions related to evaluation and data analysis of the experiments from the lab modules will be included in problem sets 3-6. Each problem set must be turned in at the start of lecture (12:10 PM) on its respective due date. You may collaborate with each other on the problems, but each student must independently write and turn in their own problem set.

The term paper for this course is due **December 16<sup>th</sup>, 2022 by 5:00pm**. The term paper should be a critical review of an important research article that features one or more electrochemical techniques as a major characterization method. More than one research article in the same theme may be selected if appropriate. The term paper should include an introduction to the research topic, a brief overview of the research article, a discussion of the electrochemical techniques and data analysis utilized in the research, your perspective on the significance of the article(s) and electrochemical methods, and your critical evaluation of the electrochemical aspects of the research. The term paper may also include a discussion of unresolved issues and/or your proposal(s) for future research opportunities that utilize electrochemistry. The term paper should be concise: 8 pages maximum, single-spaced. Figures and references do not count toward the page limit. The research article of your focus should be published in a major journal (e.g., *Science*, *Nature*, *Nature Chemistry*, *JACS*, etc.). The article selection for your term paper must be indicated on your 3<sup>rd</sup> problem set. The last week of class will be reserved for student presentations on the topic of your term paper.

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## GRADING

The grading for this course will be based on your participation and performance on the problem sets and term paper, as follows:

Problem Sets	50 %
Term Paper, Written	35 %
Term Paper, Presentation	15 %

Letter grades will be assigned based on your final percentage score in the course:

A	90-100 %	C	65-74 %
B+	85-89 %	D	55-64 %
B	80-84 %	F	below 55 %
C+	75-79 %		

Any questions or concerns about a graded assignment or assessment must be brought to the attention of the instructor within one week of receiving the grade. Requests for re-grading will not be considered after this one-week window.

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## ACADEMIC INTEGRITY

Rutgers University takes academic dishonesty very seriously. Students must adhere to the university policies on academic integrity and student conduct for all assignments, assessments, exams, and other matters regarding this course. By enrolling in this course, you assume responsibility for familiarizing yourself with the Academic Integrity Policy and the possible penalties (including suspension and expulsion) for violating the policy. These policies can be found [online](#). As per the policy, all suspected violations will be reported to the Office of Student Conduct. Academic dishonesty includes (but is not limited to):

- Cheating
- Plagiarism
- Aiding others in committing a violation
- Allowing others to use your work
- Failure to cite sources correctly
- Fabrication
- Using another person's ideas or words without attribution
- Re-using a previous assignment
- Unauthorized collaboration
- Sabotaging another student's work

If in doubt, please consult with Prof. Waldie.

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## STUDENT-WELLNESS SERVICES

**Report a Bias Incident.** If you experience or witness an act of bias or hate, report it to someone in authority. You may file a report online and you will be contacted within 24 hours. Bias is defined by the University as an act, verbal, written, physical, psychological, that threatens, or harms a person or group on the basis of race, religion, color, sex, age, sexual orientation, gender identity or expression, national origin, ancestry, disability, marital status, civil union status, domestic partnership status, atypical heredity or cellular blood trait, military service or veteran status.

[Click here to report a bias incident](#)

**Counseling, ADAP & Psychiatric Services (CAPS).** CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professionals within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community, and consultation and collaboration with campus partners. CAPS can be reached by phone at (848) 932-7884, and is located at 17 Senior Street, New Brunswick, NJ 08901.

<http://health.rutgers.edu/medical-counseling-services/counseling/>

**Crisis Intervention.** <http://health.rutgers.edu/medical-counseling-services/counseling/crisis-intervention/>

**Report a Concern.** <http://health.rutgers.edu/do-something-to-help/>

**Violence Prevention & Victim Assistance (VPVA).** The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling, and advocacy for victims of sexual and relationship violence and stalking to students, staff, and faculty. To reach staff during office hours

when the university is open or to reach an advocate after hours, call 848-932-1181. VPVA can be reached by phone at (848) 932-1181, and is located at 3 Bartlett Street, New Brunswick, NJ 08901. [www.vpva.rutgers.edu/](http://www.vpva.rutgers.edu/)

**Disability Services.** Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: <https://ods.rutgers.edu/students/documentation-guidelines>. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: <https://ods.rutgers.edu/students/registration-form>. Disability services can be reached by phone at (848) 445-6800, and is located at Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854. <https://ods.rutgers.edu/>

## COURSE SCHEDULE

Week #	Lecture #	Date	Topics	Due Dates
1	1	09/08	Redox Reactions, The Electrochemical Cell, Standard Cell Potentials, Coulometry	
2	2	09/12	Thermodynamics & Nernst Equation, Reference Electrodes	
	3	09/15	Liquid Junctions Potentials, Potentiometry, pH Electrodes	
3	4	09/19	Double Layer Structure and Capacitance	
	5	09/22		<b>PS 1 DUE</b>
4	6	09/26	Kinetics of Electrode Reactions	
	7	09/29		
5	8	10/03	Mass Transfer	
	9	10/06		<b>PS 2 DUE</b>
6	10	10/10	Practical Considerations	
	11	10/13	<b>LAB #1 - Intro &amp; Chronoamperometry</b>	
7	12	10/17	Chronoamperometry	
	13	10/20		<b>PS 3 DUE</b>
8	14	10/24	Potential Sweep Methods	
	15	10/27		
9	16	10/31	<b>LAB #2 - Cyclic Voltammetry</b>	
	17	11/03	Heterogeneous Systems	
10	18	11/07	Electrochemical Surface Area	<b>PS 4 DUE</b>
	19	11/10	Electrocatalysis	
11	20	11/14		
	21	11/17	<b>LAB #3 - Electrocatalysis &amp; Surface Area</b>	
12	22	11/21	Electrochemical Impedance Spectroscopy	
	23	11/22		<b>PS 5 DUE</b>
13	24	11/28	Hydrodynamic Methods	
	25	12/01	Ultramicroelectrodes	
14	26	12/05	<b>LAB #4 - Hydrodynamic Methods</b>	
	27	12/08	Student talks	
15	28	12/12		<b>PS 6 DUE</b>
-	-	12/16	<b>Term Paper Due December 16<sup>th</sup> by 5:00pm</b>	