

Electrochemistry 9524 Course Outline

Course Information:

Electrochemistry 9524A

Lectures held Tuesdays and Thursdays, 1430-1600 h

Instructor Information:

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Course Description:

This course covers the basic theory and application of electrochemical science. It is targeted toward students who want to better understand electrochemical processes or to add electrochemical methods to their repertoire of research approaches, including both those who have not yet had much formal electrochemical training and those with more experience. The course starts at a basic level to ensure that each student starts on a solid footing and to dispel common misconceptions. It then progresses to cover the core of electrochemical theory that forms the basis for the techniques that are detailed later in the course. Practical examples, diagrams and images illustrate and reinforce the subject matter.

Topics:

1. Introduction and Overview of Electrode Processes
 - definitions, references
2. Electrochemical Potential: Significance and Proper Measurement
 - cell potentials and EMF, half-reactions, cell notation, reference electrodes
 - electrode-solution interface and double-layer structure
3. Chemical vs. Electrochemical Thermodynamics
 - standard potentials and Nernst equation vs open circuit potential
 - ion-selective electrodes, applications in analytical electrochemistry and sensors, aqueous and non-aqueous systems
4. Chemical Stoichiometry vs. Faraday's Law
 - coulometry, bulk electrolysis
5. Theoretical Basis for Methods
 - chemical vs electrochemical kinetics, current-potential relationship, exchange current, Butler-Volmer equation, Tafel equation and Tafel plots, reaction mechanisms
 - mass-transfer effects, Nernst approximation
 - coupled reactions and corrosion
 - surface tension, adsorption and adsorption isotherms, electrocapillarity, potential of zero charge, Lippmann equation
6. Methodology
 - potentiometry, differential capacity, coulometry, cyclic voltammetry, polarography
 - potential measurements, cyclic voltammetry, Tafel analysis, linear polarization technique, chronoamperometry, chronocoulometry, rotating disk and rotating ring disc electrodes, ultra microelectrodes, electrochemical impedance spectroscopy

7. Electrochemical Instrumentation

- voltmeters, ammeters, potentiostats, galvanostats, IR compensation, design of electrochemical cells

Learning Outcomes:

After taking this course, students should:

- understand the meaning and underlying sources of electrochemical potential
- be able to visualize the structure of charged interfaces (e.g., electrode/solution interface)
- be able to calculate the expected electromotive force of a cell under standard and non-standard conditions
- understand the potential-current relationship in electrochemical kinetics and its fundamental basis
- understand the principles of a range of basic electrochemical measurement techniques (based on thermodynamic and/or kinetic theory)
- be aware of numerous practical applications of electrochemical methods, especially in analysis and characterization
- own a repertoire of practical tips for working with reference electrodes, designing electrochemical cells, and troubleshooting electrochemical measurements
- be exposed to a variety of advanced electrochemical methods and in situ, coupled electrochemical/spectroscopic techniques

Expectations:

I recommend that students read the relevant chapters of the textbook, attend classes, take notes as necessary to aid their own studies, complete the three problem assignments on time, and prepare and record a multi-media presentation to be shared with the rest of the class after being graded.

Course Materials:

An electronic copy of the course notes will be provided. The recommended textbook is:

- A.J. Bard, L.R. Faulkner and H.S. White, Electrochemical Methods: Fundamentals and Applications, Third Edition, Wiley, 2022. ISBN 978-1119334064

<https://www.wiley.com/en-us/Electrochemical+Methods%3A+Fundamentals+and+Applications%2C+3rd+Edition-p-9781119334057>

Much relevant information can be found in the first two editions of this book as well, and these are probably sufficient to help you through his course.

Methods of Evaluation:

1. Three assignments, 25% each. Due dates: Oct. 1, Nov. 1, Dec. 6
2. Multimedia presentation, 25%, Due date: Nov. 22

Statement on Academic Offences

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).”

Statement on Gender-Based and Sexual Violence

All course outlines must contain the following statement: “Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who is going through or has gone through these traumatic events. If you are experiencing or have experienced GBSV (either recently or in the past), you will find information about support services for survivors, including emergency contacts at the following website:

https://www.uwo.ca/health/student_support/survivor_support/get-help.html

To connect with a case manager or set up an appointment, please contact support@uwo.ca.”

Statement on the Use of Generative Artificial Intelligence

The use of generative artificial intelligence (AI) tools/software/apps in this course is not acceptable except in preparation of the multimedia presentation. Its use is not required for the presentation, but using it to enhance the information to be conveyed in the presentation is permitted. Please do not rely on it for factual information.