University of Wisconsin-Madison

CHM 624  Electrochemistry  Fall 2018

Lecture:  T Th 11:00-11:50 am, Room 8335

Course Instructor:  Dr. Kyoung-Shin Choi (3233A)
Email: kschoi@chem.wisc.edu (preferred contact)
Office hour: by appointment

Laboratory Instructor:  Dr. Rob McClain (2330)
Email: mcclain@chem.wisc.edu (preferred contact)
Office hour: by appointment

TA:  Brandon Taitt (3231)
Email: taitt@wisc.edu (preferred contact)
Taylor Evans (3231)
Email: tevans4@wisc.edu (preferred contact)
Office hour: by appointment

Course Credit:
Students may take this course for 2 or 3 credits. Students enrolled for 2 credits meets for two
50-minute class period (all face-to-face) each week over the fall semester and carries the
expectation that students will work on course learning activities (reading, writing, problem sets,
studying, etc) for about 2 hours out of classroom for every class period. Students enrolled for 3
credits will additionally meet for five labs over the semester and carry out experiments on
selected topics and complete lab reports.

Catalog Course Description:
Theory of interfacial electron transfer and mass transport processes in electrochemistry, with
applications to electroanalysis, electrodeposition and electrochemical separations; lecture and
laboratory projects.

Additional Description:
CHM 624 is intended to be an introductory graduate-level course on electrochemistry and
electrochemical methods. This course will blend the theory of electrochemistry with
electrochemical characterization methods and modern photoelectrochemical applications (e.g.
solar energy conversion, photoelectrochemistry).

Catalog Requisite:
Graduate standing

Course Attributes:
Advanced level; physical science breadth; counts as L&S credit

Instructional Mode:
Classroom instruction
Text Book
Derek Pletcher, A First Course in Electrode Processes, 2nd ed., RSC Publish, 2009

Reference

Contents
1. Introduction to Electrode Reaction
   Simple Electron Transfer Reactions
   Equilibrium Potentials
   Tafel Plots
   Mass Transport
   Interaction of Electron Transfer and Mass Transport
   Reversible and Irreversible Electrode Reactions
2. The Interfacial Region
   Models for the Electrical Double Layer
   Experimental Consequences of the Double Layer
   Charging Current
3. A Further Look at Electron Transfer
   Kinetics of Electron Transfer
   Absolute Rate Theory
   Transfer Coefficient
   Multiple Electron Transfer Reactions
   Hydrogen Evolution and Oxidation Reactions
   Oxygen Evolution and Reduction
   Electrocatalysis
4. Experimental Electrochemistry
   Two-Electrode vs. Three-Electrode Cells
   Uncompensated IR Drop
   Working, Counter, and Reference Electrodes
   Electrolytes
   Separators and Membranes
5. Techniques for the Study of Electrode Reactions
   Steady State Techniques
   Electrolysis/Coulometry
   Steady State Current Density vs. Potential
   Rotating Disc Electrodes and Rotating Ring Disc Electrodes
   Non-Steady State Techniques
   Potential Step Experiments
   Cyclic Voltammetry
   AC Impedence
6. Photoelectrochemistry of Semiconductors
   Electronic Properties of Semiconductors
   Semiconducto/Liquid Junctions
   Charge Transfer at a Semiconductor/Liquid Junction
   Solar Energy Conversion utilizing Semiconductor/Liquid Junctions

Course Learning Outcomes
Design and conduct electrochemistry experiments
Analyze and interpret electrochemistry data
Apply knowledge of electrochemistry to their research
Demonstrate an understanding of electrochemistry literature

Labs (Room 2330)
Students registering for 3 credits will conduct several laboratory experiments, to be conducted at times arranged on an individual group basis. Please note that some labs will require time outside of lab period for data analysis. Computers with the BioLogic EC-Lab program will be available for your use in Room 2330. Or download a demo version from the BioLogic website (http://www.bio-logic.info/potentiostat/software.html).

Exams: There will be three exams. No make-up exams will be given. Exams 1 and Exam 3 will be written exams. Exam 2 will be an oral presentation on a given topic (Topics will be announced in the middle of the semester.)

Exam 1: 6:00 PM – 8:00 PM, October 24 (Wed)
Exam 2: Oral presentations (evening exams schedule during the week of 12/3)
Exam 3: 10:05 AM – 12:05 PM, December 19 (Wed)

Grading Scheme for 3 Credits

Lab Reports: 33%
Exams 1-3: 20% each
Problem Sets: 7%

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Grading Scheme for 2 Credits

Exams 1-3: 30% each
Problem Sets: 10%

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