University of Wisconsin-Madison

CHM 624 **Fall 2018**

Electrochemistry

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

Course Instructor: Dr. Kyoung-Shin Choi (3233A)
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Office hour: by appointment

Laboratory Instructor: Dr. Rob McClain (2330)
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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 willl 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
Bard and Faulkner, Electrochemical Methods, 2nd ed., Wiley, 2009

Contents

1. Introduction to Electrode Reaction
    - Simple Electron Transfer Reactions
    - Equilibrium Potentials
    - Tafel Plots
    - Mass Transport
    - Interaction of Electron Transfer and Mass Trnasport
    - Reversible and Irreversible Electrode Reactions
2. The Interfacial Region
    - Models for the Electrical Double Layer
    - Experimental Cousequences of the Double Layer
    - Charging Current
3. A Further Look at Electron Transfer
    - Kinetcs 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-Elecrode vs. Three-Electrode Cells
    - Uncompensated IR Drop
    - Working, Counter, and Reference Electordes
    - 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
    - Semiconudctor/Liquid Junctions
    - Charge Trasnfer at a Semiconudctor/Liquid Junction
    - Solar Energy Conversion utilizing Semiconudctor/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 willl 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%

Score	Grade	Score	Grade
100-90%	A	59-50%	C
89-80%	AB	49-40%	CD
79-70%	B	39-30%	D
69-60%	BC	29-0%	F

Grading Scheme for 2 Credits

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

Score	Grade	Score	Grade
100-90%	A	59-50%	C
89-80%	AB	49-40%	CD
79-70%	B	39-30%	D
69-60%	BC	29-0%	F