University of Wisconsin-Madison

CHM 624        Fall 2019

Electrochemistry

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)
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                       Office hour: by appointment

TA:             Andjela Radmilovic (3301)
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                Michael Bender (3301)
                Email: mtbender@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
   - Semiconductor/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 two exams. **No make-up exams** will be given.

- **Exam 1:** 6:00 PM – 8:00 PM, October 23 (Wed)
- **Exam 2 (Final):** 5:05 PM – 7:05 PM, December 13 (Friday)

**Grading Scheme for 3 Credits**

- Lab Reports: 33%
- Exams 1-2: 30% each
- Problem Sets: 7%

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**Grading Scheme for 2 Credits**

- Exams 1-2: 45% each
- Problem Sets: 10%

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