I. Course Identity, Teaching Staff, and Logistics

Instructor: New hire or Prof. Shannon Boettcher, email: swb@uoregon.edu, office: 435 LISB, Phone: 541-346-2543

Office hour: The instructor will hold two office hours per week, held in faculty office #. The times will be determined on the first day of lecture based on student availability. Meetings will also be available by appointment.

Format: Laboratory

Credits: 2

Location and Time: Required laboratory sessions, W 2:00 pm - 4:50 pm, will meet in the Oregon Center for Electrochemistry (Onyx 372, tentatively)

Required course materials:


Additional course materials:


Course website: Laboratory Project Assignments, lecture notes, videos, and grades will be posted on the Canvas course site.

Pre/Co-requisite: Advanced Electrochemistry CH454/554.

II. Course Description

In CH454/554 students learn the fundamental theoretical concepts underlying electrochemical systems and complete short simple electrochemistry projects. In this course CH691, student will apply the theoretical knowledge in substantial laboratory projects in analytical electrochemistry. For students simultaneously enrolled in both courses, the
analytical electrochemistry laboratories will track with theoretical concepts developed in the lecture course. CH691 will focus on typical three-electrode electrochemical experiments and laboratory techniques that form the basis for analytical electrochemistry and for building the basic electrochemistry knowledge and intuition with respect to thermodynamics, kinetics and mass transport. Laboratory modules will focus on building a potentiostat (the basic analytical tool in electrochemistry), potential-step and potentiometric measurements, Tafel analysis of electrocatalysts, advanced concepts in cyclic voltammetry, and impedance spectroscopy and analysis. Student will also learn to use modern programming software to automate data processing and analysis. Student will meet one afternoon a week (3 h) for mandatory laboratory/group-discussion sessions led by the instructor and/or teaching assistant. Open laboratory times will also be established for students to work at their own pace and on their own schedule on the assigned projects, after appropriate safety training and with oversight as needed. Feedback from industry partners will drive curriculum changes.

III. Expected Learning Outcomes

- Understand basic electrical engineering design of potentiostat circuits and be able to design and troubleshoot basic potentiostat circuits
- Learn how to make common analytical electrochemical measurements (voltammetry, Tafel Analysis, rotating disk analysis, and impedance analysis) including experimental design, practical cell setup, and instrumentation needs
- Learn to use modern programming software to automate data processing and analysis (e.g. Matlab, Python).

IV. Estimated Student Workload

Course participants will attend laboratory sessions, perform assigned reading, attend open laboratory times and collect data, analyze data, and write professional quality reports. The table below shows the estimated workload.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated hours per term</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Project Reports</td>
<td>20</td>
<td>5 project reports, typically 5 pgs. with data per report</td>
</tr>
<tr>
<td>Preparation Literature Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Laboratory Time</td>
<td>30</td>
<td>Estimated at 3 h / week</td>
</tr>
<tr>
<td>Mandatory Laboratory Sessions</td>
<td>30</td>
<td>3 h / week</td>
</tr>
<tr>
<td>Total hours:</td>
<td>80</td>
<td></td>
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V. How Grades Will Be Determined

The grades will be determined based on the following percentage breakdown of the final total score:
Professionalism and safety in the laboratory setting - 10%
Quality of laboratory reports; data, analysis, and discussion – 90%
No final or midterm exam

Projects will be graded based on the quality of the project report. Reports are expected to be concise formal documents with professional quality graphs (including appropriate use of units and error estimates) and data analysis, and insightful discussion of the data (~5 pages for each). Each project assignment is accompanied by a document outlining project expectations.

A = Clearly written, concise document, with high-quality figures. All required pieces of data are shown and discussed without major errors in the interpretation. Laboratory reports (1) use laboratory data in quantitative and specific ways to support conclusions, (2) make comparisons to theory/expectations where possible, and (3) show mastery of the principles underlying common electroanalytical experiments.

B = One or more issues with the items above.

C = Multiple issues with quality of the written document and interpretation/discussion.

D = Multiple issues and incomplete.

+/- grades will be applied consistent with the above criteria. A+ will be given for near-perfect reports with high quality data.

A+ course grades will be given to the top-performing students in the course, provided they reach >95%. Students earning >90% in the course will earn at least and A, > 80% at least a B, >70% at least a C, and >60% at least a D. The instructor may curve the course to increase the letter grades for a given percentage score to account for variations in difficulty of the exam questions from year-to-year. Students with a given percentage score will not, however, earn a grade lower than that indicated above.

VI. Course Schedule and Assignments

Assigned reading:  Weekly reading are given after each topic.

**Week 1**
Laboratory Meeting 1: Laboratory Safety Overview, Begin Project 1: Building a potentiostat.

**Week 2**
Laboratory Meeting 1: Continue project 1. Quanitify performance of potentiostat.

**Week 3**
Laboratory Meeting 1: Laboratory project 2: Potentiometry and Mass-transfer limited voltammetry.
Reading: Bard and Faulkner, Chapter 1, pg 28-34.
Project 1 Due.

Week 4
Laboratory Meeting 1: Continue laboratory project 2

Week 5
Laboratory Meeting 1: Project 3: Electrocatalysis: Preparation, Activity, and Tafel Analysis

Week 6
Laboratory Meeting 1: Continue laboratory project 3.
Project 2 Due.
Reading: Calculation of the platinum’s active surface. Biologic Application note #11.

Week 7
Laboratory Meeting 1: Project 4: Potential Steps and Voltammetry
Project 3 Due.

Week 8
Laboratory Meeting 1: Continue laboratory project 4.

Week 9
Laboratory Meeting 1: Project 5: Impedance analysis of electrical circuits and electrochemical cells.
Reading: Bard and Faulkner, Chapter 10, pg 368 – 387. Biologic EC-Lab EIS plot – Electrochemistry & Battery – Application Note #08.
Project 4 Due.

Week 10
Laboratory Meeting 1: Continue laboratory project 5.

Finals Week

Wednesday: Project 5 due.

VII. Course Policies
• Late or missed work will not generally be accepted without prior approval.
• Project reports must be your own work. You may share data (with citation) across the class if it strengthens the quality of the report but the analysis and discussion of the data in the report must be your own work.
• There will be a zero-tolerance policy for plagiarism in laboratory reports.
• Academic Misconduct: The University Student Conduct Code (available at conduct.uoregon.edu) defines academic misconduct. Students are prohibited from committing or attempting to commit any act that constitutes academic misconduct. By way of example, students should not give or receive (or attempt to give or receive) unauthorized help on assignments or examinations without express permission from the instructor. Students should properly acknowledge and document all sources of information (e.g. quotations, paraphrases, ideas) and use only the sources and resources authorized by the instructor. If there is any question about whether an act constitutes academic misconduct, it is the students’ obligation to clarify the question with the instructor before committing or attempting to commit the act. Additional information about a common form of academic misconduct, plagiarism, is available at https://researchguides.uoregon.edu/citing-plagiarism.
• Accessibility: The University of Oregon is working to create inclusive learning environments. Please notify me if there are aspects of this course that result in disability related barriers to your participation. For more information or assistance, you are also encouraged to contact the Accessible Education Center, Suite 360 Oregon Hall, 346-1155 or uoaec@uoregon.edu; website: http://aec.uoregon.edu/content/about
• A graduate employee (GE) will serve as a teaching assistant for this course. The GE’s responsibilities will include assisting in the implementation of the project component of the course, including supervising students completing the projects and obtaining/distributing materials needed for the project. The GE may assist with grading, and will also be available for general assistance in preparing project reports, completing homework assignments, and preparing for exams. Should graduate students enrolled in the course perceive the course as leading to any conflict of interest, privacy concerns, or unfairness related to having a GE in the above role please contact the instructor to discuss paths of recourse. If the GE is involved in grading assignments, graduate students may request that a faculty member, not the GE, grade their assignments. To do this please make the request in writing via email to the instructor.