Faculty of Science Course Syllabus
Department of Chemistry
Chemistry 4311/5311: Fundamentals of Applied Electrochemistry
Fall 2018

Professor: Dr. Heather Andreas
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Office hours: Wednesday 3:00 – 4:00, Thursday 8:30-9:30

Lectures: MWF 8:35-9:25 p.m., Room Chemistry 226

Prerequisites: CHEM 2301.03 and CHEM 2304.03 (grade of C- or better)

Course: This is a fourth year/graduate level, 3 credit hour course in physical chemistry, focussing on electrochemistry.

Course description: A broad introduction to the fundamentals of electrochemistry, including electrochemical theory, double layer modelling and electrochemical methods. Additionally, important electrochemical applications will be discussed, including corrosion, energy production and storage (fuel cells, batteries and supercapacitors) and sensors (biosensors).

Web Site: There will be a Brightspace website for this class. The instructor will convey relevant information through the course website. It is your responsibility to regularly consult the course website.

Text: There is no formal text for this course. Class notes will be made available through the course website, and various reference books will be highlighted for further reading

Lecture Component Objectives/Learning Outcomes:

- Learn about the most common types of electrochemical cells, including why and when a 2-electrode or 3-electrode system should be used.
- Learn about what happens at the electrode/electrolyte surface during double-layer charging and during Faradaic reactions.
- Identify and understand how thermodynamic and kinetic information can be gained from electrochemical measurements.
- Learn about the most common electrochemical techniques for identifying physical and chemical processes and deriving analytical data. In particular, cyclic voltammetry will be used to identify resistive components, diffusion effects, underpotential deposition and various types of film formation.
- See how electrochemistry is applied in real-world applications.

List of (approximate) course material:

- Different types of electrochemical cells (basic electrochemistry)
- 2 vs. 3 electrode measurements
- Reference electrodes
- The origin of potential at the interface
- Double-layer models
- Hg capacitance and the pzc
- Electron transfer at the interface
- Transport control
- Electrochemistry at film covered electrodes
- Seminars on electrochemistry in real-world applications

Grade Conversions:

Undergraduate:

The usual Faculty of Science scheme for converting numerical grades to letters will be used:

90-100 A+	85-89 A	80-84 A-	77-79 B+	73-76 B	
70-72 B-	65-69 C+	60-64 C	55-59 C-	50-54 D	0-49 F

Graduate:

The usual Faculty of Graduate Studies scheme for converting numerical grades to letters will be used in this class:

90-100 A+	85-89 A	80-84 A-	77-79 B+	73-76 B	70-72 B-	<70 F

Grading Scheme:

Undergraduate students:

The exams will be based solely on the material presented in class (including the material presented in the seminars). The following grading scheme will be used:

Quizzes: *(dates given below, lowest quiz grade will be dropped)* 20 %

Notes: Take home quizzes are due at 8:35 pm on the Monday after the take-home quiz is given. Late quizzes will not be accepted.

During the week(s) of the seminars presented by the graduate students, to obtain full "quiz" marks you are required to ask 1 question of the seminar presenters.

Midterm 1: *(in class, October 12)* 20 %

Midterm 2: *(in class, November 9)* 20 %

Final Exam: *(3 hrs, date to be set by registrar)* 40 %

Graduate students

The exams will be based solely on the material presented in class (including the material presented in the seminars). The following grading scheme will be used:

Quizzes: *(dates given below, lowest quiz grade will be dropped)* 10 %

Notes: Take home quizzes are due at 8:35 pm on the Monday after the take-home quiz is given. Late quizzes will not be accepted.

During the week(s) of the seminars presented by the graduate students, to obtain full "quiz" marks you are required to ask 1 question of the seminar presenters.

Midterm 1: *(in class, October 12)* 20 %

Midterm 2: *(in class, November 9)* 20 %

Seminar: 20 %

Final Exam: *(3 hrs, date to be set by registrar)* 30 %

*The Department of Chemistry policy is that for all Chemistry courses, a minimum grade of 50% on the written test/final exam component is required in order to pass the course.

List of test and quiz dates: (material includes up to the end of class of the dates in brackets)

Quiz 1: Sept 21 (covering up to Sept 14)
Quiz 2: Sept 28 (covering up to Sept 21)
Test 1: Oct 12 (covering up to Oct 05)
Quiz 3: Oct 26 (covering up to Oct 19)
Quiz 4: Nov 02 (covering up to Oct 26)
Test 2: Nov 09 (covering up to Nov 02)
Quiz 5: Nov 23 (covering up to Nov 09)
Quiz 6: 1 question asked during seminars given by graduate students.

Illness:

- In case of illness on the date of a mid-term test, you should complete a "student Declaration of Absence" form **within 72 hours** of the missed test. *If you miss a mid-term test because of illness, you may be given a makeup exam (at the Dr. Andreas' discretion), alternately, the value of the test will be moved to the final exam.*
- There will be no option for make-up quizzes in this class. Quizzes that are not completed will receive a mark of zero.
- In the case of illness on the date of the final exam, you must contact Dr. Andreas **immediately**. A written medical excuse must be obtained on the day of the illness and provided to Dr. Andreas **within 7 days** of the missed exam to be allowed a make-up exam.

Cancellations:

Weather-related closure of the University implies the cancellation of all courses, including quizzes or tests, which will therefore be moved to the next immediate class date.

University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution.

Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness

Statement: http://www.dal.ca/cultureofrespect.html

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca).
Information: https://www.dal.ca/campus_life/communities/indigenous.html

Missed or Late Academic Requirements due to Student Absence (policy)

https://www.dal.ca/dept/university_secretariat/policies/academic/missed-or-late-academic-requirements-due-to-student-absence.html

Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: https://www.dal.ca/faculty/science/current-students/academic-advising.html

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: https://libraries.dal.ca/

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Copyright Office: https://libraries.dal.ca/services/copyright-office.html

Fair Dealing Guidelines https://libraries.dal.ca/services/copyright-office/fair-dealing.html

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html

Student Advocacy: https://dsu.ca/dsas

Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Safety

Chemical Safety: https://www.dal.ca/dept/safety/programs-services/chemical-safety.html

Scent-Free Program: https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html

Details of the seminar:

Each graduate student is required to present an in-class seminar. These presentations will occur Nov. 23 to Dec. 03. More dates may be added, if required. **The information provided during these seminars is testable material,** so a concise set of handouts covering the material to be presented in the seminar must also be prepared. These handouts can simply be comprised of copies of PowerPoint or other presentation materials. Students are required to ask the presenter questions regarding the material. Students will be graded on the seminar presentation and the handouts (e.g. the information contained, the clarity, etc.) and on the ability to handle questions.

Important Dates: Prior to October 12, the seminar topic must be discussed and agreed upon with the professor (H. Andreas) – failure to meet this deadline will result in a loss of 3 of the 20 marks assigned to the presentation in the overall class grade (see grading scheme, above). The presentation and handouts of the material to be presented in the seminar must be given to the professor (H. Andreas) no later than **48 hrs before** the scheduled in-class presentation to allow ample time to make copies of the handouts for the lecture and post the information on the class website. Failure to provide this material by the stated deadline will result in a loss of 5 of the 20 marks assigned to the presentation in the overall class grade (note: this is above and beyond any other deductions).

Length: *Graduate students* will present a 20 minute seminar, plus 5 minutes of questions.

Topics: *Graduate student presentations*: The seminar topic must be discussed and agreed upon with the instructor before October 12, see "Important Dates" above. The topic may be related to the student's research, or may be on one of the three applications of electrochemistry outlined in the syllabus (corrosion, energy production/storage, or sensors). Approximately half of the seminar should focus on a fundamental and detailed discussion of the topic. For example, a student studying biosensors would include in their seminar an introduction to biosensors, and how they work, and should include a small survey of the state-of-the-art biosensors. The second half of the seminar should include a discussion of the specifics of the student's research, and particularly regarding the electrochemical techniques used in the student's project. Topics should include (but not be limited to):

- How the technique(s) work for the student's specific system.
- Why that technique was chosen.
- What information is gained from that technique.
- What are the difficulties involved in using that technique.
- What types of electrodes can be used? And what are the electrode requirements? (Size, reversibility, stability)
- What errors are associated with the values from the systems studied?

Please note that even though some of these topics have likely been presented previously by the student or by fellow graduate students or group members (particularly the fundamental about the particular topics (i.e. biosensors, in the discussion above)), it is expected that the material presented in these seminars should be the student's own original work prepared particularly for this class (no slide materials should be taken from previous presentations).