



CHEM 415

ELECTROCHEMISTRY AND ELECTROCATALYSIS

GENERAL COURSE INFORMATION

Course instructor	Dr. Gregory Jerkiewicz CHE 311, Chernoff Hall Phone: 533-6413 E-mail: gregory.jerkiewicz@queensu.ca
Web site	Available through onQ
Lectures	Schedule: Mondays 9:30 Delivered via MS Teams Wednesdays 8:30 Delivered via MS Teams Thursdays 10:30 Delivered via MS Teams
Office hours	Office hour that suits the class and the course instructor will be established at the beginning of the course
Required textbook	<ol style="list-style-type: none">1. G. Jerkiewicz, Lecture Notes.2. P. Atkins, J. de Paule, <i>Physical Chemistry</i>, 8th, 9th, or 10th.3. E. Gileadi, <i>Physical Electrochemistry</i>, Wiley-VCH, Weinheim (2011).4. A. J. Bard, G. Inzelt, F. Scholtz, Eds., <i>Electrochemical Dictionary</i>, 2nd Edition, Springer, Heidelberg-New York (2012).
Marking	Quiz (2 × 20%): 40% (dates TBD) Final examination: 60% (date TBD) Total 100% The final exam will be a three-hour exam.

COURSE OUTLINE

Equilibrium Electrochemistry (review of second-year material and its expansion)

Electrodes and half-reactions

Complete electrochemical cells and electrochemical reactions

Types of electrochemical cells (galvanic and electrolytic)

Reactions quotient and the Nernst equation; Gibbs energy of half-cell and complete cells; application of the Nernst equation

Cell potential (electromotive force); standard and non-standard cell potentials

Application of cell potentials

Reference Electrodes

Electrode-Electrolyte Interface

Components of the electric double layer

Inner and outer Helmholtz layer

Gouy-Chapmann, Stern and Grahame models

Potential distribution at the electrode-electrolyte interface

Dynamic Electrochemistry

Rate of charge transfer and the activation energy of the charge transfer

Derivation of the Butler-Volmer equation

Low and high overpotential limiting cases of the Butler-Volmer equation

Tafel relation

Electro-adsorption and adsorption isotherms

Electrocatalysis

Hydrogen oxidation and oxygen reduction reactions

Rechargeable and non-rechargeable batteries

Corrosion reactions

Water electrolysis

Metal electrodeposition

Electrocatalytic hydrogenation

Electrosynthesis

Laboratory Procedures in Electrochemistry and Electrocatalysis

Components of an electrochemical setup and their roles

Cleanliness in electrochemical measurements

Electrodes

Electrochemical cells and the two-electrode and three-electrode configurations

Reference electrodes

Safety in electrochemistry and electrocatalysis research

Electrochemical Experimental Techniques

Chrono-amperometry

Coulometry

Cyclic voltammetry

Polarization curves

Tafel plots

Electrochemical quartz-crystal nanobalance