ChEE 412/512 ELECTROCHEMICAL ENGINEERING Fall 20XX

Instructor: Dominic Gervasio gervasio@email.arizona.edu

Lecture (Days / Time / Location TBD); **LAB** (Days / Time / Location TBD)

Office Hours in 146A Harshbarger (days / time TBD) or by appointment

Textbook: ***Electrochemistry***, Carl H. Hamann, Andrew Hamnett & Wolf Vielstich, Wiley-VCH, 2nd Ed, 2007 ISBN: 978-3-527-31069-2

COURSE OUTLINE (dates and topics are subject to change):

Date	Chapter	Topic	Student Presentation
August	1	**Introduction:** Scope and Class Organization **Introduction:** Foundations, Definitions and Concepts	
	2	**Introduction:** Ionic Electrical Conductivity	
September	3	Background: **Electrode Potentials Background:** Double Layer Structure	**Select Undergrad. Topic Outline** **Select Grad. Topic Outline**
October	4	**Fundamentals:** Cell Voltage and Electrical Current Overpotential and Exchange Current **E Materials Electrochemistry:** Electroplating, Corrosion	**Undergrad. Topic Due** **Grad Summary Due (annotated Bibliography)**
	5	E**lectroanalysis:** Steady-State (impedance) and Transient Methods (Voltammetry), Spectroelectrochem	**Undergraduate Presentations.**
	6	• **Analytical Applications:** Electrochemical Sensors • **Electrocatalysts:** Hydrogen, Oxygen Electrodes ▪ Reaction Mechanisms	
	7	• **Solid State Ionics and Molten Salt Electrolytes**	
November	8	**Industrial Electrochemistry:** • Electrolysis • Electro-metallurgy	**Graduate Presentations.**
	9	• Electro-synthesis **Galvanic Cells:** • Primary Batteries • Secondary Batteries • Fuel Cells and Metal Air Batteries • Polymer Electrolyte Fuel Cells • Direct Methanol Fuel Cells • Solid Oxide Fuel Cells	
December		• **In-class Lab Special Topics** Opportunities in Electrochemical Engineering **Final Exam during Final Exam Date**	

Grading Criteria:

1. **ALL Students** are expected to do readings and attend lectures for in-class **quizzes** (10% of the grade),
2. **Undergraduate Students** are to prepare a 15-minute **instructional presentation** from topics in the Chapters 1 to 9 on material that is NOT covered by the instructor and will be a topical overview including supplementary material from texts and other sources researched by the student. The instructional presentation topic is to be **selected by consulting with the instructor**. Each student is to submit a **detailed outline** (draft of a paper) describing the content of their presentation and finally will **present the instructional presentation** as 5 to 10 slide 15 minute talk (40% of the grade).
3. **Graduate Students** are to prepare a 15 to 20-minute **research topic presentation** (from a review or an original research paper from archival literature). Students will first turn in a **pdf of the paper to be discussed and a summary** if topic is approved then later a **detailed outline** (draft of a talk) describing the content of the presentation and finally each Graduate Student will give **presentation on the paper** as 5 to 10 slides for a 15 to 20 minute talk (40% of grade).
4. **ALL students** will be given a mid-term exam worth 25% of the grade and an in-class final test (worth 25% of the grade) on the assigned final exam day. The final will be comprehensive of the course material in Chapter 1 to 5. All exams are open book.
5. **There is a lab session for 4 labs to be done in room 1Harshbarger as announced.**

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OUTLINE:

Chapter	Topic
2	**Introduction:** Scope and Class Organization The goal is to give physical insight into fundamentals of electrochemistry for students with knowledge of basic chemistry, physics and chemical preps and electrical measurements. **Introduction:** Foundations, Definitions and Concepts The course will start by introducing electrochemical cells and the concept of current and voltage **Introduction:** Ionic Electrical Conductivity The relationship between ionic charge and potential is derived from the Poisson relations. This is entry into electrochemical theory. This linearized Poisson equation leads to the Debye Huckel theory, which tells how a charge in an ionic solution interacts with a potential field.
3 **4**	**Thermodynamics:** Electrode Potentials and Double Layer Structure The thermodynamics of electrochemistry is the relationship between electrical potential and state functions. This is based on the concept of the inner potential, which leads to a reference electrode and the potential of a working electrode versus a reference electrodes. **Kinetics:** Cell voltage, electrical current, overpotential and exchange current The kinetics in electrochemistry is rate of charge transfer (current) between a chemical species in an ionic solution with an electrode at a specific potential. These kinetics are based on Erying activated state theory as applied to an electrode when current is a function of electrode potential only (activation control).. **From activation control to mass transfer control** The effects of mass transfer control leads to transport limiting current. This can be derived for stagnant electrodes as given by the Cottrell equation and with convection as given by the limiting plateau of a rotating disk electrode. **Simple examples thermodynamics and kinetics in materials electrochemistry:** Electro-crystallization, Electroplating, Corrosion
5 **10** **6** **7**	**Electroanalysis:** Steady-State and Transient Methods Steady state polarization curves and Electrochemical Impedance and non-steady state Voltammetry will be discussed in relation to the earlier discussion of chapters 3 and 4 and can be illustrated in the lab. **Special Lab Topics (as time permits)** **Analytical Applications:** Electrochemical Sensors, Spectro-electrochemistry **Electrocatalysts:** Hydrogen Electrode Reaction Mechanisms **Solid State Ionics and Molten Salt Electrolytes**
8 **9**	**Industrial Electrochemistry:** Electrolysis Electro-metallurgy Electro-synthesis **Galvanic Cells:** Primary Batteries Secondary Batteries Fuel Cells and Metal Air Batteries Polymer Electrolyte Fuel Cells Direct Methanol Fuel Cells Solid Oxide Fuel Cells New Fuel Cell Types (bio, microbial, etc.)

Accessibility and Accommodations:

It is the University's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability or pregnancy, please let me know immediately so that we can discuss options. You are also welcome to contact Disability Resources (520-621-3268) to establish reasonable accommodations.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.