

EMA4303/5305 Electrochemical Engineering
Fall 2017

Basic Information

Instructor: Dr. Zhe Cheng Phone: 305-348-1973 Email: zhcheng@fiu.edu
Office: EC3172 Office Hours: Tue and Thu 9:00-11:00
Class Hours: **Friday 9:00-11:50** Classroom: **EC1116**
Prerequisite: Basic college-level chemistry and physics

Course Description

An introduction to the fundamental principles of electrochemistry and its applications in different engineering systems for energy, chemical, biomedical, and electronics industries.

Course Objective

To introduce to undergraduate and junior graduate students the basic concepts, physical/chemical principles, and engineering practices of electrochemistry and its applications in various electrochemical systems for energy, chemical, biomedical, and electronics industries.

Learning Outcomes

Through this course, students will be able to:

- Understand the concepts of electrochemical cells and related components and the basic electrochemical processes
- Understand the thermodynamics for electrochemical systems and be able to obtain basic information such as reaction potential based from thermochemical data and vice versa
- Understand basic reaction kinetics for electrochemical systems including current-voltage relationship and the influences of factors such as transport and materials properties.
- Understand the principles for basic electrochemical analysis techniques including impedance spectroscopy and other controlled current/voltage measurements
- Be able to explain basic operating principles and identify major considerations for various practical engineering electrochemical systems including corrosion and its prevention, electrolytic production of chemicals and metals, electrodeposition, batteries, fuel cells and biofuel cells, and electrochemical sensors.

Contents Covered

- Electrochemical processes and electrochemical cells
- Thermodynamics for electrochemical processes
- Electrochemical reactions and kinetics
- Transport in electrochemical processes
- Electrochemical techniques
- Corrosion
- Electrolytic production of chemicals and metals
- Electro-deposition
- Energy conversion and storage via batteries, fuel cells, and electrochemical capacitors
- Electrochemical sensors

Textbook & Other Course Materials

- Class notes
- Reference books:
 - *Electrochemical Methods: Fundamentals and Applications*, Allen J. Bard, Larry R. Faulkner, Wiley (2001), ISBN: 978-0-471-04372-0
 - *Introduction to Electrochemical Science & Engineering*, Serguei N. Lvov, CRC Press, (2015). ISBN: 978-1-4665-8285-9 (Hardback)
 - *Electrochemistry and Electrochemical Engineering: An Introduction*, Alan C. West, Wiley (2012), ISBN: 978-147-007604-7
 - *Electrochemistry*, 2nd ed., Carl H. Hamann, Andrew Hamnett, Wolf Vielstich, Wiley-VCH (2007), ISBN: 978-3-527-31069-2 (Hardback)

Grading**For EMA4303**

- Homework (10%)
- Class attendance (15%)
- Term paper (15%)
- Mid-term exam (25%)
- Final exam (35%)
- Final grades: A: >=90; A-: 87-89.9; B+: 84-86.9; B: 80-83.9; B-: 77-79.9; C+: 74-76.9; C: 67-73.9; D: 60-66.9; F: <60

For EMA5305

- Homework (10%)
- Term paper (30%)
- Mid-term exam (25%)
- Final exam (35%)
- Final grades: A: >=90; A-: 87-89.9; B+: 84-86.9; B: 80-83.9; B-: 77-79.9; C+: 74-76.9; C: 67-73.9; D: 60-66.9; F: <60

Course Policy

- Attendance required
- Students can discuss homework problems, but must independently finish it
- Grade discrepancies – resolve in the same day
- Homework will be collected
- Accommodate “make-up” quiz, tests, or delayed term paper if proven medical necessity
- Accommodate disability (<http://drc.fiu.edu/>) and religious holidays
- NO cheating or plagiarizing in ANY form (Check with me if questions)
 - No excuses will be accepted
 - Will be reported and handled according to FIU policy

Topics and Tentative Schedule

- Introduction: basic concepts of electrolyte, electrochemical cells and processes (week 1)
- Equilibrium and electrochemical thermodynamics (week 2-3)
- Electrochemical kinetics including current-voltage relationships (week 4-5)
- Transport in electrochemical processes (week 6)

- Electrochemical techniques for analysis including impedance spectroscopy and controlled current and voltage techniques (week 7-9)
- Corrosion (week 10)
- Electrolytic production of chemicals/metals and electrodeposition (week 11)
- Electrochemical energy conversion and storage via batteries and fuel cells (week 12-13)
- Other: electrochemical sensors (week 14)

Related MME Program Outcomes

- (a) Ability to apply knowledge of mathematics, science, and engineering
- (e) Ability to identify, formulate, and solve engineering problems
- (g) Ability to communicate effectively
- (i) Recognition of the need for, and an ability to engage in life-long learning
- (k) Ability to use the techniques, skills and modern engineering science necessary for engineering

Term Paper Guidelines

- Deadlines & Submission (Email submission only)

For EMA4303

- **11/10/2017**: 1st draft
- **12/08/2017**: Final submission
 - Term paper plus major references and responses to Dr. Cheng feedbacks

For EMA5305

- **10/20/2017**: 1st draft
- **11/10/2017**: 2nd draft
- **12/08/2017**: Final submission
 - Term paper plus major references and responses to reviewers' question/comments

- Format of Main Document

- Times New Roman, 12 point (Figures/table may use smaller font), single space, 1 inch margin on all sides, print double-sided
- 3 pages maximum excluding reference for EMA4303 or 4 pages maximum excluding references for EMA5305

- "Peer review" process (for EMA5305 only)

- Term papers (1st and 2nd version) will go through "review" process by the lecturer (Dr. Cheng) and fellow students to provide feedbacks/critiques for further improvement

- Grading

For EMA4303

- Missing deadline: zero
- 5 points for 1st draft
- 10 points for final term paper

For EMA5305

- Missing deadline: zero
- 4 points for 1st draft
- 4 points for 2nd draft
- 12 points for final term paper
- 5 points for quality of "review" provided to other students' paper (2 reviews)
- 5 points for answering/rebutting "peer review" questions/comments

ContentFor EMA4303

- **A short survey of a specific challenge in a chosen electrochemical system (e.g., fuel cells, batteries or electrodeposition) of interest to you.**
- It should have most of the following (but NOT necessary all)
 - Introduction to the electrochemical system
 - Background about that specific challenge
 - How researchers are trying to address that challenge
 - Different approaches taken
 - Progress and advantages/disadvantages for each solution
 - Summary of current state-of-the-art and directions for future research
 - Your own recommendation for future work on that challenge
 - Conclusions
 - References
 - Declaration of no plagiarism

For EMA5305

- **A detailed critique of at least two or more research papers** (must be by different research groups) **on a single, focused problem/challenge in a specific electrochemical system of interest to you.**
- It should have most of the following (but NOT necessary all)
 - Introduction
 - Background
 - Analysis/critiques on
 - Significance and why you are interested
 - Assumptions/Electrochemical methodology/Mathematical derivation/Argument/Logic
 - Electrochemical experimental design, data collection and analysis
 - Consistency and/or contradictions between different studies
 - Unanswered questions
 - Your own analysis/proposed research method or data analysis
 - Recommendations for future work
 - Conclusions
 - References
 - Declaration of no plagiarism