EMA4303/5305
Electrochemical Engineering
Lecture 0 Introduction

Prof. Zhe Cheng

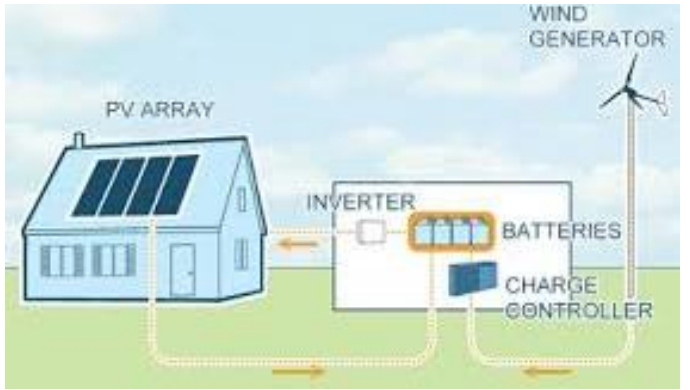
Mechanical & Materials Engineering

Florida International University

FLORIDA INTERNATIONAL UNIVERSITY

EMA4303/5305 Electrochemical Engineering

- **Basic electrochemistry & engineering related to**
  - Energy conversion & storage
    - Batteries & Fuel cells for
      - Electric vehicles (EV)
      - Renewable power generation
      - Mobile devices
  - Corrosion and prevention
  - Sensors
  - Materials/chemicals production & processing
- **Date, Time & Classroom Info**
  - Friday 9:00-11:50
  - EC1116
  - Dr. Zhe Cheng of Mechanical & Materials Engineering (MME) Department



http://www.tesla.com
http://www.greencarreports.com/news/1106296_price-cut-and-monthly-sales-spike-for-toyota-mirai-fuel-cell-sedan
http://www.dailymail.co.uk/sciencetech/article-4003522/New-phone-battery-charge-phones-just-seconds.html
http://www.fuelcelltoday.com/analysis/event-reports/2013/19th-group-exhibit-hydrogen-plus-fuel-cells
http://www.exponent.com/services/practices/engineering/materials--corrosion-engineering/?serviceId=c9288b2c-d7b1-4ad8-8fc3-1b1ed6f2c8c1&loadAllByPageSize=true&knowledgePageSize=3&knowledgePageNum=0&newseventPageSize=3&newseventPageNum=0
https://www.medgadget.com/2014/08/handheld-electrochemical-sensor-detects-diseases-measures-biomarkers-costs-25.html

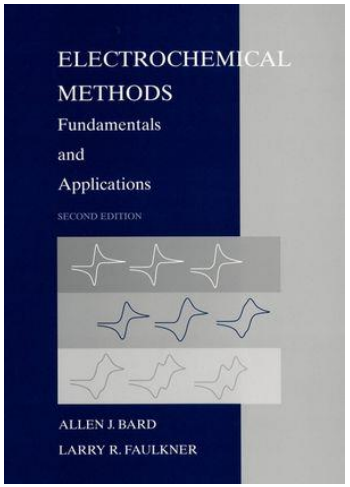
Course Information

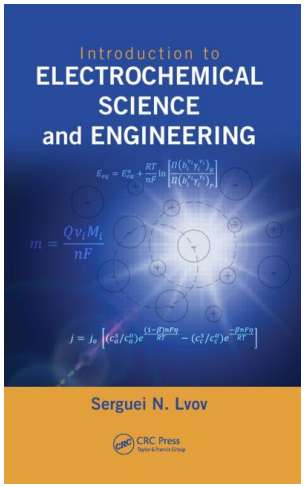
❑Zhe Cheng

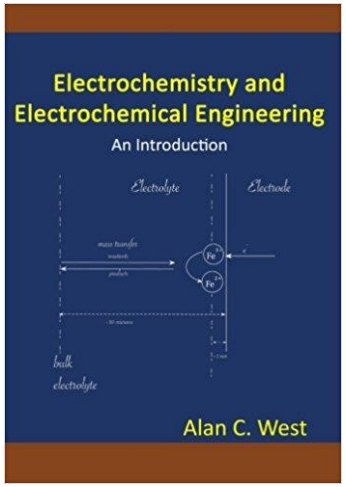
- 305-348-1973; zhcheng@fiu.edu;
- Office: EC3172

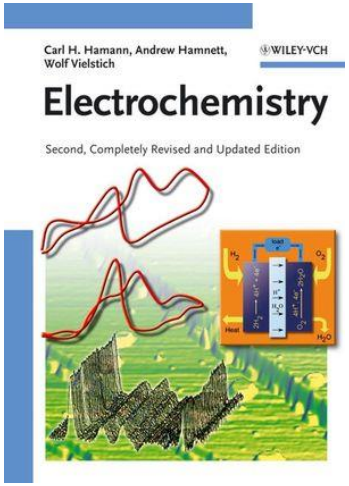
❑Course Materials

- Class notes
- *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
- *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









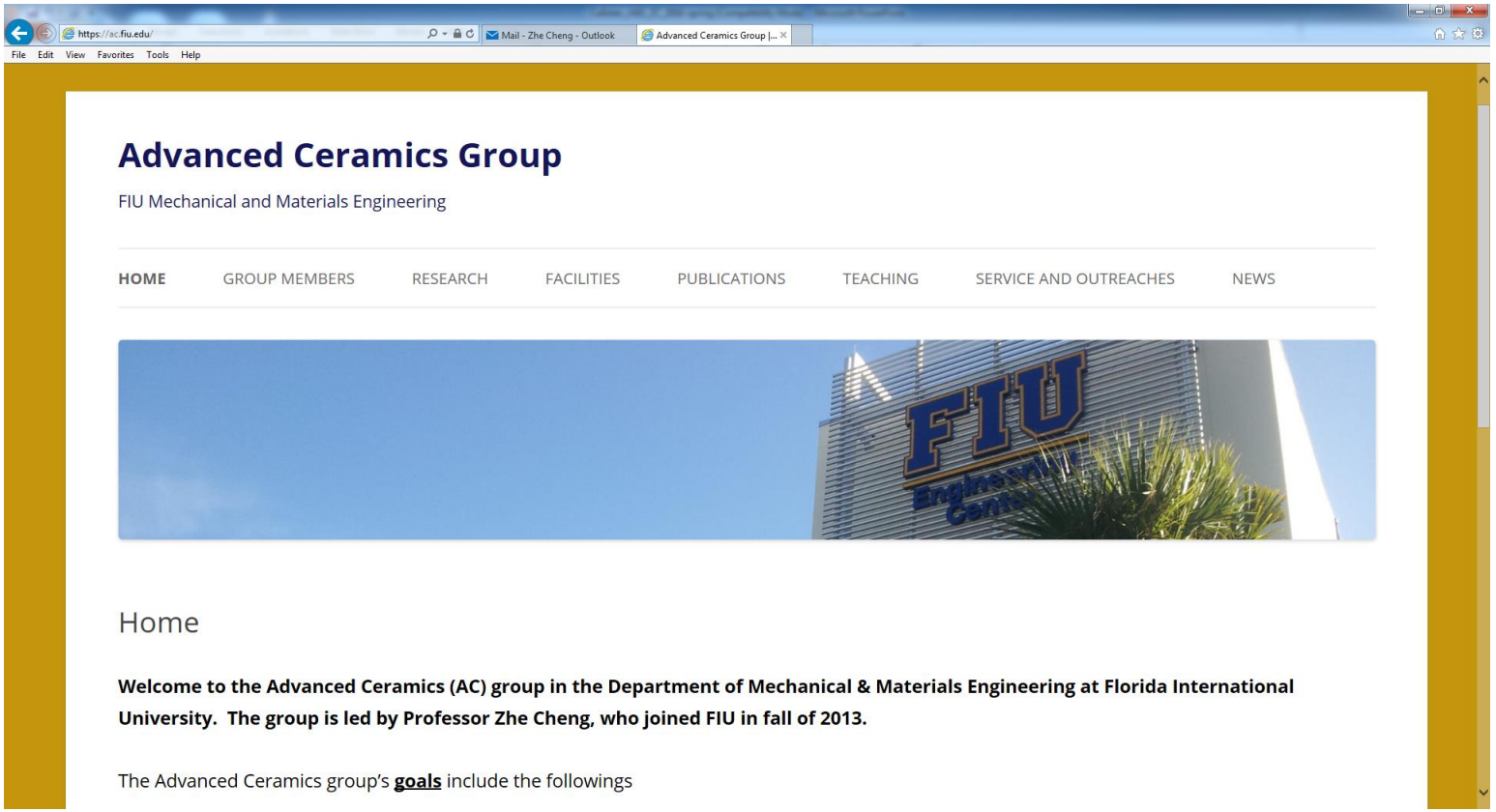
Course Policy

❑Policy

- Attendance required; Turn off cell phone/pagers during class
- Students can discuss homework problems, but must independently finish it
- Grade discrepancies – resolve in the same day
- 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

More about Dr. Zhe Cheng

- **Education & Experiences:**
  - PhD in Materials Science & Engineering, Georgia Tech, 2008
  - Research scientist, DuPont, Wilmington DE, 2008-2013
- **Research group website** https://ac.fiu.edu



Grading for EMA4303

- **Homework (10%)**
- **Attendance (15%)**
- **Term Paper (15%)**
- **Mid-term Exam (25%)**
- **Final Exam (35%)**
- **Grading Scale**
  - 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

Grading for EMA5305

- **Homework (10%)**
- **Term Paper (30%)**
- **Mid-term Exam (25%)**
- **Final Exam (35%)**
- **Grading Scale**
  - 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

Term Paper Guidelines

❑Deadlines & Submission (Email submission only)

- 1st draft
- 2nd draft (for EMA5305 only)
- Final submission
  - Term paper plus major references
  - A separate document answering the reviewers' question/comments (for 2nd draft and final version)

❑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
- Max 4 pages (excluding references) for EMA5305 or max 3 pages for EMA4303

❑Grading

- Missing deadline(s): 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

Term Paper Content for EMA4303

- **For EMA4303 term paper**
  - A **short survey** of **a specific challenge** in a chosen electrochemical system (e.g., fuel cell, battery or electro-deposition) of interest to you.
  - It should have most of the following (but NOT necessary all)
    - Introduction to the chosen electrochemical system
    - Background about that specific challenge
    - How researchers are trying to address that challenge
      - Different approaches taken
      - Progresses made 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

Term Paper Content for EMA5305

- **For EMA5305 term paper**
  - 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

Course Objective & Outcome

❑Objectives

- 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

a) Understand the thermodynamics for electrochemical systems and be able to obtain basic information such as reaction potential based from thermochemical data and vice versa

b) Understand basic reaction kinetics for electrochemical systems including current-voltage relationship and the influences of factors such as transport and materials properties

c) Understand the principles for basic electrochemical analysis techniques including impedance spectroscopy and other controlled current/voltage measurements

d) 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.

Electrochemical Systems/Processes

- **Write down one electrochemical system/applications of interest to you and explain (3 min)**
  - …

Topics & Planned Schedule

- Introduction: basic concepts of 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 electro-deposition (week 11)
- Electrochemical energy conversion and storage via batteries and fuel cells (week 12-13)
- Other: electrochemical sensors (week 14)