

ENG ME 545/MS 545 Electrochemistry of Fuel Cells and Batteries

2008-2009 Catalog Data:

ENG ME 545/MS 545 Electrochemistry of Fuel Cells and Batteries:

Electrochemistry of fuel cells, batteries, sensors, membrane separation and electrolytic processes are discussed. Thermodynamics and kinetics of electrode reactions and associated mass transport in electrochemical systems are covered. Measurements techniques (dc polarization, ac impedance spectroscopy, blocking electrodes, etc.) used in characterizing electrochemical systems are presented and discussed in a journal club setting. 4 Cr.

Class/Lab Schedule: 4 lecture hours per week

Status in the Curriculum: Elective

Textbook(s) and/or Other Required Material: None

References: Allen J. Bard and Larry R. Faulkner, "Electrochemical Methods", Second Edition, John Wiley & Sons, 2001.

Fuel Cell Handbook 7, DOE-NETL Production.

P.J. Gellings and H.J.M. Bouwmeester, Eds. "The CRD Handbook of Solid State Electrochemistry", CRC Press, 1997

John O'M. Bockris and S. Srinivasan, "Fuel Cells: Their Electrochemistry, McGraw Hill, 1969.

Research papers and notes of topical interest are handed out in the class.

Coordinator: Uday B. Pal, Professor, Mechanical Engineering

Prerequisites by topic:

1. Understanding of Undergraduate thermodynamics and transport phenomena

Goals:

Help graduate students and senior undergraduates to understand the fundamentals of electrode reactions in electrochemical cells and use that knowledge to analyze performance of electrochemical systems such as those represented by fuel cells, batteries, sensors and electrolytic cells.

Course Learning Outcomes:

As an outcome of completing this course, students will:

- i. Understand the materials properties required for electrodes and electrolytes.
- ii. Understand the operating principles of various types of electrochemical cells, including fuel cells, batteries, and sensors.
- iii. Understand various measurement techniques used to analyze the performance of the electrochemical cell and its various components.
- iv. Understand the operation of electrochemical devices at the systems level

- v. Critically analyze and be able to present a technical article in the field

Course Learning Outcomes mapped on to Program Outcomes:

| Program: | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
|------------------|---------------------|-----|-------------|---|------------------|----|---|----|-----------------------|---------------------|-----|-----|-----------|----|
| Course: | i,ii, iii, iv | iii | i,ii ,iv | | i, ii, iii,iv | iv | v | iv | i,ii,i ii,iv ,v | ii, iii, iv,v | iii | iii | ii, iv | iv |
| Emphasis: | 5 | 1 | 3 | | 4 | 1 | 4 | 2 | 3 | 4 | 3 | 3 | 2 | 1 |

Topics:

1. Materials requirements in electrochemical cells
2. Operating principles of electrochemical cells
3. Kinetic treatment of reversible electrode potentials
3. Defect Chemistry of solid-state materials
4. Mass and Charge Transport
6. DC Polarization and AC Impedance Measurements
7. Balance of Plant Components in electrochemical systems
8. Journal club reviewing contemporary topics in fuel cells, batteries, sensors, and electrolytic systems.

Contribution of Course to Meeting the Professional Component:

Engineering topics: 100%

Status of Continuous Improvement Review of this Course:

Date Last Reviewed: Spring 2008

Prepared by: Uday B. Pal

Date: 6/9/09