Spring 2011 Syllabus

Instructor:
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Class Times and location
Lecture on Tuesday and Thursday 4:00-5:15pam ***in 3201J.M Patterson Building***

Credit Hours:
3 hrs

Recommended Texts:
1. Handbook of Batteries (3rd Edition), Edited by: Linden, D.; Reddy, T.B. © 2002 McGraw-Hill (go to http://www.knovel.com.proxy-um.researchport.umd.edu/web/portal/main, searching for Handbook of Batteries)
2. Advanced Batteries, Materials Science Aspects, Robert A. Huggins, Available online, http://www.springerlink.com/content/978-0-387-76423-8#section=172379&page=1&locus=22)
3. Fuel cell Systems Explained, 2nd Ed James Larminie and Andrew Dicks, John Wiley & Sons, Inc., 2003 (go to http://www.knovel.com.proxy-um.researchport.umd.edu/web/portal/main, searching for Fuel cell Systems Explained
4. Electrochemical Methods, 2nd Ed., A.J. Bard and L.R.Faulkner, John Wiley & Sons, Inc., 2001
5. Usage of UMD's digital library including electronic papers and journals will be used to support the lecture material. Additional reference and supplemental material to be supplied via Blackboard.

Prerequisites: None

Catalog Statement:
This course is for upper level undergraduates and early graduate students interested in the scientific challenges of electrochemical power sources. The lecture will start from the fundamental electrochemistry, and thermodynamics and kinetics of electrode process, with emphasis on electroanalytical techniques and advanced electrochemical power sources including batteries, fuel cells and supercapacitors.

Introduction
Electrochemical energy conversion (fuel cells) and storage (batteries and supercapacitors) are in massive and rapidly growing demand as the power source for portable devices, electric vehicles and renewable energy storage. One critical issue to the success of EV/HEV and renewable energy is the use of electrochemical power sources such as batteries and fuel cells, which can convert chemical energy to electrical energy more efficiently and quietly than internal combustion engines. Today's college students are the future of the new electric vehicle and renewable energy industry and critical to achieving the vision of a sustainable energy. To engage

students in engineering design issues related to the battery and fuel cell technologies, Dr. Wang create this new undergraduate/graduate course.

Objective: The objective of the course is to give the students a solid foundation upon which they will be able to use the modern electrochemistry, fuel cell, battery and supercapacitor technologies into their research and career.

Course Description and Content: The lecture will start from the basic thermodynamics and kinetics of electrochemical reaction, with emphasis on electroanalytical techniques, fundamental principle and performance of batteries, supercapacitors and fuel cells.

Course content:

1. Thermodynamics of electrochemical reaction
2. Kinetics of electrochemical reaction
3. Electrochemical techniques
   Electrochemical impedance spectroscopy (EIS) and its application
   Cycling voltammetry and linear polarization
   Galvanostatic intermittent titration
4. Principle of battery
5. Advanced rechargeable battery
6. Li-ion batteries
7. Nanostructured materials for Li-ion batteries
8. Principle of supercapacitor
9. Advanced supercapacitor technology
10. Difference between batteries and supercapacitors
11. Principle of fuel cells
12. Types of fuel cells
13. New materials for proton exchange membrane fuel cell, alkaline fuel cell and solid oxide fuel cell
14. Applications of fuel cells
15. Fuel cell, battery and supercapacitor hybrid power systems

Course Schedule (subject to change)

Date	Topics
1/25	Introduction
1/27	Thermodynamics of electrochemical reaction (I)
2/1	Thermodynamics of electrochemical reaction (II)
2/3	Thermodynamics of electrochemical reaction (III) (home work 1)
2/8	Kinetics of electrochemical reaction (I)
2/10	Kinetics of electrochemical reaction (II) (home work 2)
2/15	Cycling voltammetry and Galvanostatic intermittent titration
2/17	Electrochemical impedance spectroscopy (I)
2/22	Electrochemical impedance spectroscopy (II)
2/24	Review of electrochemistry
3/01	Middle exam
3/03	Principle of rechargeable batteries

3/08	Advanced Li-ion batteries (I)
3/10	Advanced Li-ion batteries (II) (home work 3)
3/15	Advanced Li-ion batteries (III)
3/17	Advanced Li-ion batteries (IV) (home work 4)
3/22	Spring Break
3/24	Spring Break
3/29	Li-air and Li-S batteries
3/31	Principle of supercapacitor and current supercapacitor technologies
4/5	Proton exchange membrane fuel cell (I)
4/7	Proton exchange membrane fuel cell (II)
4/12	Proton exchange membrane fuel cell (III)
4/14	Proton exchange membrane fuel cell (IV) (home work 5)
4/19	Alkaline fuel cell
4/21	Ceramics for solid oxide fuel cells
4/26	Solid oxide fuel cell (I)
4/28	Solid oxide fuel cell (II)
5/3	Solid oxide fuel cell (III) (home work 6)
5/5	Review on electrochemistry
5/10	Review on Fuel cell, battery and supercapacitor
	Final exam

General Course Logistics
ENCH 468K/648K use the Blackboard course environment. Instructor will upload all course notes, syllabus, home work assignments, and related information on the Blackboard. Students can login to their course(s) by going to https://elms.umd.edu/.

Home work assignments
Six home works will be assigned to students. In each home work, the problems assigned to undergraduate students will be different from graduate student assignments.

Grading:
Home works=35%; Midterm exam=25%, Final exam=40%