ENCH 473 Electrochemical Energy Engineering
Spring 2019 Syllabus

Course: CHBE 473 Electrochemical Energy Engineering
Semester: Spring 2019
Instructor: Chunsheng Wang
Lecture Day/Time: Tuesday and Thursday 5:00pm - 6:15pm
Location: **AJC 2121**
Office hours: Tuesday and Thursday 2:00pm - 3:00pm
Office: 1223C Chemical and Nuclear Building
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TA: Tao Deng
TA office hours: Tuesday, 4:00 to 5:00 pm, TA Room (CHE1124)
Email: tdeng1@umd.edu

Website/Canvas: www.elms.umd.edu

COURSE DESCRIPTION:
The lecture will start from the fundamental electrochemistry, with emphasis on the principle and performance of batteries and fuel cells. 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 and battery technologies into their research and career.

Recommended Texts:
1. Advanced Batteries, Materials Science Aspects, Robert A. Huggins, Available online, Free download from UMD library (http://umaryland.worldcat.org/title/advanced-batteries-materials-science-aspects/oclc/656393888&referer=brief_results)
2. Fuel cell Systems Explained, 2nd Ed James Larminie and Andrew Dicks, John Wiley & Sons, Inc
3. Electrochemical Engineering, Thomas F. Fuller and John N. Harb, 2018, John Wiley & Sons, Inc, Hoboken NJ. ISBN: 978-1-119-00425-7.
4. Additional reference and supplemental material to be supplied via Blackboard.

Course policies:
- Homework should be completed on an individual basis. Students may discuss together but each student needs to turn in his or her own work. Homework copied from another student is in violation of the University's Code of Academic Integrity (https://president.umd.edu/administration/policies/section-iii-academic-affairs/iii-100a). Homework is due at the beginning of the class, and is to be submitted in paper form (not electronically). No late homework is accepted, but the lowest homework grade will be dropped.
- Any conflict regarding any grade (homework, exams, quizzes, etc) must be resolved within 1 week after the grade is returned

- The TA will address any concerns about homework grading (see above for office hours and contact information). Solutions will not be posted.
- If you need to miss class on the day of an exam or the day an assignment for a personal reason, such as a religious observation not recognized by the university, please contact the instructor and TA at least 2 weeks before your anticipated absence to discuss alternative arrangements.
- Students with disabilities are requested to provide a written request and documents from the University of Maryland Disability Support Services (http://counseling.umd.edu/DSS). Please submit any requests by February 6th.

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.

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. Electroanalytical techniques
   Electrochemical impedance spectroscopy (EIS)
   Cycling voltammetry and linear polarization
   Galvanostatic intermittent titration
4. Principle of battery
5. Li-ion batteries
6. Li-S and Li-air batteries
7. Principle of fuel cells
8. Proton exchange membrane fuel cell,
9. Solid oxide fuel cell

Grading:

Home works=20%;
Midterm exam=35%,

Final exam=40%
Quiz and attendance: 5%

Tentative course schedule:

Tentative course schedule (dates, topics, and homeworks are subject to change)

Class number	Date	Topics, and homework
1	1/29	Topics: Syllabus, course introduction, electrochemical cell basics
2	1/31	Topics: Thermodynamics of electrochemical reaction (I)
3	2/5	Topics: Thermodynamics of electrochemical reaction (II)
4	2/7	Topics: Thermodynamics of electrochemical reaction (III) Homework #1 Assignment
5	2/12	Topics: Kinetics of Electrochemical Reactions (I)
6	2/14	Topics: Electrochemical kinetics Homework #1 Due
7	2/19	Topics: Kinetics of Electrochemical Reactions (III) Homework#2 Assignment
8	2/21	Topics: Electroanalytical techniques (I)--- GITT, CV
9	2/26	Topics: Electroanalytical techniques (II) ----- EIS Homework #2 Due
10	2/28	Middle exam (whole class period)
11	3/5	Topics: Principle of batteries , Li-ion batteries --- anodes (I)
12	3/7	Topics: Review midterm results, course survey
13	3/12	Topics: Li-ion batteries ----anode (II)
14	3/14	Topics: Li-ion battery ----- anodes (III) Homework #3; Assignment
Spring Break		
15	3/26	Topics: Li-ion battery ----- cathodes (I)
16	3/28	Topics: Li-ion batteries----- cathodes (II) Homework #3 Due
17	4/2	Topics: Li-ion batteries----- electrolytes (I)
18	4/4	Topics: Li-ion batteries----- electrolytes (II) Homework #4 Assignment
19	4/9	Topics: Special topic: Li-S, Li-air and flow batteries
20	4/11	Topics: Proton exchange fuel cells (I) Homework #4 Due
21	4/16	Topics: Proton exchange fuel cells (II)
22	4/18	Topics: Proton exchange fuel cells (III)
23	4/23	Topics: Proton exchange fuel cells (IV)
24	4/25	Topics: Solid oxide fuel cells (I) Homework #5 Assignment
25	4/30	Topics: Solid oxide fuel cells (II)
26	5/2	Topics: Solid oxide fuel cells (III) Homework #5 Due
27	5/7	Topics: TBD based on student input
28	5/9	Topics: Review of electrochemistry

29	5/14	Topics: Review of batteries and fuel cells
	TBD	Final exam