Syllabus of ME 4803, Electrochemical Storage and Conversion

Spring 2017

Course Purpose:

Energy is a fundamental issue facing society world-wide. Electrochemical devices play an important role in energy storage and conversion, especially at certain power-levels. Evolving renewable energy sources may have a critical dependence on electrochemical devices.

ME 4803 is an elective class for senior level undergraduates in ME or other disciplines (with permission of instructor). The course is appropriate for students interested in the general topic of energy and more specifically electrochemical devices used to store or convert energy from one for to another.

The course begins with a survey of our energy needs, world-wide distribution, and the role of different energy conversion and storage devices, including electrochemical methods. The fundamentals of electrochemical devices are presented including thermodynamic, kinetic, and transport issues. The contribution of thermodynamics, kinetics and transport to potential, current and power in electrochemical devices is discussed. The fundamentals and applications (i.e. specific case studies) of (i) batteries, (ii) fuel cells, and (iii) other electrochemical devices are presented and compared. The course will conclude with a team-based project where state-of-the-art issues with different technologies will be explored in-depth.

Select reading from specialized reference books, text books and journal papers will be assigned. Very limited homework will be assigned. It will be used as a learning tool where working a problem is important to understanding the concept.

Course evaluation will include (i) 35%- a weekly quiz covering the previous week's material (5-10 minutes- the lowest quiz will be dropped), (ii) 30%- a final exam (required by GT), (iii) 15%-a short project, (iv) 15%-Homework, and (v) 5%- perhaps other minor things like class participation.

ME 4803 Electrochemical Energy Storage and Conversion: Spring 2017
Book: Electrochemistry and Electrochemical Engineering

Bold text is for 2017

Week #	Class	Topic	Quiz Schedule
1:	1	**Introduction**	
	2	**What is energy**	
	3	**World energy use, renewables**	
2:	4	**Battery concept, electrochem series**	
	5	**Battery thermos and Nernst**	**Quiz 1**
	6	**Battery Characteristics**	
3:	7	**Charge, Field, Potential-Poisson Eq.**	
	8	**Gibbs Energy and Equilibrium**	**Quiz 2**
	9	**Poisson Eq. and battery discharge**	
4:		**Poisson Eq. and battery discharge**	
	10	**Chemical potential and Nernst Eq.**	**Quiz 3**
	11	**Electrochemical potentials**	
5:	12	**Electrochemical potential**	
	13	**Homogeneous kinetics**	**Quiz 4**
	14	**Heterogeneous kinetics and BV**	
6:	15	**Linear Kinetics and Tafel equation**	
	16	**Mass Transfer.**	**Quiz 5**
	17	**Diffusion and potential step, CV**	
7:	18	**Transference number**	
	19	**Binary electrolyte & copper example**	**Quiz 6**
	20	**Binary electrolyte and Li ion example**	
8:	21	**Battery discharge**	
	22	**Battery V-I**	**Quiz 7**
	23	**Battery Capacity**	
9:		**Battery metrics**	
	24	**Battery metrics**	**Quiz 8**
	25	**Primary batteries**	
10:	26	**Primary batteries**	
	27	**Finish Primary batteries, Zn air**	**Quiz 9**
	28	**Lead acid**	
11:	29	**Lead acid**	
	30	**Wagner number**	**Quiz 10**
	31	**Porous electrodes**	
12:	32	**Porous electrodes**	
	33	**Porous electrode conclusions and Li**	**Quiz 11**
	34	**Lithium Ion**	
13:	35	**Lithium Ion**	
	36	**Li Air and Li-S**	**Quiz 12**
	37	**Beyond Lithium (sodium ion)**	
14:	38	**Beyond Lithium (Mg and)**	

	39	**Solid state battery**	**Quiz 13**
	40	**Fuel cell equations from chapter**	
15:	41	**Alkaline, molten carbonate, SOFC**	
		PEM	**Quiz 14**
		PEM	
16:	42	**Supercapacitors**	
	43	**Supercapacitors**	
	44	**Quiz and final comments**	
Final Exam			
Holiday		Jan 16	
Holiday		March 20-24	
Holiday			
TA		TBD	
Office Hr		TBD	