MAE 4301/ME 5390 Introduction to Alternative Energy Systems

Fall 2011 MW 4:00~5:20PM WH 210

INSTRUCTOR: Dr. Daejong Kim, Assistant Professor
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Office hours: TTh 3~5pm or by appointment by email or phone

PREREQUISITES: MAE 3310 Thermodynamics I and/or graduate standing

COURSE DESCRIPTION

The course introduces: principles and thermodynamics applied to fuel cell-based power generation systems; materials and manufacturing methods of two common fuel cells and their stacks; modeling, analysis, and design of fuel cells and various reformers; and design issue of balance of plants such as steam management systems

COURSE OBJECTIVES

1. Learn thermodynamics, electrochemistry, reaction kinetics, and chemical equilibrium applied to fuel cells systems including reformers
2. Learn how to model, formulate, solve, and analyze fuel cell systems and reformer
3. Learn how to design balance of plants for fuel cell systems

TEXTBOOK:

Primary: Fuel Cell Engines, 2nd ed., M. M. Mench, Wiley
References: Fuel cell fundamentals, 2nd ed., O'Hayre et al, Wiley; Fuel cell systems explained, 2nd ed., J. Laminie, A. Dicks, Wiley; Class notes and published papers

GRADING - Grading will be based on weighted average of homework assignments, midterm exam, and final exam.

HW: 30%
Midterm Exam: 30%
Final Exam: 40%

CLASS SCHEDULE (Tentative)

Weeks	Topics	Assignments
1	Introduction to fuel cell	
	Type of fuel cells	
2	Electrochemical reaction	
	Basics of electrochemistry	HW 1
3	Enthalpy, Gibb's energy, thermodynamic relations	
	Heat potential of fuel, enthalpy of reaction, work potential of fuel	
4	Gibb's energy and cell open circuit voltage (OCV), Nernst equation	HW 2
	Effect of temperature, pressure, and activities on OCV	
5	Fuel cell efficiency, fuel utilization, air utilization	HW 3
	Air/fuel calculation for stoichiometric fuel cell	
6	Fuel cell loss: activation polarization (loss)	HW 4
	Fuel cell loss: activation polarization (loss); cont.	

7	Butler-Volmer Equation	
	Fuel cell loss: Ohmic polarization (loss)	HW 5
8	Fuel cell loss: Ohmic polarization (loss); cont.	
	Fuel cell loss: concentration polarization (loss)	HW 6
9	Materials for PEM fuel cells , Design and manufacturing of PEM fuel cell stacks	
	Principle of SOFC , Architecture of SOFC systems	
10	Phase and chemical equilibrium	
	Reaction rates, equilibrium constants	HW 7
11	Reaction rates, equilibrium constants; cont.	
	Materials for SOFC fuel cells	Exam
12	Design and manufacturing of SOFC fuel cell stacks	
	Introduction to reformers and their principles	
13	Introduction to reformers and their principles; cont.	
	Calculation of equilibrium composition of reformer	
14	Heat exchangers for fuel cell and reformer	HW 8
	Steam management of SOFC systems	
15	Introduction to SOFC-Gas turbine hybrid systems	
	Cycle analysis of SOFC-Gas turbine hybrid system	
16	Review	
	Final exam (Dec 14 Wed 2~4:30pm)	Final exam