MAE 4301/ME 5390 Introduction to Alternative Energy Systems

MW 2:30~3:50PM

INSTRUCTOR: Dr. Daejong Kim, Assistant Professor
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Office hours: MW 4~5pm or by appointment by email or phone

PREREQUISITES: MAE 3311 Thermodynamics II 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 design issue of balance of plants such as steam management systems and heat exchangers.

COURSE OBJECTIVES
1. Learn thermodynamics, electrochemistry, reaction kinetics, and chemical equilibrium applied to fuel cells systems
2. Learn how to model, formulate, solve, and analyze fuel cell systems
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, one exam, and term project.

HW: 20% (HW assignment schedule may be different from the class schedule)
Exam: 30%
Term project: 50% (two persons per team, topic to be assigned later)

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	HW 2
4	Gibb's energy and cell open circuit voltage (OCV), Nernst equation	
	Effect of temperature, pressure, and activities on OCV	HW 3
5	Fuel cell efficiency, fuel utilization, air utilization	
	Air/fuel calculation for stoichiometric fuel cell	HW 4
6	Fuel cell loss: activation polarization (loss)	
	Butler-Volmer Equation	HW 5

7	Fuel cell loss: Ohmic polarization (loss)	
	Fuel cell loss: concentration polarization (loss)	HW 6
8	Materials for PEM fuel cells	
	Design and manufacturing of PEM fuel cell stacks	
9	Principle of SOFC	
	Architecture of SOFC systems	
10	Phase and chemical equilibrium	
	Reaction rates, equilibrium constants	HW 7
11	Materials for SOFC fuel cells	
	Design and manufacturing of SOFC fuel cell stacks	Exam
12	Internal reforming, modeling of reformer	
	Modeling of SOFC fuel cell stacks	
13	1-D CFD method for fuel cell flows	
	Modeling of heat exchangers	HW 8
14	Steam management of SOFC systems: modeling/design of ejector	
	Steam management of SOFC systems: modeling/design of blower	
15	Introduction to SOFC-Gas turbine hybrid systems	
16	Presentation of term project	Term project