

## ME262 – Fuel Cell Fundamentals, Modeling, and Diagnostic

### FACULTY INFORMATION:

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Office Hours: Tuesday and Wednesday 5:30 – 6:30 pm

### COURSE INFORMATION:

Term: Spring 2018  
Designation : ME 262  
Course Title: Fuel Cell Fundamentals, Modeling, and Diagnostics  
Credits: 3 Credit Hours  
Prerequisite(s): N/A (Knowledge of Fluid Mechanics and Thermodynamics are required)  
Textbook: R. O'Hayre, S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley M. H. Nehrir, C. Wang, Modeling and Control of Fuel Cells, Wiley  
H Wang, X. Yuan, H. Li, PEM Fuel Cell Diagnostic Tools, CRC Press  
A. Bard, L. R. Faulkner, Electrochemical Methods, Wiley  
Class Date/Time: TR 10:30 am – 11:45 am  
Location: CLSSRM 279

### COURSE LEARNING OUTCOMES:

This course will focus on the introduction of fundamental knowledge of fuel cell operation and applications of various fuel cell technologies. Upon completion, students should be able to:

1. Apply fundamentals of electrochemistry, thermodynamics, fluid mechanics, and heat and mass transfer, as appropriate, to examine various fuel cells.
2. Articulate the basic fundamentals of electrochemistry in terms of electrode processes, electrochemical potential, thermodynamic and kinetics of electrode reactions applicable to electrochemical systems.
3. Describe, explain, and model the various types of electrochemical over-potential occurring within the electrochemical system including ohmic, concentration, and activation overpotentials.
4. Identify the main components, advantages, and limitations of proton exchange membrane, direct methanol, solid oxide, molten carbonate, alkaline, phosphoric acid, and solid oxide fuel cell systems.
5. Design and conduct experiments and/or simulations of mechanical systems, and to analyze and evaluate these solutions in the context of fuel cell technology
6. Work more effectively in groups to work through open-ended design problems.
7. Demonstrate professionalism, and respectful interaction with faculty and colleagues.

### PROGRAM LEARNING OUTCOMES:

The course relates to these following mechanical engineering program learning outcomes:

1. Identify significant research questions in fuel cell technology, and contextualize their research in the current literature of the field.
2. Apply knowledge of mathematics, science, and engineering to solve a problem, and to design and implement a suitable solution.
3. Design and conduct experiments and/or simulations of fuel cell systems, and to analyze and evaluate these solutions in the context of existing technologies.
4. Communicate effectively through oral, visual, and written means, with a broad range of technical audiences.

**COURSE CONTENTS:**

- Overview of fuel cells and fuel cell systems
- Basic electrochemistry of electrode reaction
- Thermodynamics of a fuel cell system
- Efficiency and open circuit voltage
- Kinetics and electrochemical reaction, Ohmic losses, Mass transfer losses
- Water and thermal management
- 1-D single-phase PEM Fuel cell modeling
- Electrochemical Impedance Spectroscopy (EIS)
- Cyclic Voltammetry (CV)
- Laboratory fuel cell experiment
- Group design project

**GRADING POLICY & DISTRIBUTION:**

93.0 – 100	A	HW (1-3 assignments)	15%
90.0 – 92.9	A-	HW (4-5 assignments)	20%
87.0 – 89.9	B+	Midterm Exam	20%
83.0 – 86.9	B	1-D Fuel Cell Model	15%
80.0 – 82.9	B-	Final Project (Presentation)	25%
< 79.9	C	Others (Quiz, participation, etc.)	5%
TOTAL			100%

***Homework Assignment:***

Bi-weekly homework will be assigned and will be posted on Canvas on Thursday before 11:59 pm. The assignment will be collected on the following Thursday before class. Half of the points will be deducted if turned in late before 5 pm on Thursday. You can bring it to my office or slide it under my door. No points will be given if turned in later than 5 pm on Thursday.

***In-Class Midterm Exam:***

There will be one in-class midterm exam on 3/13 (Tuesday). It is an open book exam and you are allowed to use the textbook and course notes and/or written notes. There will not be any make-up exam available.

***Final Exam:*** There will not be a final exam, but rather a final project will be assigned.

**Grade Disputes:**

If a student feels that an exam or homework set was graded unfairly, or if there is an error in the grading, it should be brought to instructor's attention within one week after the graded material is handed back. Scores will not be reconsidered beyond one week after they are handed back.

**COURSE EVALUATION NOTICE:**

During the last two weeks of the semester, you will be provided an opportunity to evaluate this course and your instructor. On Monday of the 15<sup>th</sup> week of classes, you will receive an official email from evaluation administrators with a link to the online evaluation site. You will have two weeks to complete this evaluation. Your participation in this evaluation is an integral part of this course. Your feedback is vital to improving education at UC Merced.

**CLASSROOM RULES:**

Courtesy in the classroom is a necessary for enhancement of learning. The following administrative guidelines and rules shall apply:

- Please turn off all cell-phones, pagers, beepers, etc. before entering the classroom.
- Do not read newspapers or use your smart phone once the lecture has started.
- Refrain from socializing with fellow students during the lecture.

Your cooperation in complying with these rules is appreciated by the instructor and your classmates.

### **ACADEMIC DISHONESTY STATEMENT:**

- a. Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work.
- b. You are encouraged to study together and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e mail, an e mail attachment file, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action.
- c. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.

### **ATTENDANCE POLICY:**

Attendance is essential to keep up-to-date with coursework. Be familiar with University Regulations, part 2, Section VI, regarding class participation. Please read this important document. Major medical incidences and emergencies that affect any student's participation in the course need to be reported to the instructor as soon as possible. Extended medical absences will require documentation. If you have to miss a live online lecture, please arrange to get class notes from a classmate.

### **DISABILITY STATEMENT:**

Accommodations for Students with Disabilities: The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. I am available to discuss appropriate academic accommodations that may be required for student with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with Disability Services Center to verify their eligibility for appropriate accommodations.

### **CATALOG DESCRIPTION:**

Fundamentals of equilibrium, temperature, energy, and entropy. Equations of state and thermodynamic properties, with engineering applications.

### **DISCLAIMER:**

In the event of a major campus emergency, the above requirements, deadlines and grading policies are subject to changes that may be required by a revised semester calendar. Any such changes in this course will be posted once the course resumes on CANVAS or can be obtained by contacting the professor via email or phone.