Faculty of Engineering

COURSE OUTLINE

Mech 449 – Fuel Cell Technology

Term – SPRING 2016 (201601)

Instructor	**Office Hours**
Dr. Ned Djilali	Days: Monday, Tuesday
Phone: 250 721-1099	Time: 2:30-3:30
E-mail: ndjilali@uvic.ca	Location: EOW 525

Prerequisites: Mech 240; Mech 345

Lecture Schedule

Section: A01 /CRN 22219	Days:	Time:	Location:
	Tuesday	9:30-11:20	Cornett A 129
	Wednesday	9:30-10:30	Cornett A 229

Attendance

Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time.

An instructor may refuse a student admission to a lecture or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations.

Students who do not attend classes must not assume that they have been dropped from a course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tuition fee for the course." UVic Calendar, (2015) http://web.uvic.ca/calendar2015-09/FACS/UnIn/UARe/Atte.html

TA Name	**E-mail**
Padmini Kutturu	padminik@uvic.ca

Required Text
Title: *Fuel Cell Engines*
Author: M. M. Mench
Publisher/Year: Wiley, 2008

COURSE OBJECTIVES: Fuel cells are at the forefront of what has been termed the "hydrogen economy". They offer the prospect of zero-emission sustainable energy for a wide spectrum of applications and over a broad range of power requirements, from mW to MW. Examples of existing and planned commercial applications include: FCs powered buses, stand-by power plants for buildings and telecommunications, cellular phones, and in-situ drug delivery systems.

Fuel cells are electrochemical energy conversion devices. The practical implementation of FC technology involves system integration of a fuel cell stack with ancillaries (compressor, heat exchanger, fuel processor etc.) and a fuel supply. The primary focus of the course will be on fuel cell stacks, with an introductory overview of system issues.

The objectives of the course are to: (i) develop a basic understanding of the electrochemical, thermodynamic and transport processes governing fuel cell operation; (ii) acquire technical competence in fuel cell technology including design and quantitative analysis of various types of fuel cells and the parameters affecting their performance; (iii) develop an appreciation for some of the practical aspects of fuelling and fuel cell system integration and operation; (iv) become familiar with the Canadian fuel cell and hydrogen sector; and (v) broaden awareness with respect to the role and impact of energy in society.

LEARNING OUTCOMES: At the end of this course, students will:

Develop a basic understanding of the electrochemical, thermodynamic and transport processes governing fuel cell operation.
Be able to calculate Gibbs free energy and enthalpy; calculate efficiency; estimate losses and performance (polarization curve); calculate fuel/oxidant consumption rates and water/heat production rates.

Acquire technical competency in fuel cell technology including design, performance assessment, and quantitative analysis related to:
i) PEM fuel cells: structure and design; materials; transport processes; water management
ii) Microfuel cells: architectures, fuelling, performance
iii) Solid Oxide Fuel Cell: architectures, materials,

Develop an appreciation for practical aspects of fuelling and fuel cell system integration operation related to:
i) Economic aspects of fuelling
ii) Hydrogen production via reforming and electrolysis
iii) Hydrogen storage and fuelling

TOPICS COVERED

Module		**Topic**
I.	1.	OVERVIEW OF FUEL CELL SYSTEMS Fuel cells and the hydrogen economy. Fuel cells basic operation. Brief history of development. Fuel cell plants; performance; emissions. Characteristics and status of various types of fuel cells. FUNDAMENTALS
	2.	Fuel cell thermodynamics; open circuit voltage; efficiency. Basic electrochemistry. Operational fuel cell performance; losses. Transport phenomena.
II.	3.	PROTON EXCHANGE MEMBRANE FUEL CELLS Components; polymer electrolyte membranes; catalysts; gas diffusion electrodes; collector plates. Water management. Heat management. Testing and diagnostics. Cell and stack design issues MICRO FUEL CELLS
	4.	Drivers & Market. Principles, design, components, materials, and performance: direct methanol FCs; air breathing fuel cells; microfluidic and bio fuel cells.

III.	5.	SOLID OXIDE FUEL CELLS (SOFCs) Components and materials. Design and stack configurations. Performance. New developments.
	6.	FUELLING & SYSTEM INTEGRATION Transition in energy sources. Introduction to fuel processing. Renewable hydrogen production. Electrolysis. Hydrogen storage. System integration.
	7.	SUMMARY AND OUTLOOK

ASSIGNMENTS:

4 problem sets will be assigned and solutions will be posted on the course web site. Grades for assignments will be based on marking of selected question(s).

QUIZZES:

"Flash Quizzes" of about 5-10 min. duration will be randomly assigned during class. These will be on various topics discussed in class and/or from assigned readings. Marks from these quizzes will be added as an up to 3% bonus towards the final course grade.

MIDTERMS:

The course is organized in three modules; each of which will be examined separately.

The examinations will be held on the following dates (location to be specified):

Module I	Tuesday February 2
Module II	Thursday March 8
Module III	Thursday March 29

You will be allowed to use class notes, handouts, assignments and a handwritten formula page (standard letter size; no photocopies). No other texts or material are permitted.

FINAL EXAMINATION:

There is no final examination.

Assessment:	**Weight**	**Due Date**
Assignments:	15%	TBA for each assignment
Mid-term 1	35 %	Date: Feb. 2
Mid-term 2	35 %	Date: March 8
Mid-term 3	15 %	Date: March 29

NOTE: Notes, assigned readings and assignments will be posted regularly on CourseSpaces as the course proceeds

The final grade obtained from the above marking scheme for the purpose of GPA calculation will be based on the percentage-to-grade point conversion table as listed in the current Undergraduate Calendar.

There will be no supplemental examination for this course.

Note to Students:

Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Chair's Secretary to set up an appointment.

Accommodation of Religious Observance (AC1210)
http://web.uvic.ca/calendar2015-09/GI/GUPo.html

Discrimination and Harassment Policy (GV0205)
http://web.uvic.ca/calendar2015-09/GI/GUPo.html

Faculty of Engineering, University of Victoria
Standards for Professional Behaviour

"It is the responsibility of all members of the Faculty of Engineering, students, staff and faculty, to adhere to and promote standards of professional behaviour that support an effective learning environment that prepares graduates for careers as professionals…."

You are advised to read the Faculty of Engineering document Standards for Professional Behaviour which contains important information regarding conduct in courses, labs, and in the general use of facilities.
http://www.uvic.ca/engineering/current/undergrad/index.php#section0-23

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult the Undergraduate Calendar for the UVic policy on academic integrity.

Policy on Academic Integrity
http://web.uvic.ca/calendar2015-09/FACS/UnIn/UARe/PoAcI.html

Course Lecture Notes

Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.