COURSE OUTLINE
AREA 300 Fuel Cells

Prepared By: Michael J. Newtown
Updated By: Matthew Bullwinkel April 2012
Updated By: Michael J. Newtown, P.E. May 2015
A. **TITLE**: Fuel Cells

B. **COURSE NUMBER**: AREA 300

C. **CREDIT HOURS**: 3

D. **WRITING INTENSIVE COURSE**: No

E. **COURSE LENGTH**: 15 weeks

F. **SEMESTER(S) OFFERED**: Fall or Spring

G. **HOURS OF LECTURE, LABORATORY, RECITATION, TUTORIAL, ACTIVITY**: 3 hours of lecture per week

H. **CATALOGUE DESCRIPTION**: Students will discover the science involved in the operation of fuel cells and technical applications of a fuel cell in providing electricity and heat. Topics explored are hydrogen as a fuel, energy efficiency, and operational characteristics of a fuel cell. In depth studies of proton exchange membrane, alkaline electrolyte fuel cells, and direct methanol fuel cells will teach students about the conversion of hydrogen fuel to useable forms of energy.

I. **PRE-REQUISITES/CO-COURSES**:
   a. Pre-requisite: CHEM 150, College Chemistry I

J. **STUDENT LEARNING OUTCOMES**: By the end of the course, the student will be able to:

<table>
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<tr>
<th>Course Objective</th>
<th>Institutional SLO</th>
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<tr>
<td>b. Identify the major types of fuel cells.</td>
<td>2. Crit. Thinking 3. Prof. Competence</td>
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<td>c. Evaluate the benefits and disadvantages of fuel cells as a means of providing power.</td>
<td>1. Communication 3. Prof. Competence</td>
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<td>d. Create a graphical image describing the function of a full cell.</td>
<td>2. Crit. Thinking 3. Prof. Competence</td>
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<td>e. Assess the practical applications of fuel cells</td>
<td>2. Crit. Thinking</td>
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<tr>
<td>f. Calculate operational and capital costs of a typical fuel cell.</td>
<td>2. Crit. Thinking 3. Prof. Competence</td>
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<tr>
<td>g. Identify typical operating parameters such as pressure, reactant types and water management.</td>
<td>2. Crit. Thinking 3. Prof. Competence</td>
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L. **REFERENCES:**
   International Journal of Hydrogen Energy
   Journal of the Electrochemical Society
   Journal of Power Sources

M. **EQUIPMENT:** Technology enhanced classroom

N. **GRADING METHOD** (P/F, A-F, etc.): A-F

O. **MEASUREMENT CRITERIA:**
   Exams 3-4
   Homework and Quizzes
   Term Research Project
   Short Paper/ Presentation

P. **DETAILED TOPICAL OUTLINE:** See attached sheet

Q. **LABORATORY OUTLINE:** N/A
I. Introduction to Fuel Cells
   a. Basic Principles
   b. Types of fuel cells
   c. Limits to fuel cells
   d. Advantages and applications

II. Efficiency of Fuel Cells
   a. Energy and Electromagnetic force
   b. Open circuit voltage
   c. Efficiency and limits of fuel cells
   d. Effect of pressurization and gas levels

III. Operation of Fuel Cells
   a. Terminology
   b. Irreversibility and voltage drop
   c. Types of losses
   d. Fuel cross over and internal currents
   e. Double layering charges

IV. Proton Exchange Membrane Fuel Cells
   a. How a polymer electrolyte works
   b. Electrodes and structures necessary to produce current
   c. Water and air flow problems
   d. Cell cooling
   e. Bipolar plate
   f. Operating pressure
   g. System examples

V. Alkaline Electrolyte Fuel Cells
   a. Basic principle and advantages
   b. Types of alkaline electrolyte fuel cells
   c. Pressures and temperatures
   d. Materials for electrodes
   e. Systemic problems
VI. Direct Methanol Fuel Cells
   a. What are direct methanol fuel cells
   b. Catalysts for reactions
   c. Electrolyte and contamination
   d. Cathode reactions
   e. Fuel production and storage
   f. Applications

VII. Fuel for Fuel Cells
   a. Fossil fuels
   b. Bio-Fuels
   c. Processing of fossil fuels
   d. Biological production of hydrogen
   e. Storage of hydrogen
      i. Gaseous methods
      ii. Chemical methods

VIII. Delivering Fuel Cell Power
   a. Direct current regulation
   b. Inverters
   c. Electric motors
   d. Hybrid systems
Core Competency Course Evaluation Form

Course No. AREA 300
Course Name FUEL CELLS
Evaluator: Michael J. Newtown
Date: September 22, 2004

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This course meets the following core competencies: (check all that apply and note exceptions)

- X I Mathematics (except 3)
- X II Communication
- X III Problem Solving (except )
- X IV Critical Thinking (except 9,10)
- X V Information Literacy (except )
- X VI Individual & Social Responsibility (except )
- X VII Science (except )
- X VIII Technology (except )

The method of measurement is: (check all that apply)

- class participation
- speeches
- projects
- comprehensive final
- portfolio
- standardized test
- P/F laboratory competency
- X other (please specify) Homework

X written exams
X research papers
X quizzes
oral reports
laboratory practicums
laboratory reports
essays

Comments: