MECH-426, Fuel Cell Science and Engineering

Catalog Data: Credit (4-0-0-4) Four Lecture Hours

Prerequisites
MECH-322 Fluid Mechanics
CHEM-135/136 Principles of Chemistry

The objectives of this course are to introduce the students to, and to provide an experience, in the engineering and design of PEM fuel cell devices and systems. The course lecture will cover the five main types of fuel cells and their operational parameters and applications, efficiency, and open circuit voltages. Other topics include fuel cell systems, compressors, turbines, fans, blowers, pumps, DC voltage regulation and voltage conversion, fuels for fuel cells and methods of processing. Students will also study the design requirements for the introduction of fuel cells into various devices such as: golf-cart, bicycles, laptops, toys, road signs, etc. The lecture is supported with laboratory experiences. Students will also be exposed to Fuel Cells as a mitigating technology for Global Warming and Climate Change.

Textbook(s): PEM Fuel Cells: Theory and Practice, 2nd Edition, Frano Barbir, Elsevier, 2013.

Interdisciplinary handouts are used.

References: Fuel Cells and Their Applications. Karl Kordesch, Gunter Simander. VCH Publishers Inc. N.Y., N.Y. USA. Reprint 2001.

Fuel Cell Systems Explained, James Larminie, Andrew Dicks, John Wiley & Sons, 2003.

Fuel Cell Systems. Leo J.M.J. Blomen, Michael N. Mugerwa. Plenum Press, New York, 1993

SAE publications 1999-2016

Coordinator(s) K. J. Berry, Ph.D., P.E., Professor of Mechanical Engineering

Course Learning Objectives:

1. Student will demonstrate the ability to understand the operation of PEMFC, SOFC, AFC, MCFC, and ZAFC.
2. Students will demonstrate the ability to understand the performance charts of various forms of fuel cells, compressors, DC-DC electronics, and other components required for system design.
3. Students will demonstrate the ability to apply fuel cell equations for the computation of fuel cell stack, component, and system efficiencies.
4. Students will demonstrate an understanding of hydrogen production technology.
5. Students will demonstrate an understanding of safety and regulatory issues regarding onboard transportation and storage of FC devices in passenger aircrafts and public transport systems.
6. Students will demonstrate an understanding of simulation of fuel cell balance of plant.
7. Students will demonstrate an understanding of the impact of global warming and climate change and how fuel cells can be a mitigating technology.

Prerequisites by topic:

1. Gas laws, Nernst Equation, Electrolysis of water, Chemical Equilibrium
2 Compressors, Turbines and Pumps
3. Electric Motors

Topics covered:

- Hydrogen Fuel Cells- Introduction, Types, Basic Principles (2 hours)
- Efficiency and open current voltage (2 hours)
- Operational fuel cell voltages (2 hours)
- Proton Exchange Membrane (PEM) fuel cells (6 hours)
- High Temperature PEM fuel cells (HTPEM) (2 hours)
- Medium and High temperature fuel cells, PAFC, MCFC, SOFC, ZAFC (4 hours)
- Hydrogen production and storage (4 hours)
- Compressors, turbines, fans, blowers, pumps (4 hours)
- Fuel Cell BOP modeling and simulation (4 hours)
- Exams (2 hours)
- Laboratory Experiences (8 hours)

Schedule: Two 120-minute sessions per week

Computer usage: Project requiring the use of EXCEL software to simulate fuel and oxidant flow rates and predict various processes occurring in the cell.

Laboratory projects: Laboratory exercises using Greenlight, Schatz Fuel Cell Test Stand and other apparatus.

Relationship to professional component: Two credits of Engineering Science and two credits of Engineering Design.

Prepared by: Dr. K. J. Berry

COMMON STATEMENT ON STUDENTS WITH DOCUMENTED DISABILITIES

The University will make reasonable accommodations for persons with documented disabilities. Students need to register with the Wellness Center every term they are enrolled in classes. To be assured of having services when they are needed, students should contact the Wellness Center during the first week of each term. Note that it is the student's responsibility to arrange accommodations with each professor. Testing accommodations are provided through the Academic Success Center (ASC). For more information on "Disability Services," refer to the Student Life section of Undergraduate Catalog.

COMMON STATEMENT ON ETHICS IN THE UNIVERSITY AND ACADEMIC INTEGRITY

Kettering University values academic honesty and integrity. Cheating, collusion, misconduct, fabrication, and plagiarism are serious offenses. Each student has a responsibility to understand, accept, and comply with the University's standards of academic conduct as set forth in our statement, "Ethics in the University," and "Academic Integrity" as well as policies established by individual professors. For more information, refer to the Undergraduate Catalog or the University's policy on Ethical and Behavioral Standards. This information is also noted in the Student Handbook.

COMMON STATEMENT ON MEDICAL EXCUSE POLICY

ONLY PROFESSORS MAY EXCUSE ABSENCES OF ANY TYPE. The Kettering University Wellness Center does not "excuse" absences except under certain specific circumstances, i.e., if an illness or injury that, after examination by a licensed health care practitioner [either at the Wellness Center or elsewhere, is determined to be either so severe or contagious that it possesses a threat to the patient or to the university community. Except in these circumstances, the Wellness Center does not produce written medical excuses.

Faculty are not expected to determine or diagnose a student's medical condition. Faculty must use flexibility and good judgment in determining whether to excuse missed work, extend deadlines, or substitute an alternative assignment.

Students who cannot reach a suitable agreement with an instructor regarding missed classes and related assignments or tests as a result of a documented serious medical condition should contact the appropriate academic department head or the Dean of Students' office.

ACADEMIC ASSISTANCE

Academic assistance with class work and writing is available not only from your professors, but also from the Academic Success Center (ASC).

STATEMENT ON SEX AND GENDER-BASED DISCRIMINATION

Kettering University is committed to an inclusive learning environment free from discrimination or harassment based on gender, sexual orientation, gender identity, or expression. Such discrimination and harassment include sexual harassment, sexual assault, stalking, domestic/dating violence, or any other form of sex-based discrimination. The University encourages anyone who experiences such harassment or discrimination to report the matter to the Kettering University Title IX Coordinator, Betsy Homsher, at bhomsher@kettering.edu, 810-762-9540. For more information about your options, including reporting and confidential resources, please visit https://my.kettering.edu/page/what-title-ix.