The Hydrogen Economy and Hydrogen Infrastructure Needs (4 credits)

TIME & DATES:
5:30 p.m. - 7:20 p.m. Mondays and Wednesdays

LOCATION:
Main Campus TBD

INSTRUCTOR:
Peter Faguy, Ph.D. Adjunct Professor of Chemical Engineering and Materials Science
Phone: 248-396-2399 peter.faguy@wayne.edu

OFFICE HOURS:
By appointment only, to be scheduled and confirmed via e-mail.

OBJECTIVE:
That hydrogen fuel cells will emerge to replace fossil fuels as the dominant global energy carrier is no longer an expectation shared only by a few academics and entrepreneurial risk takers; it has become a popular idea embodied in the concept of a new energy economy—a hydrogen economy. This massive migration from petroleum as the sole energy-to-fuel source for transportation to multiple energy-to-hydrogen sources to fuel our cars will require a new transportation energy infrastructure; hydrogen production, H₂ transportation, H₂ storage, and (of course) fuel cell-powered vehicles. And all of these technology platforms must be developed. Engineers and scientists who understand the technical challenges and opportunities inherent to the hydrogen economy are the most critical resource needed for the inevitable and unprecedented change in the global energy economy. Note that such a change might not be to hydrogen, at least not to dominance within the next twenty-five years, but understanding the technological needs and implications of a transportation hydrogen infrastructure provides the technological decision makers the necessary background to implement such decisions. Thus, the main objective of this course is to point motivated engineers and scientists in the right direction and help build their fundamental understanding of the post-fossil fuel energy paradigm, specifically in the context of a hydrogen infrastructure.

LECTURE NOTES:
All lectures will be in the form of PowerPoint presentations and will be available in electronic form (PDF files) accessible directly through the course site on Blackboard. In most cases, these documents will be available before the actual lecture date.

REFERENCES & MANDATORY READINGS:
There is no specified textbook, but there are mandatory required readings. All suggested and required reading materials will be in electronic format and accessible directly or indirectly through the course site on Blackboard.

NOTE: this course has a substantial reading requirement; much of the exam and assignment materials will be taken from the readings.
COURSE LEARNING OBJECTIVES:
Students who successfully complete AET 5420 will be able to:

- understand the chemical and energetic properties of molecular hydrogen;
- understand the current and historical utilization of molecular hydrogen;
- explain the energy storage characteristics of hydrogen in the context of alternative fuels;
- describe and compare H$_2$ production technologies including reforming and electrolysis;
- describe and compare H$_2$ storage technologies including compressed gas, metal hydrides, and advanced carbon materials;
- outline hydrogen production/storage/delivery systems design and integration issues;
- identify technological barriers and research trends in hydrogen production, storage, and delivery;
- detail the technological, societal, and economic components of the hydrogen economy; and
- explain/critique/defend the various hydrogen-centric scenarios for the future energy economy.

PREREQUISITES:
Senior standing in an engineering or science discipline, or consent of appropriate curriculum advisor. Contact Andrea Eisenberg, AET Academic Service Officer, aeisen@eng.wayne.edu with inquiries.

DEFERRED GRADES:
Deferred grades are allowed only if (1) the student is not failing, and (2) the student can complete the required materials without retaking the course or requiring faculty supervision.

DROPPING:
Last day to drop this course is by the end of the 5th week. The instructor will not generally approve drop actions after this date.

EXTRA CREDIT:
No extra credit projects will be allowed.

STUDENTS WITH DISABILITIES:
For students with documented disability that requires accommodations, please register with Student Disability Services for coordination of your academic accommodations (See http://studentdisability.wayne.edu/) Once accommodations have been arranged, please meet with Dr. Faguy to discuss your special needs. Student Disability Services' mission is to assist the university in creating an accessible community where students with disabilities have an equal opportunity to fully participate in their educational experience at Wayne State University.
COURSE METRICS:

**HOMEWORK**
Assigned every Monday, usually embedded in the previous weeks lecture notes. Due the next Monday. Homework is graded as: submission → ½ full grade; correct response(s) → ½ full grade. Homework grades decay exponentially; late submissions are costly!

**MAJOR ASSIGNMENT: LITERATURE REVIEW**
The details are outlined in the separate Literature Review document (on BLACKBOARD). Required individual student effort.

**EXAMS**
All exams will be conducted during the class period as scheduled in the course outline. These are closed book exams and the 2nd exam is not cumulative. Make-up exams will be given only by prior arrangement and only for valid reasons. College policy states that anyone giving or receiving information during an exam will be given an immediate failing grade for the course.

**CLASS PARTICIPATION**
All students are expected to participate in the debate and to contribute to the learning process. Expect direct questions regarding assigned readings and previous class discussions.

**GRADING**
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<td>Exam 1</td>
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<td>Exam 2</td>
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<td>Literature Review</td>
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<td>Homework</td>
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<td>Class Contributions</td>
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**GRADE SCALE (%)**
A (> 94), A- (94-89), B+ (88-83), B (82-77), B- (76-71), C (70-65), D (64-50), F (<50).

**TOPICS & LECTURE SCHEDULE**

**TOPICS**
Course Introduction: The Future of Transportation
Drivers: Climate Change & Energy Security
Energy Consumption: 2009 and 2050
Transportation Energy Mix
Why Hydrogen?
Proton Exchange Membrane Fuel Cells (PEMFCs)
Hydrogen: Properties, Human History, and Utilization
Hydrogen Production
Hydrogen Storage
Hydrogen Delivery
H₂ Safety and Codes & Standards
H₂ Economy: Modeling, Scenario Building, and Life Cycle Assessment

**LECTURE SCHEDULE**
Distributed through Blackboard.