

The University Senate of Michigan Technological University

Proposal 17-09 (Voting Units: Academic)

“Interdisciplinary Minor in Hydrogen Technology”

1. Introduction

The search for alternative energy sources is an area that has received great attention on and off over the last few decades. A growing area of research and development is currently occurring in the area of hydrogen energy and hydrogen fuel cells. Such technology has been suggested for transportation (motor vehicles) and stationary (heating and electricity) applications.

This proposal for a new minor is a portion of a Department of Energy grant for Hydrogen Education (9/2008 – 8/2011) which has 10 faculty and staff participants, from 4 academic departments and one research center. This minor is based upon the curriculum set forth in the successful “Enterprise Minor” (Senate Proposal 13-02) and “Nanoscale Science and Engineering (Nanotechnology) Minor” (Senate Proposal 17-05) which integrate coursework with research and/or enterprise project work.

The minor in Hydrogen Technology is designed to:

- 1) Introduce students to the fundamentals of this field
- 2) Encourage students to pursue interdisciplinary course and project work outside of their major
- 3) Allow for participation by students in diverse majors

2. Rationale

In the future, hydrogen may be used as an energy carrier for transportation and stationary applications. In order to introduce students into this area, a formal minor in Hydrogen Technology is proposed to give students the proper background for success in industry, graduate school, or government.

This minor builds upon the multi-year, interdisciplinary Enterprise and Nanotechnology minors by which students will work on hydrogen-related projects in the Alternative Fuels Group Enterprise or on hydrogen-related research projects.

Modifying the framework of the enterprise minor and nanotechnology minor is the most appropriate format for this minor. It is based upon elements of a Department of Energy award to Michigan Technological University, “Hydrogen Education Curriculum Path at Michigan Technological University” (J. Keith PI) by which undergraduate students will gain specific knowledge of hydrogen technology and hydrogen fuel cells. This will be through elective courses and also through enterprise project work or undergraduate research. The enterprise projects are either hands-on or paper studies focused on hydrogen technology. In some instances, they are projects funded through coordination with the Institute for Interdisciplinary Studies and in collaboration with other MTU enterprises. These projects will foster student creativity and entrepreneurship.

The Hydrogen Technology minor is a non-departmental minor that will be administered through the Department of Chemical Engineering and in cooperation with the Institute for Interdisciplinary Studies.

The proposal has been written by the following individuals: Jason M. Keith, Daniel A. Crowl, and David W. Caspary (Department of Chemical Engineering); Jeffrey S. Allen, Jeffrey D. Naber, Abhijit Mukherjee, Dennis Desheng Meng (Department of Mechanical Engineering - Engineering Mechanics); John T. Lukowski (Department of Electrical and Computer Engineering); Barry D. Solomon (Department of Social Sciences); and Jay S. Meldrum (Keweenaw Research Center).

3. Details of Catalog Copy

I. Title of Minor

Hydrogen Technology Minor

II. Catalog Description

This interdisciplinary minor focuses on hydrogen technology as an alternative to fossil fuels for stationary and transportation applications. One component is participation in the Alternative Fuels Group Enterprise with project work based upon hydrogen fuel cells and/or other hydrogen technologies, such as hydrogen production or storage. Students will also enroll in hydrogen related elective course modules to receive the appropriate training. Students will also be exposed to the broader, societal impacts of hydrogen technology. Although the minor is open to all students, targeted majors are chemical engineering, electrical engineering, mechanical engineering, materials science and engineering, electrical engineering technology, and mechanical engineering technology.

III. List of Courses

The Hydrogen Technology Minor will require 16 semester credit hours. The Minor must include at least 6 semester credit hours of 3000 level or higher courses which are not required for the Major degree program except as free electives.

A minimum cumulative grade point average of 2.0 is required for courses in this minor.

Required Courses

Select 4 to 6 credits from the list below:

Course #	Title	Credits	Prerequisites / Corequisites	Offered	Frequency
ENT1960	Alternative Fuels Group	1**	None	Fall, Spring	Annually
ENT2950	Alternative Fuels Group	1**	Sophomore, Junior, or Senior Standing	Fall, Spring	Annually
ENT2960	Alternative Fuels Group	1**	Sophomore, Junior, or Senior Standing	Fall, Spring	Annually
ENT3950	Alternative Fuels Group	1**	Junior Standing	Fall, Spring	Annually
ENT3960	Alternative Fuels Group	1**	Junior Standing	Fall, Spring	Annually
ENT4900	Alternative Fuels Group	2**	Senior Standing	Fall, Spring	Annually
ENT4910	Alternative Fuels Group	2**	Senior Standing	Fall, Spring	Annually
ENT4950	Alternative Fuels Group	2**	Senior Standing	Fall, Spring	Annually
ENT4960	Alternative Fuels Group	2**	Senior Standing	Fall, Spring	Annually
ENT4961	Alternative Fuels Group	1**	Permission of Instructor; Senior Standing ENT3950 and ENT3960 and ENT4950 and ENT4960	Fall, Spring	Annually

Select one course from the list below:

Course #	Title	Credits	Prerequisites / Corequisites	Offered	Frequency
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CM/ENT 3974	Fuel Cell Fundamentals	1	CH1100 or CH110	Fall	Annually
MEEM 4990/5990	Fuel Cell Technology	3	(MEEM2200 or MY3100 or CM3230) and (CH1110 or CH1110)	Fall	Annually

Select at least one course from the list below:

Course #	Title	Credits	Prerequisites / Corequisites	Offered	Frequency
CM/ENT 3977	Fundamentals of Hydrogen as an Energy Carrier	1	PH2200 and (CH1100 or CH1110)	Fall	Annually
CM/ENT 3978	Hydrogen Measurements Laboratory	1	PH2200 and (CH1100 or CH1110)	Spring	Annually

Elective Courses: Select remaining credits from the list below:

Course #	Title	Credits	Prerequisites / Corequisites	Offered	Frequency
CM3110	Transport / Unit Operations 1	3	CM2120 and PH2100 and (MA3520 or MA3521 or MA3530 or MA3560)	Fall, Spring	Annually
CM3120	Transport / Unit Operations 2	3	CM3110 and (MA3520 or MA3521 or MA3530 or MA3560)	Spring	Annually
CM4000	Chemical Engineering Research	1-3**	None	Fall, Spring	Annually
CM4310	Chemical Process Safety / Environment	3	Senior Standing CM3120 and CM3230	Fall	Annually
CM4550	Industrial Chemical Production	3	(CH2400 or CH2410) and CM3510(C)	On Demand	Annually
EC4620	Energy Economics	3*	(EC3001 or EC3002 or EC3003) and UN2002	Spring	Annually
EE2110	Electrical Circuits	3	EE2150 and (MA3520 or MA3521 or MA3530 or MA3560)	Fall, Spring, Summer	Annually
EE3010	Circuits and Instrumentation	3	May not be enrolled in one of the following majors: Computer Engineering,	Fall, Spring, Summer	Annually

			Electrical Engineering		
EE3120	Introduction to Energy Systems	3	EE2110 or EE3010	Fall, Spring	Annually
EE3221	Introduction to Motor Drives	4	EE2110 or EE3010	Spring	Annually
EE4000	Electrical Engineering Undergraduate Research	1-4**	None	Fall, Spring	Annually
EET2120	Circuits II	4	EET1120 and (MA1160(C) or MA1161(C) or MA1135(C) or MA1140(C))	Fall, Spring, Summer	Annually
EET3131	Instrumentation	3	EET 1411 or EET 2311 or EET 2220	Spring	Annually
EET3390	Power Systems	3	EET2233	Fall	Annually
ENG5510	Sustainable Futures I	3	UN2002 Junior or Senior Standing	Fall	Annually
ENG5520	Sustainable Futures II	3	None	Spring	Annually
ENT3956	Industrial Health and Safety	1	Junior or Senior Standing	Fall	Annually
ENT3975	Intro to Vehicle Design and System Modeling	1	ENG1102	Fall	Annually
MEEM 3210	Fluid Mechanics	3	Co-requisite: MEEM3220 Pre-requisite: MEEM2200 and MEEM2700(C)	Fall, Spring, Summer	Annually
MEEM 3230	Heat Transfer	3	MEEM3210 and (MA3520 or MA3521 or MA3530 or MA3560)	Fall, Spring, Summer	Annually
MEEM 3999	ME Undergrad Research Project	3**	None	Fall, Spring	Annually
MEEM 4220	Internal Combustion Engines 1	3	MEEM3210	Fall	Annually
MEEM 4990/5990	Micro- and Nanofabrication for Energy Applications	3	EE4200 or MEEM4640/5640	Fall	Annually
MET3250	Applied Fluid Mechanics	4	MET2130	Fall	Annually
MET4300	Applied Heat Transfer	3	MET3600	Fall	Annually
MET4390	Internal Combustion Engines	3	MET3600(C) or MET3361	Spring	Alternate years beginning with 07-08
MET4900	Alternative Energy Systems	3	Junior or Senior Standing MET3600 or MET3361	Spring	Alternate years beginning with 06-07
MY3100	Materials Processing I	4	MY2100	Fall	Annually
MY3110	Materials Processing II	4	MY3100	Spring	Annually
MY4140	Science of Ceramic Materials	3	MY2100	Spring	Annually
MY4990	Materials Science and	1-6**	None	Fall, Spring	Annually

	Engineering Undergraduate Research				
MY5410	Materials for Energy Applications	3	MEEM2200 or MY3100 or CM3230	Spring	Annually
SS3800	Energy Technology and Policy	3*	UN2002	Spring	Alternate years beginning with 01-02

Students are encouraged, though not required, to take at least one course from the list above which are related to the broader context and societal impacts of hydrogen technology:

CM4310 Chemical Process Safety / Environment (3)
 EC4620 Energy Economics (3)*
 ENG5510 Sustainable Futures I (3)
 ENG5520 Sustainable Futures II (3)
 ENT3956 Industrial Health and Safety (1)
 SS3800 Energy Technology and Policy (3)*

* indicates that the course may be used to satisfy HASS Distribution Course Requirement if not required by major.

** topic must be approved by minor program coordinator (J. Keith)

4. New Course Descriptions

Two new courses have been proposed and have been through the new course review process in October 2008, independent of this minor proposal. They will be first taught in the semesters indicated of the 2009-2010 academic year. Development of these courses was funded by the United States Department of Energy.

Fundamentals of Hydrogen as an Energy Carrier (1 credit)

Course numbers: CM/ENT 3977

Description: This course provides an overview of traditional and alternative energy sources, with particular emphasis on hydrogen energy. Discussion of energy production and sources; electric and hydrogen vehicles; production, distribution, and policy of hydrogen and the hydrogen economy.

Semesters offered: Fall on an annual basis

Hydrogen Measurements Laboratory (1 credit)

Course numbers: CM/ENT 3978

Description: This course provides an introduction to basic experiments and measurements that relate to hydrogen and hydrogen powered fuel cells. Includes chemical and electrical safety, fuel cell operation and introduction to fuel cell integration into practical applications.

Semesters offered: Spring on an annual basis

5. Estimated Costs

The immediate initiation of this minor has no direct new costs. The minor-specific courses CM/ENT3974, CM/ENT3977, and CM/ENT3978 will be taught by one or more of the investigators (Keith, Crowl, Caspary, Allen, Naber, Mukherjee, Meng, Lukowski, Solomon, Meldrum) or by other faculty who may have a research and teaching interest in this area.

The Alternative Fuels Group Enterprise project work courses (ENT1960, ENT2950, ENT2960, ENT3950, ENT3960, ENT4900, ENT4910, ENT4950, ENT4960, and ENT4961) will also be taught by one or more of the investigators (Keith, Crowl, Caspary, Allen, Naber, Mukherjee, Meng, Lukowski, Solomon, Meldrum) or by other faculty who may have a research and teaching interest in this area.

Funded projects will be pursued in concert with the Institute of Interdisciplinary Studies at Michigan Technological University.

Introduced to Senate: 01 April 2009

Adopted by Senate: 15 April 2009

Approved by Administration: 22 April 2009