**Name of the module: Hydrogen & Energy**

**Number of module: 365.2.6905**

BGU Credits: 3

ECTS credits:

Academic year: 2012-2013

Semester: 1st semester

Hours of instruction: 3 hours lecture

Location of instruction: will be defined each semester.

Language of instruction: Hebrew

Cycle:

Position: a compulsory course for graduate students of Materials Engineering Department

Field of Education: Materials Engineering

Responsible department: Materials Engineering

General prerequisites:

1. Materials Science 1
2. Materials Science 2

Grading scale: the grading scale would be determined on a scale of 0 – 100 (0 would indicate failure and 100 complete success 0 to 100), passing grade is 56.

Lecturer: Prof. Dan Eliezer

Contact details: Room 108

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Office hours:

Wednesday, from 12 to 2 PM

Module evaluation: at the end of the semester the students will evaluate the module, in order to draw conclusions for the lecturer and university's internal needs.

Course Description:

This course covers the topics of progress and challenges of a Hydrogen Economy. Hydrogen production and delivery (Nuclear, thermo-chemical, photo-electrochemical, photo-biological and biomass). Hydrogen Storage (Liquid, compressed gas, and solid state (complex light metal hydrides, zeolites, clathrates, metal-organic frameworks, carbon and boron-nitride based nanostructures, chemical hydrides). Fuel Cells and Hydrogen (polymer electrolyte and Hydro-carbon membranes). Nanotechnology for the Hydrogen Challenge. Environmental Impact of Hydrogen Technologies.

Aims of the module:

Fuel cells and hydrogen systems are important technologies which may contribute positively to the world energy situation. Already, fuel cells are used commercially in a wide range of applications in products. Other applications will follow in the future. Students who have this introductory course in hydrogen energy will be exposed to the hydrogen economy, understanding why this element is so vital in today's world.

Objectives of the module:

To familiarize students with the fundamentals of hydrogen and energy in order that they will be capable to evaluate issues. This will expose the students to the hydrogen economy and current and future applications.

Learning outcomes of the module:

On successful completion of the course the students should be able to:

1. Have general knowledge of the hydrogen economy and its future.
2. To comprehend the detailed operation, functionality and interaction between the various components used in fuel cell and hydrogen production systems.
3. For the student to develop analytic skills in system integration with respect to system efficiency and control engineering aspects of fuel cell energy systems.
4. To glean knowledge related to the practical realisation and implementation of fuel cell systems, especially pertaining to innovative aspects, business planning and financial considerations.

Attendance regulation: attendance and participation in class is mandatory. Teaching arrangement and method of instruction: lectures and tutorials that include assignments.

Assessment: Mid-term Exam 30%

Assignments 30%  
Final Paper 40%

100%

Confirmation: the syllabus was confirmed by the faculty academic advisory committee to be valid on 2012-2013.

Last update: 21.10.2012

Work and assignments: Review and Present Article.

Time required for individual work: in addition to attendance in class, the students are expected to do their assignment and individual work: at least 4 hours per week.

Module Content\ outlines:

* Hydrogen: Its merit as a fuel  
  Applications Hydrogen production methods
* Hydrogen Economy
* Production of hydrogen from fossil fuels, electrolysis, thermal decomposition, photochemical and photo-catalytic methods.
* Hydrogen storage methods - Metal hydrides, metallic alloy hydrides, carbon nano-tubes, sea as source of deuterium
* Hydrogen Embrittlement
* Fuel cell BASICS - Fuel cell definition, Difference between batteries and fuel cells, fuel cell history, components of fuel cells, principle of working of fuel cells
* Fuel cell types – Classification by operating temperature/electrolyte type, Fuel Cell Performance, Activation, Ohmic and Concentration over potential
* Overview of intermediate/high temperature fuel cells - Solid oxide fuel cells (SOFC), Molten carbonate fuel cells (MCFC), Phosphoric acid fuel cells (PAFC) Polymer Electrolyte fuel cells (pefc) - Heat and mass transfer in polymer electrolyte fuel cells, water management in PEFCs, Current issues in PEFCs Direct methanol fuel cells (DMFC) - Electrochemical kinetics methanol oxidation, Current issues in DMFCs, Fuel crossover in DMFCs, Water management in DMFCs, high methanol concentration operation, limiting current density.

Required reading:

-Stolten, D. (ed.): **Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications**. Weinheim, Wiley-VCH (2010).

-Jenna, P., Kandalam, A., Sang, Q. (eds.): **Materials Issues in a Hydrogen Economy: Proceedings of the International Symposium**. Richmond, Virginia, USA, 12 – 15 November 2007. Singapore, World Scientific Publishing, (2009).

-Zuttel, A. Borgschulte, A., Schlapbach, L. (eds.):**Hydrogen as a Future Energy**

**Carrier**. Weinheim, Wiley-VCH, (2008).

-National Academies of Science: **The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs.** [online]<http://www.nap.edu/books/0309091632/html/>, (2004).

-Moody , N.R., Thompson, A.W., Ricker, R., Was, G., Jones, R. (eds.): **Hydrogen Effects on Material Behavior and Corrosion Deformation Interactions: Proceedings of the International Conference.**Moran, Wyoming, USA, 22-26 September 2006. Warrendale, TMS, (2003).