

Course Name:	Hydrogen Generation and Storage
Course Number:	CY 552
Credits:	3-0-0-3
Prerequisites:	None
Intended for:	UG/PG.
Distribution:	Elective for B. Tech (3 rd year), M. Tech. (Energy Materials), M.Sc Chemistry and Ph. D. students
Semester:	Odd/Even

Preamble:

The course forms an elective course for the M. Tech. (Energy Materials) degree program. The other elective courses in this basket include alternative energy sources for transportation and nuclear material for power system. This course will give a preview on the viability of hydrogen as a renewable energy source and the barriers to a hydrogen economy. It will evaluate hydrogen's role on various criteria: hydrogen's properties, production methods, storage, conversion to usable energy, costs, drivers for market penetration, and safety issues. Thus, this course will provide understanding and knowledge of the importance of hydrogen as an alternative source of energy, implementation and difficulties on the practical approaches on materialization of hydrogen economy in conjunction with other core and elective courses in the M. Tech. program.

Course Outline:

This course will provide an overall review on hydrogen as future energy resource. Renewable energy has huge potential in the market and hydrogen energy is considered to be one of the complementary energy carriers for future. In this course we will learn about production of hydrogen using different sources and purification as well as separation of hydrogen. The major problem related to handling and storage of hydrogen also will be addressed. Students also will learn about the advancement in the synthesis and characterization techniques.

Modules:

Module 1: Production of Hydrogen (12)

Different methods of hydrogen production, Renewable electrolysis, Steam Methane Reforming, Gasification of coal and other hydrocarbon, partial oxidation of hydrocarbon, Hydrogen from biomass, hydrogen generation from wind energy, water electrolysis, Thermonuclear/other methods and solar energy for hydrogen generation. The course will include at least few lectures of elaborate study and description about each of the method of hydrogen production.

Module 2: Hydrogen Handling and transport (12)

Major issues regarding the handling of hydrogen and safety requirement .Materials issues :

hydrogen embrittlement, Hydrogen leakage and monitoring, hydrogen sensors, Liquid hydrogen: liquefaction costs and low temperature, Pipelines for hydrogen transport-main issue. Few lectures will be given on these above issues with detailed discussion. Emphasis will be given on the role of materials science in the improvement of the handling of hydrogen.

Module 3: Hydrogen Storage

(12)

Hydrogen storage requirements: what is crucial? Metal Hydride requirements for hydrogen storage for mobile application, Onboard hydrogen storage system for light-duty vehicles, Hydrogen storage: materials point of view, Storage through surface adsorption: nanocarbon, metal organic framework, Conventional metal hydrides, Light metal hydrides, Clathrates for hydrogen storage. Material Scientist's point of view: scope of research on the materials for hydrogen storage, their stability under loading and unloading of hydrogen.

Module 4: Hydrogen R & D Opportunities

(6)

Safe handling and safe storage of hydrogen for long term usage, Evaluation of the technique for hydrogen generation, Codes and safety: hydrogen technology standards

Text books:

1. Hydrogen Fuel Production, Transport and Storage Edited by Ram B Gupta
published July 30, 2008 by CRC Press , ISBN 9781420045758 - CAT# 4575X

Reference Books:

1. Electrochemical Methods second edition, A.J. Bard and L.R. Faulkner, *John Wiley and Son (2001)*.
2. Fuel Cell Catalysis: A Surface Science Approach ,Marc Koper (Editor), Andrzej Wieckowski ISBN: 978-0-470-13116-9 Wiley-Interscience; 1 edition (April 20, 2009)
3. Electrochemical Components (Electrical Engineering) Marie-Cécile Pera (Editor), Daniel Hissel (Editor), Hamid Gualous (Editor), Christophe Turpin (Editor) Wiley-ISTE; 1 edition (August 2, 2013)