



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Mechanical, Energy Engineering)

Subject Code: 3723920

Semester – II

Subject Name: Hydrogen Energy

Type of course: Program elective

Prerequisite: Knowledge of I. C. Engine, Alternate fuels

Rationale: The course is design to provide comprehensive and logical knowledge of hydrogen production, storage and utilization, understanding of various fuel cell technologies, application of hydrogen and various challenges to use hydrogen as a fuel.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Fundamentals of Hydrogen – as a Fuel: Physical and chemical properties of hydrogen, Properties of hydrogen as a fuel (likes Energy content, Flammability, Flash point, Auto ignition temperature, Octane number, Ignition energy, Burning speed, Quenching gap, Flame characteristics), Comparisons of hydrogen as fuel with others fuels.	7
2	Hydrogen Production Processes: Natural gas reforming, Coal gasification, Thermochemical water splitting, Solar thermochemical hydrogen (STCH), Photo electrochemical (PEC), Photo biological, Biomass gasification, Biomass-derived liquid reforming, Microbial biomass conversion, Electrolysis via different kind of electrolyzers like Alkaline electrolyzers, Solid oxide electrolyzers, Polymer electrolyte membrane	9
3	Hydrogen Storage: Physical and chemical properties, General storage methods, Compressed storage-composite cylinders, Glass micro sphere storage, Zeolites, Metal hydride storage, Chemical hydride storage and cryogenic storage, Carbon based materials for hydrogen storage.	9
4	Applications of hydrogen: History - principle - working - thermodynamics and kinetics of fuel cell process, Performance evaluation of fuel cell – comparison between battery and fuel cell, Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, Microbial fuel cells, Relative merits and demerits. Fuel cell usage for domestic power systems, Automobile, Future trends in fuel cells.	10
5	Hydrogen safety: Hydrogen powered vehicles, Hydrogen safety aspects, Backfire, Pre-ignition, Hydrogen emission NOx control techniques and strategies.	7

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	20	20	20	20	10



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Mechanical, Energy Engineering)

Subject Code: 3723920

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Alternative Transportation Fuels by Arumugam S. Ramadhas, CRC Press, 2010.
2. Alternative Fuels; Concepts, Technologies and Developments by S. S. Thipse, Jaico Book Distributors, 2010.
3. Hydrogen and Fuel Cells: Advances in Transportation and Power by M. F. Hordeski, The Fairmont Press, Inc. 2009.
4. Hydrogen and Fuel Cells: Emerging Technologies and Applications by B. Sorenson, Bent Sorenson, Academic Press, 2005.
5. Hydrogen and Fuel Cells: A Comprehensive Guide by R. L. Busby, Penn Well Books, 2005.
6. Fuel Cells, Principles, Design and Analysis by Shripad T. Revankar and Pradip Majumdar, CRC Press, 2014.
7. Hydrogen and Fuel Cells by Bent Sorensen, Academic Press, 2012.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand basic fundamental physical, chemical and other properties, which useful for hydrogen applications.	10%
CO-2	Understand various method to produce hydrogen with different_available technologies.	20%
CO-3	Understand various storage techniques to store hydrogen, Design and develop suitable hydrogen storage system to be used along with fuel cell system.	25%
CO-4	Understand various applications of hydrogen as fuel and understand various techniques to use the hydrogen.	30%
CO-5	Minimize environmental hazards associated with the use of hydrogen storage and fuel cell technology.	15%

List of Experiments:

1. To Study the various production techniques of hydrogen.
2. To Study the various method to store the hydrogen.
3. To study the hydrogen production via biological process.
4. To study the hydrogen production via Electrolysis process.
5. Case study on HHO as substitute fuel for automobile vehicles.
6. To study and Performance of I.C. Engine with hydrogen as fuel.
7. To study and performance of dual fuel (hydrogen-Gasoline) I.C. Engine.
8. To study of fuel cells.
9. The Comparative study of hydrogen performance as a fuel with gasoline and diesel.
10. To Study the infrastructure requirement for hydrogen production and storage.



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Mechanical, Energy Engineering)
Subject Code: 3723920

Major Equipment:

- 1) Single/Multi cylinder Petrol/Diesel Engine.
- 2) HHO Kit.
- 3) Gas analyzer
- 4) Electrolysis Kit.

List of Open Source Software/learning website:

- 1) <http://ocw.mit.edu/courses/energy-courses/>
- 2) <https://nptel.ac.in/courses/103102015/19>