GUJARAT TECHNOLOGICAL UNIVERSITY

Minor Degree – Energy Engineering
Subject Code : N116AP01
Semester – 6 (w.e.f. AY 2025-26)
Subject Name : Hydrogen and Nuclear Energy

Prerequisite : Nil

Rationale : The course is designed to provide comprehensive knowledge of hydrogen and nuclear energy, their production, storage and utilization, various technologies, applications and challenges to use them as a fuel.

Teaching and Examination Scheme :

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	-	30	-	100

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 (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	4
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 electrolyzer like Alkaline electrolyzer, Solid oxide electrolyzer, Polymer electrolyte membrane. Introduction to Green Hydrogen production policy 2022 in Indian context.	7
3	**Hydrogen Storage:** 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. Use of Hydrogen in IC engines and in fuel cell along with safety concerns and its merits and demerits	7
4	**Nuclear Energy:** The world-wide nuclear renaissance, comparison with other energy sources, public perception, non-proliferation and nuclear safeguards, financial costing, Nuclear energy program in India. **Reactor Physics:** Mechanism of Nuclear Fission and Fusion, Nuclides, Radioactivity, Decay chains, Neutron reactions (scattering, absorption, fission), Fission process and product distribution; neutron energy distribution; moderation; delayed neutrons; neutron cycle reactor types, Fast Breeding, Design and construction of nuclear reactors, Heat transfer techniques in nuclear reactors; Reactor shielding	11

5	**Nuclear Fuel Cycle:** Characteristics of nuclear fuels and various cycles, mining, conversion, enrichment, refueling, transport, reprocessing, waste handling, storage, geological disposal	7
6	**Reactor Systems:** Introduction to reactor system and three stage Indian nuclear power program. Classification of reactors, Characteristics, Selection criteria; Core configuration and cycle diagrams of thermal reactors (BWR, PWR, PHWR, AGR, HTGR, and AHWR) and Fast Reactors, process heat applications, transmutation of nuclear waste, safety systems and accidents	9

Suggested Specification table with Marks (Theory) :

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**30**	**20**	**00**	**00**

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
2. Basile A and Iulianelli A, Advances in Hydrogen Production, Storage and Distribution, Woodhead Publishers
3. Hydrogen and Fuel Cells: Advances in Transportation and Power by M. F. Hordeski, The Fairmont Press, Inc.
4. Hydrogen and Fuel Cells: Emerging Technologies and Applications by B. Sorenson, Bent Sorenson, Academic Press
5. Hydrogen and Fuel Cells: A Comprehensive Guide by R. L. Busby, Penn Well Books
6. Fuel Cells, Principles, Design and Analysis by Shripad T. Revankar and Pradip Majumdar, CRC Press
7. Hydrogen and Fuel Cells by Bent Sorensen, Academic Press
8. Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, Raymond M and Keith E. H. Butterworth-Heinemann
9. Nuclear Energy: Principles, Practices and Prospects, Bodansky D. Springer
10. Nuclear Reactor Design, Oka Y. and Kiguchi T. Springer
11. Nuclear Decommissioning, Waste Management, and Environmental Site Remediation, Bayliss C. and Langley K. Butterworth-Heinemann.
12. The Economics of Nuclear Energy, Brookes L. G. Springer

Course Outcomes :

At the end of the course students shall be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Comprehend various properties of hydrogen a fuel and demonstrate hydrogen storage system.	24
CO-2	Explain recent technologies to produce hydrogen fuel.	16
CO-3	Comprehend various nuclear reaction processes for energy conversion.	24
CO-4	Explain various stages of nuclear fuel cycle.	16
CO-5	Demonstrate construction and working of various nuclear reactor.	20

Activity to be carried out (1) Visit of any green hydrogen production plant (2) Visit of any nuclear power plant

List of Open-Source Software/learning website :

(1) http://ocw.mit.edu/courses/energy-courses/
(2) https://nptel.ac.in/courses/112103243
(3) https://nptel.ac.in/courses/115106087/