



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Environmental Engineering

Subject Code: BE05013051

Subject Name: Fundamentals of Green Hydrogen and Safety

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course-I

Prerequisite:	Basic Knowledge of Chemistry
Rationale:	A key highlight of the course is the introduction to Green Hydrogen—a clean energy source aligned with India's National Green Hydrogen Mission. By exploring its production, storage, applications and safety students are encouraged to adopt and innovate sustainable technologies for a greener future. This interdisciplinary course ensures all engineering graduates are environmentally conscious and equipped to contribute to sustainable development.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Remember the properties and classification of hydrogen energy systems.	17
CO-2	Understand green hydrogen production technologies and their working principles.	23
CO-3	Apply engineering principles to analyze hydrogen storage and transport systems.	20
CO-4	Analyze safety hazards and risk associated with hydrogen handling.	17
CO-5	Evaluate sustainable hydrogen solutions and propose safety management strategies.	23

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/C A (I)	PBL (I)	ESE (V)	
45	30	0	15	90	3	70	30	20	30	0	150



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Environmental Engineering

Subject Code: BE05013051

Subject Name: Fundamentals of Green Hydrogen and Safety

Content:

Sr. No.	Content	Total Hrs
1	Introduction to hydrogen Energy: Global energy scenario, Types of hydrogen (Grey, Blue, Green, Turquoise), Physical & thermodynamic properties of hydrogen, Combustion characteristics & energy density comparison	08
2	Green Hydrogen Production Technologies: Fundamentals of water electrolysis, Thermodynamics of electrolysis, Alkaline electrolysis system design, Electrolyser efficiency calculations, Renewable energy integration (Solar/Wind coupling), hybrid hydrogen production systems, Emerging methods (Photoelectrochemical & Biological), Techno-economic analysis of green hydrogen	10
3	Hydrogen Storage & Transportation: Compressed gas storage systems, Liquid hydrogen & cryogenic storage, Metal hydrides & solid storage materials, Hydrogen blending in natural gas pipelines, Transportation logistics & infrastructure challenges, Storage system safety considerations	09
4	Hydrogen Utilization & Applications: Hydrogen fuel cell fundamentals, Hydrogen in mobility, Industrial hydrogen applications, Grid integration & energy storage, Case study: Hydrogen-powered industry	08
5	Hydrogen Safety & Risk Management: Hydrogen flammability & explosion characteristics, Leak detection technologies, Hazard identification (HAZID, HAZOP), Quantitative Risk Assessment (QRA), International safety codes & standards, Case studies of hydrogen accidents	10
TOTAL		45

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	30	20	0	00

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.



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Environmental Engineering

Subject Code: BE05013051

Subject Name: Fundamentals of Green Hydrogen and Safety

The Fundamentals of Green Hydrogen and Safety syllabus achieve the following sustainable goals:

SDG 3	Good Health and Well-being
SDG 7	Affordable and Clean Energy
SDG 9	Industry, Innovation and Infrastructure
SGD 13	Climate Action
SDG 12	Responsible Consumption and Production
SDG 8	Decent Work and Economic Growth
SDG 11	Sustainable Cities and Communities
SDG 17	Partnerships for the Goals

Reference Books:

1. Hydrogen and Fuel Cells: Emerging Technologies and Applications
By Bent Sørensen — Comprehensive introduction to hydrogen production, storage, applications, and fuel cells.
2. Hydrogen Energy: Economic and Social Challenges
By Veziroglu & Barret — Focus on economics, sustainability, and the hydrogen economy.
3. Hydrogen: Fundamentals, Processes, and Applications
By Ali Demirbaş — Detailed fundamentals and production technology overview.
4. Hydrogen Fuel: Production, Transport, and Storage
Edited by Ram Ouwerkerk — Practical insights into infrastructure and logistics.
5. Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications
By Rebecca L. M. Dincer & Calin Zamfirescu — Scientific principles and engineering applications.

List of Tutorials:

1. Tutorial 1: Hydrogen Economy & Sustainability
2. Tutorial 2: Electrolysis Technologies
3. Tutorial 3: Hydrogen Storage & Transportation
4. Tutorial 4: Hydrogen Safety & Risk Assessment

List of Open Source Software/learning website:

1. Open Modelica- Open-source modeling & simulation environment- Dynamic system modeling (electrolysis, hydrogen systems)
2. HOMER Energy - Plan hybrid energy systems with hydrogen storage, <https://www.homerenergy.com/>
3. PHAST / SAFETI- Use for hydrogen safety case studies- <https://www.dnv.com/software/>



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Environmental Engineering

Subject Code: BE05013051

Subject Name: Fundamentals of Green Hydrogen and Safety

4. QUANTIFY – Hydrogen Tools- QUANTIFY – Hydrogen Tools, <https://hyquant.org>

List Self Learning Activities:

Sr. No.	PBL Category	Name of the Activity	No. of Hours	Evaluation Criteria
1	Seminar	Seminar based on given technical topics beyond syllabus	Duration = 10 hrs	Based on Presentation Skills, PPT Quality, Technical Depth, Literature Review
1	Technical Report Preparation	Collect global hydrogen production statistics and prepare a trend graph, identify 5 countries investing heavily in hydrogen and compare policies.	Duration = 5 hrs	Based on Data Collection & Authentic Sources, Graphical Representation, Interpretation & Conclusion, Report Formatting & Referencing
2	Numerical Practice	Calculate hydrogen production rate for given current and efficiency, Compare energy consumption of different electrolysis types.	Duration = 5hrs	Based on Correct Formula Application, Presentation of Solution
3	Case studies	Study one hydrogen transportation project (Japan, Germany, India).	Duration= 5 hrs	Based on Project Background Technical Understanding Economic & Policy Aspects
4	Safety Analysis	Study hydrogen flammability limits and explosion range, Design emergency response plan for hydrogen leakage.	Duration= 5 hrs	Based on Risk Identification, Safety Standards Reference, Presentation & Documentation
6	Environmental Assessment	Calculate carbon reduction potential for hydrogen substitution,	Durations= 5 hrs	Based on Methodology Selection, Assumptions & Justification, Interpretation of Results, Report Structure
7	Poster Presentation	Prepare posters on given topics	Duration= 5 hrs	Based on Technical Content Visual Design, Innovation & Creativity, Explanation During Evaluation
