GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Chemical Engineering

Subject Code: DI04005051

Subject Name: Clean and Renewable Energy Technology

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	Professional Elective - I

Prerequisite:	Student should have knowledge regarding Energy, Engineering Physics, Fundamental of heat transfer & Basics Mathematics
Rationale:	The growing global demand for sustainable energy has made clean and renewable energy technologies essential for future development. This course equips students with the knowledge of conventional fuels as well as renewable sources such as solar, wind, hydro, and geothermal energy. It emphasizes cleaner production methods, energy efficiency, and environmental sustainability. Students will gain the ability to analyze energy resources, apply modern technologies, and understand India's and the world's energy scenario. Overall, the course prepares diploma engineers to contribute effectively to the transition towards green and sustainable energy solutions.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Identify types of clean energy as an indicator of global development.	R,U
02	Apply concept of Green Hydrogen as a clean energy source.	R, U, A
03	Apply concept of solar technology for clean energy source.	R, U, A
04	Apply concept of wind technology for clean energy source.	R, U, A
05	Apply concept of hydro and geothermal technology for clean energy source.	R, U, A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE (V)	
3	1	0	4	70	30	00	00	100

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
Unit – I Introduction to Clean Energy	1.1 Definition and importance of energy 1.2 Concept of clean energy and renewable energy 1.3 Need and significance of clean and renewable energy 1.4 World and Indian energy scenario 1.5 Comparison of fossil fuel-based and renewable routes for energy production	06	13
Unit – II Green Hydrogen Production	2.1 Introduction to Hydrogen Economy 2.2 Properties and significance of Green Hydrogen 2.3 Production routes: 2.3.1 Water electrolysis (alkaline, PEM, SOEC) 2.3.2 Biomass-based hydrogen production 2.3.3 Photo-electrochemical and thermochemical processes 2.4 Storage, transport, and safety considerations 2.5 Applications of Green Hydrogen (fuel cells, mobility, industry) 2.6 Global and Indian initiatives on hydrogen energy 2.7 Advantages, limitations, and future scope 2.8 Numerical: Numerical on energy generation on Hydrogen burning	15	34
Unit – III Solar Energy Production	3.1 Sun as a source of clean energy 3.2 Solar radiation, spectrum, and solar insolation 3.3 Angles related to solar energy: incidence, tilt, declination, hour angle, latitude 3.4 Techniques for solar energy conversion: 3.4.1 Solar thermal systems 3.4.2 Solar photovoltaic systems 3.5 Applications of solar energy (domestic, industrial, power generation) 3.6 Advantages and limitations of solar technology 3.7 Numerical: Numerical on solar cell energy calculation, case studies	09	20
Unit – IV Wind Energy Production	4.1 Wind as a source of clean energy 4.2 Characteristics and computation of wind energy 4.3 Types of wind energy systems 4.4 Wind machines: Horizontal axis vs. Vertical axis wind turbines 4.5 Mechanism and working of windmills 4.6 Wind energy in India and global scenario 4.7 Advantages and limitations of wind technology	06	13

	4.8 Numerical: Problems on wind power calculation		
Unit – V Production Hydro and Geothermal Energy Production	5.1 Hydro Energy: 5.1.1 Hydrologic cycle as renewable source 5.1.2 Mechanism and components of hydro power plants 5.1.3 Classification of hydro power plants 5.1.4 Hydropower scenario in India and world 5.1.5 Advantages and disadvantages 5.2 Geothermal Energy: 5.2.1 Sources and applications of geothermal energy 5.2.2 Mechanism of conversion of geothermal heat to electricity 5.2.3 Types of geothermal power plants 5.2.4 Indian and global geothermal energy scenario 5.2.5 Advantages and limitations 5.3 Numerical: Based on hydro and geothermal energy production	09	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
23	**25**	**22**	---------	_____	_____

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

S.No.	Title of Book	Author	Publication with place, year and ISBN
1	Energy Sources	G.D. Rai	Khanna Publishers, New Delhi, 2nd Ed.
2	Energy Technology	S. Rao & B.B. Parulekar	Khanna Publishers, New Delhi
3	Non-Conventional Energy Resources	B.H. Khan	Tata McGraw-Hill, New Delhi, Latest Ed., ISBN: 9780070597426
4	Energy Technology	S. Rao & B.B. Parulekar	Khanna Publishers, New Delhi, Latest Ed., ISBN: 9788174091223
5	Renewable Energy Resources	J. Twidell & T. Weir	Taylor & Francis, London, 2nd Ed., 2006, ISBN: 9780419253204

6	Solar Energy: Principles of Thermal Collection and Storage	S.P. Sukhatme & J.K. Nayak	Tata McGraw-Hill, New Delhi, 3rd Ed., 2008, ISBN: 9780070260641
7	Energy Management and Conservation	F. Kreith & D.Y. Goswami	CRC Press, New York, 2008, ISBN: 9781420044309
8	Sustainable Utilization of Natural Resources	P. Mondal & A.K. Dalai	CRC Press, New York, 2017, ISBN: 9781498761840
9	Renewable Energy Engineering	J.P. Hadiya & H.G. Katariya	Books India Publications, Ahmedabad, 2nd Ed., 2018
10	Green Hydrogen: Bridging the Energy Transition	J. Rivas & E. Rosales-Asensio	Springer, Cham, 2023, ISBN: 9783031265246
11	Hydrogen Economy: Opportunities and Challenges	M. Ball & M. Wietschel	Cambridge University Press, Cambridge, 2009, ISBN: 9780521882163
12	Hydrogen and Fuel Cell: Technologies and Applications	B. Sorensen	Academic Press (Elsevier), London, 2nd Ed., 2018, ISBN: 9780128111321
13	Green Hydrogen: Technology, Economics and Policy	S. Chakraborty & A. Majumdar	Elsevier, Amsterdam, 2022, ISBN: 9780323916785

(b) Open-source software and website:

1. https://ndl.iitkgp.ac.in/
2. https://www.vlab.co.in/
3. https://swayam.gov.in/
4. https://onlinecourses.nptel.ac.in
5. Literature available in any laboratory manual of Process heat transfer
6. MIT Open course lecture available on Internet etc…
7. National Digital Library of India

Suggested Tutorials List:

Sr. No.	Tutorials	Approx. Hrs Required
1	Classify different types of clean and renewable energy sources.	1
2	Illustrate the World and Indian energy scenario through a chart.	1
3	Calculate hydrogen production by electrolysis using simple numerical problems.	1

4	Demonstrate hydrogen generation with a simple electrolysis model.	1
5	Construct a flowchart showing methods of Green Hydrogen production.	1
6	Analyze applications of Green Hydrogen in industry, transport, and power generation.	1
7	Solve numerical problems on solar insolation and efficiency of solar collectors.	1
8	Design a simple model or chart of solar photovoltaic/thermal system.	1
9	Evaluate the applications, advantages, and limitations of solar energy.	1
10	Compute wind power output through numerical problem-solving.	1
11	Develop a simple model or chart of a horizontal/vertical axis wind turbine.	1
12	Calculate hydro power potential and turbine efficiency using given data.	1
13	Prepare a chart of major hydropower projects in India with capacity details.	1
14	Explain applications and advantages of geothermal energy.	1
15	Design a schematic/model of a geothermal power plant.	1

Suggested Activities for Students:

1. Assignments
2. Technical Quiz / MCQ Test
3. Preparation of non-working models or charts
    a. Non-working models of solar PV system, wind turbine, hydro turbine, and geothermal plant
    b. Chart on different methods of Green Hydrogen production (electrolysis, biomass, thermochemical)
    c. Chart of Indian renewable energy scenario (installed capacity by source)
4. Preparation of PowerPoint slides or multimedia content
    a. PowerPoint with videos or animations showing working of solar panels or wind turbines
    b. PowerPoint on Green Hydrogen production process and storage methods
    c. Animated presentation on hydropower and geothermal power plants
5. Case study or report writing
    a. Report on a successful renewable energy project in India (for example Pavagada Solar Park, Gujarat Wind Farms, Tehri Dam)
    b. Report on the future potential of hydrogen as a fuel in India
6. Micro projects (individual or group)
    a. Develop a mini solar cooker or solar water heater model
    b. Fabricate a demonstrative model of a wind turbine using simple materials
    c. Comparative study of cost and efficiency of renewable energy systems in India

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