



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Diploma Engineering**

**Level: Diploma**

**Branch: Electrical Engineering**

**Subject Code: DI05009021**

**Subject Name: Green Technology**

<b>w. e. f. Academic Year:</b>	2026-27
<b>Semester:</b>	5 <sup>th</sup>
<b>Category of the Course:</b>	PEC-04

<b>Prerequisite:</b>	Basic knowledge of electrical engineering, energy systems, and environmental studies.
<b>Rationale:</b>	India aims to achieve net-zero emissions by 2070. With increasing energy demand and dependency on fossil fuels, there is a strong need to adopt sustainable and renewable energy technologies. This course introduces students to solar, wind, and emerging green technologies along with policies and regulations. It enables diploma engineers to contribute towards sustainable energy systems and environmentally responsible engineering practices.

**Course Outcomes:** After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Describe different renewable energy sources and technologies	R, U
02	Analyze the performance of solar photovoltaic systems	U, A
03	Explain operation and types of wind energy systems	U
04	Interpret government policies and schemes related to renewable energy	U

\*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
L	T	PR		C	Theory		Tutorial / Practical	
			ESE (E)		PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150



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## Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	<b>Unit 1 – Renewable Energy Resources</b> <ul style="list-style-type: none"><li>• Energy scenario in India (Installed capacity, Generation Capacity, Energy Demand, Supply)</li><li>• Environmental impact of fossil fuels</li><li>• Renewable energy sources overview Yearly Generation Growth, Generation State-wise</li><li>• Hydrogen energy: Characteristics, advantages, and applications</li><li>• Hydrogen types: Green, Blue, Grey hydrogen</li><li>• Biofuels: Biodiesel, Bioethanol, Bio-CNG</li></ul>	7	15%
2.	<b>Unit 2 – Solar Energy</b> <ul style="list-style-type: none"><li>• Solar Energy Potential in India, National institute of solar energy, Off grid solar PV Programme</li><li>• Intensity of light, Electromagnetic radiation</li><li>• Solar radiation concepts (DNI, DHI, GHI)</li><li>• Albedo, Factors affecting albedo</li><li>• Solar cell working and types with comparison</li><li>• Working and features of Perovskite, Tandem, HJT and Bifacial Solar cells</li><li>• Series &amp; Parallel Connection of Solar array</li><li>• Solar cell, modules and array</li><li>• I – V and P – V Characteristics of Solar Cell, Maximum power point, fill factor, effect of irradiance on characteristic of solar cell</li><li>• Sun – Earth relation: Equinox, Summer solstice, Winter solstice</li><li>• Tilt angle &amp; its case study. Solar hour angle, Declination angle, Altitude angle, Zenith angle, Azimuth angle &amp; its case study</li><li>• Orientation of solar panel, case study</li><li>• Solar inverter: Grid connected, central, string, micro inverter, off grid inverter, hybrid inverter, Estimation of inverter size and battery size</li><li>• Solar tracking: single axis tracking, dual axis tracking, Cosine effect in solar tracking</li><li>• Shadow analysis: distance between two arrays</li></ul>	18	40%



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	<ul style="list-style-type: none"> <li>• Solar Farm, Case Study</li> </ul>		
3.	<p><b>Unit 3 – Wind Energy</b></p> <ul style="list-style-type: none"> <li>• Wind energy potential in India, Wind energy potential at 120 m, 150 m and above 150 m level</li> <li>• Wind power equation</li> <li>• Wind power curve</li> <li>• HAWT, VAWT, Savonius &amp; Darries wind turbine</li> <li>• Wind speed measure instrument: Cup type, pitot tube type, impeller type, ultrasonic type, LIDAR and SODAR anemometer</li> <li>• Construction and working of wind generator: squirrel cage, wound rotor, double fed, wound rotor permanent magnet and permanent magnet synchronous generator</li> </ul>	13	25%
4.	<p><b>Unit 4 – Renewable Energy Policies</b></p> <ul style="list-style-type: none"> <li>• Grid connected solar roof top solar programme, objectives, CFA for different sectors</li> <li>• Grid connected solar power projects</li> <li>• PM KUSUM Scheme, component A, component B and component C, incentives, Feeder level solarization scheme</li> <li>• Solar park and Ultra mega solar power plant policy</li> <li>• Wind solar hybrid policy 2018, objective of policy, incentives, waiver of charges</li> <li>• National green hydrogen mission: Objectives and Incentives for electrolyzer and green hydrogen production</li> <li>• Fame II policy: Objectives, Incentives, Target etc.</li> </ul>	7	15%
<b>Total</b>		<b>45</b>	<b>100%</b>

**Suggested Specification Table with Marks (Theory):**

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
15 %	45 %	40 %	00	00	00

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



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## References/Suggested Learning Resources:

### (a) Reference Books:

- 1 Renewable and Efficient Electric Power Systems, by Gilbert M. Masters, John Wiley & Sons Ltd, 2nd Edition, ISBN: 9780471280606
- 2 Energy Harvesting: Solar, Wind, and Ocean Energy Conversion Systems, by Alireza Khaligh & Omer C. Onar, CRC Press, 2nd Edition, ISBN: 9781439815083
- 3 *Wind Energy Explained: Theory, Design and Application*, by J.F. Manwell, J.G. McGowan, A.L. Rogers, John Wiley & Sons Ltd, 2nd Edition, ISBN: 9780470015001
- 4 *Renewable Energy Resources and Emerging Technologies*, by D.P. Kothari, K.C. Singal, Rakesh Ranjan, PHI Learning Pvt. Ltd., 2nd Edition, ISBN: 9788120344730
- 5 Solar Energy: Fundamentals, Design, Modelling and Applications, by G.N. Tiwari & Swapnil Dubey, RSC Publishing, ISBN: 9781849730204
- 6 Non-Conventional Energy Sources, by G.D. Rai, Khanna Publishers, Latest Edition, ISBN: 9788174090737

### (b) Open-Source Software and Website:

#### PVsyst (Solar Simulation Software)

Description:

PVsyst is a widely used software for designing and analyzing photovoltaic systems including grid-connected, off-grid, and hybrid systems.

Website: <https://www.pvsyst.com>

Features:

- Solar PV system design and simulation
- Performance analysis (I–V, P–V curves)
- Shading and loss analysis
- Battery storage modeling

#### SAM (System Advisor Model – NREL)

Description:

SAM is a free performance and financial model developed by NREL for renewable energy projects.

Website: <https://sam.nrel.gov>

Features:

- Solar, wind, and hybrid system simulation



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- Financial feasibility analysis
- Energy output estimation
- Detailed system modeling

## HOMER Pro (Hybrid System Design Software)

Description:

HOMER Pro is used for designing and optimizing hybrid renewable energy systems.

Website: <https://www.homerenergy.com>

Features:

- Hybrid system optimization (solar, wind, diesel, battery)
- Cost and performance comparison
- Microgrid design

## MNRE (Ministry of New and Renewable Energy, India)

- Website: <https://www.mnre.gov.in>
- Provides policies, schemes, and latest updates on renewable energy

## Solar Rooftop Calculator (India)

- Website: [https://solarrooftop.gov.in/rooftop\\_calculator](https://solarrooftop.gov.in/rooftop_calculator)
- Used for estimating solar plant capacity and savings

## National Renewable Energy Laboratory (NREL)

- Website: <https://www.nrel.gov>
- Global research in solar, wind, and sustainable energy

## Bureau of Energy Efficiency (BEE)

- Website: <https://www.beeindia.gov.in>
- Energy efficiency programs and standards

## Suggested Course Practical List:

Sr. No.	Practical Outcome/Title of experiment	Unit/CO	Approx. Hours required
1	To plot I – V characteristics of solar cell and determine fill factor.	II	4
2	Perform P – V characteristics of solar cell.	II	2
3	To measure efficiency of solar cell	II	2



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4	To study effect of irradiance on the I – V and P – V characteristics of solar cell	II	2
5	Analyze the performance of solar panel based on tilt angle of solar panel	II	4
6	Analyze the performance of solar cell based on azimuth angle of the solar panel.	II	2
7	Estimate size of solar panel for small residential load	II	2
8	Estimate AC energy output of small solar farm considering fixed array, one axis tracking and dual axis tracking.	II	4
9	Estimate AC energy output of small solar farm, cost of power plant and payback period.	II	2
10	To measure sunshine hours by using sunshine recorder	II	4
11	Measure solar irradiance & record it during solar time of a place	II	2
12	Estimate Bifacial gain by the albedo in the solar panel	II	2
13	To plot I – V characteristics of solar cell and determine fill factor.	II	2
			<b>34 Hrs</b>

## List of Laboratory / Learning Resources Required:

### Hardware Resources

- Solar PV panel setup
- Pyranometer / Solar irradiance meter
- Solar IV tester
- Wind turbine model
- Anemometer
- Data logger
- Solar tracker
- Battery & inverter setup

### Suggested Activities for Students:

- Seminar on renewable energy topics
- Solar energy potential analysis of India
- Wind energy mapping
- Case study on solar power plant
- Group discussion on green policies