GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Program
Level: UG
Branch: Minor/Hons. Solar Energy Systems
Course/Subject Code: BE040AJ011
Subject Name: Solar Energy System - I

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	Core Courses

Prerequisite:	Basic Electrical Engineering, Basic Electronics, Fundamental of Physics
Rationale:	Solar energy has emerged as one of the most promising and sustainable sources of electrical power in both developing and developed countries. With the increasing demand for clean energy, it is essential for engineering graduates to understand the fundamentals of photovoltaic technology and its practical applications. This subject deals with the principles of solar radiation, working of photovoltaic cells and modules, their electrical characteristics, and various financial and policy models supporting PV system deployment.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Explain the historical development, growth trends, and applications of photovoltaic systems in global and Indian contexts.	20
CO-2	Analyze various financial models and regulatory mechanisms of PV systems such as net metering, PPAs, and leasing models.	15
CO-3	Describe solar radiation characteristics, insolation patterns, and working principles of solar cells.	15
CO-4	Interpret and analyze I–V and P–V characteristics of solar cells.	30
CO-5	Evaluate PV module performance considering mismatch losses, irradiance, temperature, and diode configurations.	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	0	30	45	120	4	70	0	0	30	50	150

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**** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Content:

Sr. No.	Content	Total Hrs
1	Historical Growth of Photovoltaic, Growth Potential of Photovoltaic, PV Growth: India Case Study, Applications of PV	09
2	PV financial models: Net metering, PV financial models: PPAs, Leasing, The Terminology of PV, Fundamentals of PV	07
3	Introduction: The Sun, The Solar Spectrum, Insolation and irradiance, insolation variation with time, Insolation on horizontal flat plane and Energy on horizontal flat plane, Working principles of Solar Cells, Recent development on solar material	07
4	Introduction: The IV-curve, The Maximum Power Point, The Non-ideal Diode Equation, Electrical Cell Interconnection	12
5	Mismatch Losses and Bypass Diodes, Bypass diodes vs. blocking diodes, Module Components, The PV Circuit, Measuring power in a PV circuit, Data Sheet Reading of PV Module, Introduction to the tools of the solar PV system	10
	TOTAL	**45**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**15**	**10**	**45**	**10**	**0**

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

Reference Books:

1. Deutsche Gesellschaft für Sonnenenergie (DGS). Planning and installing photovoltaic systems: a guide for installers, architects and engineers. Routledge, 2013.

2. Solanki, Chetan Singh. Solar photovoltaics: fundamentals, technologies and applications. Phi learning pvt. Ltd., 2015.
3. Solanki, Chetan Singh. Solar photovoltaic technology and systems: a manual for technicians, trainers and engineers. PHI Learning Pvt. Ltd., 2013.

List of Tutorials: Nil

List of Open Source Software/learning website:

Design of Photovoltaic Systems - Course

List of suggested activities for Problem Based Learning:

1. To demonstrate the I-V and P-V characteristics of PV module with varying radiation and Temperature level.
2. To simulate solar PV model with MATLAB.
3. Hands on practice on voltage and current measurement of solar PV system.
4. To measure temperature of solar cell with thermography.
5. To find IV and PV characteristic of series connected PV Modules.
6. To find IV and PV characteristic of parallel connected PV Modules.
7. To demonstrate the working of diode as bypass diode and blocking diode.
8. To understand the growth of the solar PV system with the data available on GEDA and MNRE in terms of the growth of solar PV systems.

Sr. No.	Activity Name	Units Mapped	Hours	Brief Description	Evaluation Criteria / Remarks
1	Case Study on PV Growth in India	Unit 1	6	Students analyze India's solar energy policies, installed capacities, and major solar parks to identify drivers and barriers to PV growth.	Report submission and presentation on findings (policy analysis, data interpretation).
2	Economic Analysis using PV Financial Models	Unit 2	6	Teams calculate payback period, ROI for	Problem-solving accuracy and financial

				rooftop solar system	comparison report.
3	Solar Irradiance Measurement and Data Analysis	Unit 3	6	Students collect or simulate solar irradiance data for different times of the day and analyze insolation variation and energy potential.	Data collection accuracy and analytical interpretation.
4	Design and Simulation of a Solar PV Cell	Units 3 & 4	8	Students simulate I-V and P-V characteristics of a solar cell/module using Simulation Tools and determine MPP under varying conditions.	Simulation results, analysis report, and viva.
5	Study of IV Curve and Maximum Power Point Tracking (MPPT)	Unit 4	5	Groups perform a lab-based or virtual experiment to plot the IV curve and identify the effect of temperature and irradiance on MPP.	Practical demonstration and result explanation.
6	Module Connection and Losses Analysis	Unit 5	6	Students analyze effects of series/parallel	Performance comparison and loss analysis chart.

				connections, mismatch losses, and bypass diode operation using circuit simulation tools.	
7	PV System Design for a Residential Building	Units 1–5 (Integrated Project)	8	Comprehensive problem: Design a grid-connected rooftop PV system including selection of modules, inverter sizing, and cost estimation.	Final project report, presentation, and justification of design choices.

Total Hours: 45

Note:

- All the suggested activity should be related to the subject.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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