GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Minor/Hons. Degree
Level: UG
Branch: Minor/Hons. Solar Energy Systems
Subject Code: BE050AJ011
Subject Name: Solar Energy System- II

w. e. f. Academic Year:	2026-27
Semester:	5
Category of the Course:	Core Courses

Prerequisite:	Basic Electrical Engineering, Basic Electronics
Rationale:	The *dc-dc* converter, grid-tied and off-grid inverters are now being widely used in off-grid and grid tied solar photovoltaic system. The course is aimed to provide exposure about connection of solar photovoltaic modules, different types of *dc-dc* converter, charge controller, different types of solar inverter, and control of solar inverter.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Analyze the electrical performance and interconnection of PV modules under varying conditions.	10
CO-2	Design and evaluate DC-DC converters and charge controllers for solar power management.	30
CO-3	Compare single and double-stage inverter topologies for efficiency and application suitability.	30
CO-4	Implement MPPT algorithms and synchronize PV systems with the electric grid.	15
CO-5	Develop functional solutions for battery storage, solar pumping, and lighting systems.	15

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

**** 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, PBL = Problem based Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

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Content:

Sr. No.	Content	Total Hrs
1	Series and parallel interconnection of PV modules and array circuits; Photovoltaic module and array electrical characteristics; PV power characteristics.	5
2	DC–DC converters; Types of charge controllers; Design of charge controller.	12
3	PV inverter types; Power converters in PV applications; Efficiency of power converters; Single-stage and double-stage PV inverter; Comparison of dual-stage and single-stage PV inverter.	16
4	Control of PV inverter; Maximum Power Point Tracking (MPPT); Interfacing PV systems with the electric grid.	7
5	PV loading techniques; Battery energy storage system; Working principle of solar streetlight and solar water pump.	5
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	**35**	**30**	**10**	**5**	**0**

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

Reference Books:

1. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
2. N. Mohan, T. M. Undeland, W.M. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Edition, 2007.
3. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
4. Solanki, Chetan Singh. Solar photovoltaics: fundamentals, technologies and applications. Phi learning pvt. Ltd., 2015.
5. Deutsche Gesellschaft für Sonnenenergie (DGS). Planning and installing photovoltaic systems: a guide for installers, architects and engineers. Routledge, 2013.
6. Erickson, Robert W., and Dragan Maksimovic. Fundamentals of power electronics. Springer Science & Business Media, 2007.

List of Tutorials: Nil

List of Open Source Software/learning website:

Software: LTSPICE
Learning website: Design of Photovoltaic Systems - Course

Suggested Course Practical List:

1. To demonstrate the I-V and P-V characteristics of PV Modules.
2. To demonstrate the I-V and P-V characteristics of series connected PV Modules.
3. To demonstrate the I-V and P-V characteristics of parallel connected PV Modules.
4. Analyze impact of partial shading on power output of solar PV array.
5. To draw the charging and discharging characteristics of battery.
6. To perform boost conversion operation of boost converter with varying solar input.
7. To perform 120 degrees and 180-degree conduction mode of three phase inverter with microcontroller.
8. To perform unipolar sinusoidal pulse width modulation of single phase inverter.
9. To do harmonic analysis of output current of single phase inverter with square and sine wave output.

List of suggested activities for Problem Based Learning:

Sr. No.	Activity Name	Units Mapped	Hours	Brief Description	Evaluation Criteria / Remarks
1	Study of PV Module Datasheets and Calculations	Unit 1	4	Analyze datasheets of different PV modules and calculate power rating for series and parallel configurations.	Datasheet analysis, correctness of calculations
2	MATLAB/Simulink Modeling of PV Module	Unit 1	5	Develop PV module model and plot I–V and	Model accuracy, I-V and P-V plots

				P–V characteristics under varying irradiance and temperature	
3	Comparative Study of maximum power point tracking (MPPT) Techniques	Unit 2	5	Study perturb & Observe (P&O), Incremental Conductance, and Hill Climbing MPPT techniques and compare performance parameters.	Technical depth, comparison table, and conclusions
4	Simulation of MPPT Controlled DC–DC Boost Converter	Unit 2, Unit 3	5	Implement MPPT with a boost converter and evaluate tracking efficiency.	Simulation results, MPPT performance in terms of steady state and dynamic response
5	Design Calculation of *dc–dc* Converter for solar PV Application	Unit 3	5	Perform calculation of sizing of passive components and selection of power electronic switch rating.	Accuracy in calculation and consideration of different scenario during calculation
6	Study and Design of Solar Charge Controller	Unit 3	4	Study PWM and MPPT-based charge controllers and propose a design for a small PV system.	Circuit design, explanation
7	Study of grid connected commercially available inverter	Unit 4	4	Evaluate efficiency and technical parameter of the inverter	Explanation of electrical parameter of inverter.
8	Comparative Study of Single-Stage and Two-Stage PV Inverters	Unit 4	4	Analyze structure, control,	Comparative analysis, technical

				efficiency, and cost of single-stage vs two-stage PV inverters.	justification
9	Grid Synchronization Techniques for PV Inverters	Unit 5	4	Study phase locked loop (PLL)-based grid synchronization methods and simulate grid voltage tracking.	Understanding of control concept, simulation
10	Case Study on Grid-Connected Rooftop PV System	Unit 1–5	5	Perform complete system study including sizing, inverter selection, and grid interfacing as per standards.	System design approach, documentation

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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