

Program : <b>Diploma in Electrical and Electronics Engineering</b>	
Course Code : <b>6032A</b>	Course Title: <b>Solar Power Technologies</b>
Semester : <b>6</b>	Credits: <b>4</b>
Course Category: <b>Program Elective</b>	
Periods per week: <b>4 (L:3 T:1 P:0)</b>	Periods per semester: <b>60</b>

### Course Objectives:

- To motivate the students to adapt efficient solar technology as future energy techniques.
- To organize an outline for extracting electrical power/ heat using various solar technologies.
- To understand the basic technology knowledge to select the size of solar PV systems and its erection.

### Course Prerequisites:

Topic	Course code	Course name	Semester
Electrical Energy Generation, Transmission and Distribution		Electrical Energy Generation, Transmission and Distribution	3

### Course Outcomes

On completion of the course, the student will be able to:

CO <sub>n</sub>	Description	Duration (Hours)	Cognitive Level
CO1	Explain the various technologies to harness solar energy in the form of heat	14	Understanding
CO2	Classify various concentrated solar power (CSP) plants.	13	Understanding
CO3	Explain the various array configurations of roof top solar modules and its maintenance	15	Understanding
CO4	Outline Solar PV system operation and grid synchronization.	16	Understanding
	Series Test	2	

**CO-PO Mapping:**

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1					3		
CO2					3		
CO3					3		
CO4					3		

3-Strongly mapped, 2-Moderately mapped, 1-Weakly mapped

**Course Outline:**

Module Outcome	Description	Duration (Hours)	Cognitive level
<b>CO1</b>	<b>Explain the various technologies to harness solar energy in the form of heat</b>		
M1.01	Outline the scope of solar energy and discuss its potential.	2	Understanding
M1.02	Illustrate various solar collectors.	3	Understanding
M1.03	Explain the utilisation of solar energy in domestic and industrial applications	5	Understanding
M1.04	Illustrate the solar space heating and space cooling.	4	Understanding

**Contents:**

Solar energy - introduction - advantages - disadvantages - applications - scope and potential of solar energy - reasons to promote solar heating

Solar collectors - types - diagrams - concentrated (parabolic, trough, mirror strip and Fresnel lens) - non concentrated (Flat plate and evacuated tubes) - comparison - concentrating and non concentrating type solar collectors.

Solar thermal devices - Construction-working,-merits and demerits -Solar cooker(box type and dish type) - solar water heater(Natural circulation & forced circulation) - solar domestic water heating system-

Industrial applications - Schematic arrangement and operation - solar furnace - Solar still (single slope & double slope) - solar air heater - solar crop dryer - solar kilns - solar wax melter - solar pump - Solar green houses.

Solar space heating - basic concept with sketches - passive techniques (direct gain - indirect - gain - isolated gain) - active techniques (hot air solar heating system - solar steam heating system)

Solar Space cooling-Block diagram- working-solar absorption technique

<b>CO2</b>	<b>Classify various concentrated solar power (CSP) plants.</b>		
M2.01	Classify Concentrated solar power plants based on temperature	4	Understanding
M2.02	Explain the working of low temperature solar power plant	3	Understanding
M2.03	Explain the working of medium temperature solar power plant	3	Understanding
M2.04	Explain the working of high temperature solar power plant	3	Understanding
	Series Test-I	1	

**Contents:**

Concentrated Solar Power (CSP) plants-Classification of solar power plants based on Temperature - (low/medium/high)

Solar power plants - Schematic diagram - working -Low temperature solar power plant (solar pond power plant - Flat plate collector power plant) - Medium temperature solar power plant (Line focusing parabolic collector power plant) - High temperature solar power plant - Parabolic dish power plant-Central receiver power plant - fresnel reflectors - stirling engine)

<b>CO3</b>	<b>Explain the various array configurations of roof top solar modules and its maintenance</b>		
M3.01	Illustrate photovoltaic effect and various PV technologies	3	Understanding
M3.02	Explain the characteristics of a solar cell and draw its equivalent circuit.	4	Understanding
M3.03	Illustrate various array configurations of solar modules	4	Understanding
M3.04	Explain the specification, the Standard parameters of solar cell and identify the factors affecting module output.	4	Understanding

**Contents:**

Solar cell - working principle (photovoltaic effect) - basic construction - PV module technologies - first - generation (crystalline silicon)second generation (thin film) – third - generation (emerging and novel technologies).

V/I characteristics of pv module - definitions - short circuit current (Isc) - open circuit voltage (Voc) - Maximum Power (Pmax) - voltage at maximum power (Vmp) - current at maximum power (Imp) - fill factor - equivalent circuit of a solar cell.

Array Configuration: definitions - cells - module - panel - array - series and parallel connection in solar modules - single string in - series systems - multiple string in - series systems - micro - inverter systems

Specification of solar module - electrical & mechanical parameters - module energy output-standard Test Conditions (STC)parameters - cell temperature - irradiance - air Mass de rating factor of a solar cell - important factors considered for installing a solar panel - direction - tilt - shading - temperature - preventive maintenance of solar module

<b>CO4</b>	<b>Outline Solar PV system operation and grid synchronization.</b>		
M4.01	Outline solar PV system components.	4	Understanding
M4.02	Classify inverters used in solar PV systems and their power controllers.	4	Understanding
M4.03	Explain the main features and working of net meters and summarize active power export.	4	Understanding
M4.04	Classify the types of solar PV system and draw the block diagram	4	Understanding
	Series Test - II	1	

**Contents:**

PV system components - functions - PV Modules, - Storage Battery - Inverter, - Charge Controller - Solar Array Mounting System,-Cables & Connectors, - blocking diode - bypass diode, - junction box

Inverter - classification - specification(Electrical Characteristics DC and AC, mechanical characteristics) - types of batteries used (list only)

Solar Power converters and controllers - power converters - Buck converter - Boost converter - charge controller - block diagram - MPPT-PWM

Types of PV systems - block diagram - Off - Grid Solar Systems - Grid-Tied Solar Systems (on grid) - Hybrid systems-Solar wind hybrid system-net metering - main features and working - Active power export (brief idea) - Grid synchronization (brief idea)

**Text / Reference:**

<b>T/R</b>	<b>Book Title/Author</b>
R1	Deambi, Suneel: From Sunlight to Electricity: a practical handbook on solar photovoltaic application; TERI, New Delhi ISBN:9788179935736
R2	Solanki, Chetan Singh, - Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning, New Delhi, ISBN: 9788120351110
R3	Solanki, Chetan Singh, - Solar Photovoltaic Technology and Systems - A Manual For Technicians, Trainers and Engineers, PHI Learning, New Delhi, ISBN: 9788120347113
R4	B.H Khan-“Non- Conventional Energy Resources”,Mc Graw Hill Education(India)Private Limited.ISBN:978-93-5260-189-9
R5	Kothari, D.P. et al: Renewable Energy Sources and Emerging Technologies, PHI Learning, New Delhi, ISBN: -978-81-203-4470-9
R6	David M. Buchla, Thomas E. Kissell, Thomas L. Floyd - Renewable Energy Systems, Pearson Education New Delhi , ISBN: 9789332586826,
R7	O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi (ISBN: 978-9386173-683)
R8	G.D.Rai, “Non conventional Energy sources” Khanna Publishing House, New Delhi (ISBN: 81-7409-073-8)
R9	Er.R.K.Rajaput “Non- conventional Energy sources and utilisation” S Chand, ISBN : 81-219-3971-2

**Online resources:**

<b>Sl.No</b>	<b>Website Link</b>
1	<a href="https://www.swayam.gov.in/">https://www.swayam.gov.in/</a>
2	<a href="https://nptel.ac.in/">https://nptel.ac.in/</a>
3	<a href="https://www.teriin.org/">https://www.teriin.org/</a>
4	<a href="https://www.youtube.com/">https://www.youtube.com/</a>
5	<a href="https://mnre.gov.in/">https://mnre.gov.in/</a>
6	<a href="https://www.anert.gov.in/">https://www.anert.gov.in/</a>