COURSE CODE: **1152EE143**	COURSE TITLE: **SOLAR PHOTOVOLTAIC SYSTEMS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

COURSE CATEGORY:

Program Elective

PREAMBLE:

Due to the growing demand for renewable energy sources especially harnessing power from sun, it is felt essential to offer a basic course on solar Photo Voltaic technology and Systems comprising up of the fundamentals, design and application of solar photovoltaic systems for power generation on small and large scale electrification.

PRE-REQUISITES:

Basic Electrical Engineering

COURSE EDUCATIONAL OBJECTIVES:

To impart knowledge on

- To familiar with basics of solar PV
- To familiar with various PV performance measure terminologies.
- To understand about manufacturing of PV cells & sizing aspects of PV systems.
- To understand about PV system components and apply them in installation practices,& associated trouble shootings.
- To understand about PV system applications & associated safety measures.

COURSE OUTCOMES:

Upon the completion of the course students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand the principle of direct solar energy conversion to power using PV	K2
CO2	Contrast the performance measures of PV	K2
CO3	Infer on various solar cells & design aspects of solar PV	K2
CO4	Identify various PV components & construct few systems	K2
CO5	Develop ideas for working on solar PV systems & associated safety practices	K2

CORRELATION OF COs AND POs

COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H									H		
CO2	H	M	M							H		H
CO3	H			H						H		H
CO4	H	M		H						H		
CO5	H									H		

COURSE CONTENTS

UNIT I	**SOLAR CELL FUNDAMENTALS**	**6**
Principle of solar energy conversion, Photovoltaic effect, Semiconductor properties, energy levels, basic equations. Solar cell structure, parameters of solar cell.		
UNIT II	**PV MODULE PERFORMANCE**	**6**
Solar PV modules & arrays, I-V &P-V characteristics, maximum power point ,series parallel combination, cell efficiency, fill factor, role of bypass & blocking diode, factors affecting output of a solar cell.		
UNIT III	**MANUFACTURING OF PV CELLS & DESIGN OF PV SYSTEMS**	**6**
Commercial solar cells - Production process of single crystalline silicon cells, multi crystalline silicon cells, amorphous silicon, cadmium telluride, copper indium gallium diselenide cells. Design of solar PV systems, cost estimation, various aspects, system simulation tools.		
UNIT IV	**SOLAR PV SYSTEMS INSTALLATIONS & TROUBLE SHOOTING**	**6**
Classification - Central Power Station System, Distributed PV System, Stand alone PV system, grid Interactive PV System, small system for consumer applications, hybrid solar PV system, concentrator solar photovoltaic. System components - PV arrays, inverters, batteries, charge controllers , net metering ,. PV array installation, operation, costs, reliability. Troubleshooting of PV system components.		
UNIT V	**PV SYSTEM APPLICATIONS & SAFETY**	**6**
Building-integrated photovoltaic units, grid connected central power stations, stand-alone devices for distributed power supply in remote and rural areas, Outlook for the Indian PV industry& challenges, Applications: solar home system, solar cars, Solar Charger, aircraft, space solar power satellites. Socio-economic and environmental merits of photovoltaic systems safety in Installation of solar PV systems		
		TOTAL: 45 PERIODS

TEXTBOOKS:

1. Chetan Singh Solanki., *Solar Photovoltaic: "Fundamentals, Technologies and Application",* PHI Learning Pvt., Ltd., 2009.
2. Jha A.R., "*Solar Cell Technology and Applications"*, CRC Press,2010.
3. John R. Balfour, Michael L. Shaw, Sharlave Jarosek*., "Introduction to Photovoltaics",* Jones & Bartlett Publishers, Burlington, 2011.

REFERENCE BOOKS:

1. Chetan Singh Solanki "*Solar PV technology and system",* PHI learning private limited, 2015.
2. Luque A. L. and Andreev V.M., "*Concentrator Photovoltaic"*,Springer, 2007.
3. Partain L.D., Fraas L.M., "*Solar Cells and Their Applications"*, 2nd ed., Wiley, 2010.
4. S.P. Sukhatme, J.K.Nayak., "*Solar Energy",* Tata McGraw Hill Education Private Limited, New Delhi, 2010.
5. R.K Pachauri "*From Sun light to Electricity" TERI, 15th Reprint , 2013*

LABORATOTY PRACTICES

1) To perform experiment to study I-V characteristics of SPV module.
2) To perform experiment to study series combination of SPV modules.
3) To perform experiment to study parallel combination of SPV modules.
4) To perform experiment to study effect of tilt angle on SPV module output.
5) To perform experiment to demonstrate the effect of shading on SPV module output.
6) To study the effect of shading on the output of solar panel.
8) To understand how to use various electrical measuring equipments.

WEB REFERENCES:

https://www.nrel.gov The **National Renewable Energy Laboratory** (**NREL**), located in Golden, Colorado, specializes in renewable energy and energy efficiency research and development. **NREL** is a government-owned, contractor-operated facility, and is funded through the United States Department of Energy.

https://nise.res.in/ **National Institute of Solar Energy**, an autonomous institution of Ministry of New and Renewable (MNRE), is the apex National R&D institution in the field Solar Energy. The Government of India

http://www.seriius.org/ **(SERIIUS**—the Solar Energy Research Institute for India and the United States—is co-led by the Indian Institute of Science (IISc)—Bangalore, India, and the National Renewable Energy Laboratory (NREL), Golden, Colorado, USA.)