Course type	Course code	Name of the course	L	T	P	Credit
DE	NECD515	Fundamentals of Photovoltaic Devices	3	0	0	9

Course Objective
This course offers a comprehensive understanding of photovoltaic (PV) device technology, from fundamental semiconductor physics to advanced PV devices. The objective is to explore about the principles, materials, and manufacturing techniques used in PV devices, covering both conventional and emerging technologies.
Learning Outcomes
Basic principles of solar energy conversion, familiarization with various techniques employed in the fabrication of PV devices and comprehensive knowledge of different characterization techniques used for PV device analysis.

Module No.	Topics to be covered	Lecture Hours	Learning Outcome
1	Semiconductor material and properties, intrinsic and extrinsic semiconductor, direct and indirect semiconductor, electrostatics of PN junction	7	Foundation in the fundamental concepts in semiconductor materials
2	The basic principle of the photovoltaic device, Brief history of Photovoltaic cells, Losses: Optical and electrical Characteristics of photovoltaic cell: Short circuit current, Open-circuit voltage, Fill factor, Quantum efficiency, Parasitic resistance, Equivalent circuit, The Shockley-Queisser limit	8	Comprehensive knowledge of the principles and characteristics governing PV devices
3	Overview of different PV technologies Silicon PV design, Crystalline silicon PV, the latest advancement in crystalline solar PV: PERC, PERL and PERT	7	Comprehension of Crystalline Si PV technology
4	Thin film PV devices: Inorganic PV devices -Amorphous and poly-crystalline Si PV, $Cu(In,Ga)Se_2$, CdTe, Cu_2ZnSnS_4 and Sb_2Se_3 PV devices Organic PV devices - Organic, Dye-sensitized and Perovskite PV devices Nanomaterials in PV technology, prospects and challenges	10	Understanding and perspective on emerging thin film PV technologies
5	Thin film fabrication techniques: E-beam and thermal evaporation, DC/RF Sputtering, Chemical bath deposition, Successive Ionic Layer Adsorption and Reaction and Close-spaced sublimation techniques Characterization techniques: Resistivity measurement using the Four-point probe method, Hall effect for determining charge carrier type, density and mobility, UV-Vis-NIR spectroscopy, external and internal quantum efficiency and Photoluminescence	10	Learn about the various thin film deposition techniques and the techniques for PV device characterization
	Total	42	

Text Books:

1. Antonio Luque and Steven Hegedus, Handbook of Photovoltaics Science and Technology, John Wiley & Sons, Ltd.
2. Jenny Nelson, The Physics of Solar Cells, Imperial College Press.

Reference Books:

1. Peter Würfel and Uli Würfel, Physics of solar cells: from basic principles to advanced concepts, Wiley-VCH.
2. Jef Poortmans and Vladimir Arkhipov, Thin Film Solar Cell Fabrication, Characterization and Applications, John Wiley & Sons, Ltd.
3. Simon M. Sze, Ming-Kwei Lee, Semiconductor Devices: Physics and Technology, John Wiley & Sons, Ltd.