Course Code ESE-803	Credit Hours (Th-Pr) 3-0	**Photovoltaic Devices (Core)**	Contact Hrs/Week (Th-Pr) 3-0	Total Contact Hrs (Th-Pr) 45-0

Course Outline:

An introduction to Photovoltaics, the physics behind the technology, the devices and practical applications. Traditional and renewable energy sources, thermodynamics and general energy related issues. Photovoltaic cells, semiconductor physics, solar cell structures, their principle of operation, design and fabrication. Photovoltaic systems including power converters and energy storage, residential grid-connected photovoltaic systems.

Eligibility Criteria: B.E (Chemical, Mechanical, Electrical, Environmental and Materials)

Recommended Books:

S. No.	Title	Author(s)	Assigned Code	Remarks
1.	PracticalPhotovoltaicsElectricity from solar cell	Richard J.Komp	RK	Text
2.	THE PHYSICS OF SOLAR CELLS	Jenny Nelson	JN	Text
3.	Solar Cell Device Physics, Second Edition	Stephen J.Fonash	JF	Reference
4.	Planning and installing photovoltaic systems	Deutsche Gesellschaftfür Sonnenenergie	DG	Reference

Course Objectives:

Solar cells harness the energy of sunlight and convert it directly into electricity. This course covers factors important in the understanding, design and characterization of solar cells. Students are introduced to a range of laboratory-based and commercial solar cell technologies in this course including silicon (wafer-based) technologies, thin film technologies, multi-junction, concentrator and third generation concepts and technologies.

Learning outcome:

The course will extend students' existing semiconductor device understanding and provide a sound basis in key practical processes such as solid state diffusion and device contacting.

Topics Covered:

No.	Topics	Text Book	Contact Hours
1.	**Energy**: Energy and Role of Photovoltaic, World Energy Requirement, renewable Energy Sources,Photovoltaic in Energy Supply, Solar PV production and cost	RK	4
2.	**Core concepts of Solar Cell:** Semiconductors as basic solar cell material, materials and properties, P – N junction and Solar cell. Sources of Losses and prevention.	RK	4
3.	**Physics of Solar Cell:** The basic properties of semiconductor materials, such as bandgap, charge carriers, mobility, doping, Fermi level, conductivity, recombination and luminiscens.	JN	4
4.	**Diode Behavior:** Analytically calculate the operational flow and diffusion flow in semiconductor materials and especially for transitions between p-and n-layers. Describe the behavior of a diode and analytically calculate contact potential, depletion zone, electric field strength, charge carrier distributions and current-voltage relationship.	JN	6
5.	**Optical Process:** The optical processes in semiconductor materials and explain the behavior of light-emitting diode, photo detector and solar cell. Evaluation of new semiconductor materials and components with regard to	JN	6

	photo voltaic and electronic applications.		
6.	**Solar Cell technologies: Crystalline Cells:** Mono-crystalline and poly – crystalline cells, Metallurgical Grade Si,Electronic Grade Si, wafer production, Mono – crystalline Si Ingots, Poly – crystalline SiIngots, Si – wafers, Si – sheets, Solar grade Silicon, Si usage in solar PV, Commercial Sisolar cells, process flow of commercial Si cell technology, process in solar cell technologies, Sawing and surface texturing, diffusion process, thin film layers, Metal contact	RK	6
7.	**Thin Film Cells:** Advantage of thin film, thin film deposition techniques, Evaporation, Sputtering, LPCVD and APCVD, Plasma Enhanced, Hot Wire CVD, closed space sublimation, Ion Assisted Deposition. Substrate and Super-state configuration, Amorphous Si Solar cell technology	RK	4
8.	**Concentrators and PV Modules:** Concentration: Advantages and disadvantages, Series Resistance optimization, Concentrating techniques; tracking / non-tracking systems, High concentration solar cells	RK	4
9.	**Solar Photovoltaic Modules:** Solar PV modules: Series and Parallel connections, Mismatch between cell and module, Design and structure, PV module power output, Electrical Storage: Battery technology, Batteries for PV systems, DC – DC converters, Charge Controllers, DC – AC inverters; single phase, three phase, MPPT.	RK	4
10.	**Planning & Design:** Planning Procedure, System capacity and Energy Demand, Site selection, System concept, Module selection and PV Generator, Selection and sizing of cables, Standalone System; Battery sizing, Charge Controller and Inverter, Grid	RK	3

	Connected Systems; Selection and inverter sizing, Generator Junction Box and DC Main Switch, Safety Measures, Grid Interface		