Course Title: Photovoltaic Devices **(Elective Course)**

Course Code: ESE-803

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.

Contents:

Energy and Role of Photovoltaic, World Energy Requirement, renewable Energy Sources, Photovoltaic in Energy Supply, Solar PV production and cost .

Semiconductors as basic solar cell material, materials and properties, P – N junction and Solar cell. Sources of Losses and prevention. The basic properties of semiconductor materials, such as bandgap, charge carriers, mobility, doping, Fermi level, conductivity, recombination and luminiscens. :

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.

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 photo voltaic and electronic applications. 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.

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.

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

Recommended Books

Photovoltaic Solar Energy: From Fundamentals to Applications; Angèle Reinders (Author), Pierre Verlinden (Author), Wilfried van Sark (Author), Alexandre Freundlich (Author); Wiley; 1st edition (January 3, 2017)

- Practical Photovoltaics: Electricity from Solar Cells; Richard J. Komp (Author); Aatec Pubns
- The Physics of Solar Energy Conversion 1st Edition by Juan Bisquert; CRC Press