CH-912 Solar Photovoltaics

Credit Hours: 3-0

Prerequisite: Nil

Course Objectives

The fundamental objectives of this course are to let the students know about:

a. Recent energy infrastructure and needs of renewable energy.
b. Solar energy conversion
c. Photovoltaics as an efficient tool
d. Solar Cells: Materials, methods and operations

Course Outcomes

After having completed the course, the candidates would be able to:

a. Students would be expected to design new materials for solar photovoltaics
b. Understanding and Interpretation of various characterization techniques used in solar photovoltaics.
c. Understanding of various properties to optimize different working conditions of solar cells
d. Working and preparation of solar cells

Course Contents

Introduction: Energy infrastructure in today's world, Renewable energy sources with special emphasis on solar energy, Solar cells: From fundamentals to practical applications, Characteristics of the cell, Short circuit current, Open circuit voltage, Fill factor and efficiency of solar cells

Charge Transport in Donor/Acceptor Materials: Polymers based materials, Visible-light active materials, Transport layers

Semiconductors: Band models, electron states in semiconductors, Extrinsic and Intrinsic semiconductors: Impurities and Doping.

Drift and Diffusion: Current equations in terms of drift and diffusion, Validity of the drift-diffusion equations, Current equations for non-crystalline/crystalline solids.

Junctions: Work function and the origin of photovoltaic action. Metal-semiconductor junction, semiconductor-semiconductor junction, electrochemical junctions and junctions in organic materials.

Fabrication and Characterization of Various Types of Solar Cells: Silicon based solar cells, Thin film solar devices, methodologies and development, ($CuInSe_2$, CdTe and ZnTe etc.), Organic and Hybrid solar cells, Photoelectrochemical devices and the concept of dye sensitization in dye sensitized solar cells (DSSC), Bulk heterojunction solar cells, performance and morphology of the devices, Electrodes and substrates requirements for organic photovoltaics, Barrier Films, Current approaches and recent trends, Some case studies.

Recommended Books

1. Tom Markvart, "Solar Cells: Materials, Manufacture and Operation", Elsevier 2005.
2. Karl W. Boer, "Handbook of the Physics of Thin Film Solar Cells", Springer 2013.
3. M.A. Green, "Third Generation Photovoltaics: Advances in Solar Energy Conversion", Springer 2007