Photovoltaics

1.1 Course Number: CH556

1.2 Contact Hours: 3-0-0 Credits: 9

1.3 Semester-offered: 4th Year- odd

1.4 Prerequisite: Basic understanding of material science and electronic materials

1.5 Syllabus Committee Member: Dr. Amit Ranjan

2. **Objective:** The objective of this course is to enable the students to understand the physics of solar cell device operation and to familiarize themselves with different designs of solar cells. Students would understand the material aspects and difference in operational principles of different kinds of solar cells. This course would help students to analyze the performance of a solar cell device and to understand issues faced at the panel installation level.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topic	Lectures
1	Electronic Properties of material and Device physics	Qualitative discussion on phonons, dispersion curves, electronic band structures, First Brillouin Zone, DoS, VB and CB in Si and GaAs, Electron and hole conduction, Localized states. Gap states. Traps. Donor and acceptor states. Excitons. Electronic behavior in nanoparticles, nanocrystals, amorphous, and organic solids. Interaction with light. Plasmons. Carrier recombination and trapping. Photogeneration. Carrier transport.	7
2	Photovoltaic action	Band bending in heterostructures. Photovoltaic action from electrostatic fields, diffusion, and effective fields. Various structures: p-n, p-i-n, heterojunction, Schottky junction, dye semiconductor cell. Absorber materials. Contact materials.	7
3	Homojunction and heterojunction solar cells	Analysis of homojunction and heterojunction device physics, numerical and analytical approaches. Some configurations.	12
4	Surface barrier and dye-sensitized solar cells	Analysis of devices' physics. Numerical and analytical approaches. Some solar cell configurations.	10
5	Perovskite solar cells	Introduction and recent advances.	4
		Total	**40**

4. **Readings**

4.1 Textbook:

1. S. Fonash, *Solar Cell Device Physics*, Academic Press, 1981.

4.2 Reference books:

.1. Journal Papers and Policy Papers

5. **Outcome of the Course:** Upon completion of this course, students will be able to understand the difference in operational principles of different kinds of solar cells, rationally design a solar cell given the absorber material and numerically and analytically study behavior of a solar cell device.