# ELEMENTS OF SOLAR ENERGY CONVERSION

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**PRE-REQUISITES :** Basic UG thermodynamics, UG heat transfer, basic electronics, basic engineering mathematics

**INTENDED AUDIENCE :** Any Interested Learners

**INDUSTRIES APPLICABLE TO :** Any solar energy based company. Such a course is non-existent in most curricula in India and it was the industry persons whose suggestions initiated the course.

**COURSE OUTLINE :**

This course intends to introduce the basic concepts required for the engineers to work in the field of solar energy technology, both industrial installations and research endeavours. The major focus is on the following topics: the apparent movement of the sun, irradiation prediction, intensity estimation on tilted plane, flat plate collectors, concentrating collectors of various kinds, thermal and photovoltaic routes of solar energy conversion. The course assumes basic knowledge in UG level thermodynamics, optics, semiconductor physics, heat transfer and engineering mathematics. The advanced UG ME students and the PG ME students intending to work in the solar energy field should opt for this course.

**ABOUT INSTRUCTOR :**

Prof. Jishnu Bhattacharya is an associate professor in Mech. Engg. In IIT, Kanpur. He works in the field of energy storage and conversion through sustainable routes. He teaches courses related to thermodynamics, heat transfer, air-conditioning, atomistic simulations for energy materials, electrochemical energy storage, solar energy conversion etc. Prior to IIT Kanpur, he was associated with IIT Kharagpur, Northwestern University, University of Michigan, Indian Institute of Science and Bengal Engineering College, Shibpur in reverse chronological order.

**COURSE PLAN :**

**Week 1:** Basic concepts related to solar radiation, the sun, spectral distribution, sun- earth relationship, extraterrestrial radiation, revolution of earth, seasons, position of sun in the sky, position of sun with respect to the center of the earth

**Week 2:** Concept of time, equation of time, solar time, standard time, Role of atmosphere on solar radiation, air mass, terrestrial spectrum, prediction of solar radiation

**Week 3:** Diffuse and direct radiation, derivation of the relationships between angles

**Week 4:** Sign conventions, angle of incidence on a tilted plane, shading, sun-path diagram, overhangs, parallel rows of solar collectors, measurement of radiation

**Week 5:** Estimation of total irradiance on a tilted surface, radiation augmentation

**Week 6:** Flat plate collector, thermal analysis, heat removal factor

**Week 7:** Air heaters, thermal analysis of air heaters, overview of other thermal collectors, testing procedure

**Week 8:** Single axis tracking, concentrating collectors, theoretical limit, classifications of concentrators

**Week 9:** Parabolic trough collector, thermal analysis, compound parabolic concentrators, parabolic dish collector, central receiver tower

**Week 10:** Non-thermal routes for solar energy conversion, Basics of photovoltaic effect, Electron-hole carrier formation and motion

**Week 11:** Band bending, photovoltaic generation, P-N junction diode, forward Bias, reverse bias

**Week 12:** Dark current, light-generated current, IV characteristic curve for P-N junction diodes, efficiency, effect of temperature intensity and spectrum, Comparative discussion on different solar conversion technologies in the state of the art form and the future directions