

Course Description

Introduction of solar and other renewable energy generation. Silicon and other semiconductor solar cells. Physics and circuit modeling. Energy storage and distribution. *Prerequisite(s)*: ELEC 3500

List of Topics

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| Week 1 | Energy sources, energy usage, fossil fuels, environmental issues, global warming |
| Week 2 | Blackbody radiation, relevance to global warming and solar energy, energy forms and conversion, energy supply chain, electricity generation by Faraday's law |
| Week 3 | Current electricity production methods, thermal power plants, thermodynamics of energy conversion, nuclear energy, hydroelectricity, wind energy, solar energies |
| Week 4 | Review of semiconductor physics, crystal structures, energy bands, carriers, drift and diffusion currents, p-n junctions |
| Week 5 | Optical properties of semiconductors, photovoltaic current generation, recombination mechanisms, solution of Poisson's equation in a p-n junction, charge-current-field distributions |
| Week 6 | Ideal diode equation, estimation of PV efficiency and fill factor, light trapping techniques, theoretical S-Q limit |
| Week 7 | More PV physics. Circuit model of real solar cells, circuit analysis, device structures, series and shunt resistances, design optimization |
| Week 8 | More circuit modeling, real solar cell fabrication supply chain, silicon materials supply, crystal growth, wafer processing |
| Week 9 | PV system, energy storage devices, electrical circuits |
| Week 10 | Thin film solar cells, a-Si, CIGS, CdTe, fabrication technologies |
| Week 11 | Economics of PV energy, emerging PV technologies, DSSC, OPV, application of nanotechnologies |
| Week 12 | PV roadmap, solar farms, PV applications |
| Week 13 | Thermal PV, artificial photosynthesis, water splitting, hydrogen economy |

Statement of Objectives/Outcomes:

On completion of this course, students will be able to:

CO1 - Understand the current energy situation

CO2 - Understand the current energy supply chain using fossil fuels and its environment consequences

CO3 - Understand some current alternative technologies related to energy generation

CO4 - Understand the operation of solar cells and related semiconductor physics

CO5 - Analyze and simulate operation of solar cells

CO6 - Understand the operation of thin film solar cells

CO7 – Solve homework problems based on class discussions and lecture notes

CO8 – Perform research and complete a term project on a topic relevant to the course

Textbook(s):

Lecture notes distributed through the course URL

Reference Books/Materials:

M A Green, *Third Generation Photovoltaic*, Springer 2003

Stephen Fonash, *Solar Cell Device Physics*, Academic Press 2010

Goezberger and Hoffmann, *Photovoltaic Solar Energy Generation*, Springer 2005

Relationship of Course to Program Outcomes:

Please refer to the Report Section 4.3.2 (iii).

Grading Scheme:

Homework	20%
Final Examination	40%
Term Project	40%