ELEC4530 Fundamentals of Photovoltaic and Renewable Energy

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

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%