PHYS 6980: Fundamentals of Solar Cells

PHYS 4400: Principles and Varieties of Solar Energy

Instructors: Profs. R. Ellingson and M. Heben

Tuesday & Thursday 12:30 – 1:45 pm; Location: R1, 2000N

Syllabus, updated March 22, 2011

General advice and things to remember

1. Keep current with the coursework.

2. Complete the reading assignment before the lecture – this will help you follow the class. Read the assignment again after lecture – this will help you to consolidate your knowledge.

4. Do the assigned homework on time and right after you have read the assignment the second time -- this will help to solidify your understanding.

5. Follow the University's Missed Class/Excused absence policy; the simplest link may be this one: [http://www.utoledo.edu/facsenate/missed_class_policy.html].

6. Turn cell-phones and pagers off when in class.

7. Know the University's class withdrawal rules: Students may withdraw from the course until March 25, 2011 according to [http://www.utoledo.edu/offices/registrar/main_campus/registration_dates.html]. You must withdraw either on-line or in person at the Registrar's Office.

GRADING and EXAMS

Only material covered in class or in homework will be used for exams. There will be 3 types of exam:

1. Quiz

The Quizzes will be short (5 minutes) and multiple choices (MCQ). They are given to make sure that you have understood the basic concepts taught during the last 3-4 classes. The Quizzes are closed-book, closed-notes.

2. Final exam

The Final exam will be a combination of MCQ and problems. The Final exam will be open-book, open-notes.

3. Project

Projects will be assigned to groups of students no later than March 1st. Each project will include a summary report and a presentation.

Grading

Grades will be determined according to: Project: 35%, Seven in-class quizzes: 35%, Final exam: 30%

Textbook: The primary text will be "The Physics of Solar Cells", by Jenny Nelson:
http://www.amazon.com/Physics-Solar-Properties-Semiconductor-Materials/dp/1860943497

Secondary texts you may be interested in accessing (do not feel compelled to purchase the books below, unless you wish to do so):

1. Thin Film Solar Cells: Fabrication, Characterization and Applications, ed. Poortmans and Arkhipov: http://www.amazon.com/gp/product/0470091266/ref=oss_product

2. Practical Photovoltaics: Electricity from Solar Cells, Richard Komp:
http://www.amazon.com/gp/product/093794811X/ref=oss_product

3. Third Generation Photovoltaics: Advanced Solar Energy Conversion, Martin Green:
http://www.amazon.com/gp/product/3540265627/ref=oss_product

Week of	**Topic(s)**
Jan. 11	Introduction; Earth's energy; the solar resource (the Sun's extraterrestrial and terrestrial spectra, blackbody approximation, atmospheric absorption and scattering, direct vs. indirect insolation, integrating the solar spectrum); solar energy conversion (PV vs. solar thermal vs. photoelectrochemical)
Jan. 18	No lectures
Jan. 25	Solar cell economics: efficiency, production costs, BOS, ageing and durability, goal of $ per Watt.
Feb. 1	Photovoltaic effect and fundamental solar cell properties; diode equation, dark current, light current; efficiency, J_{SC}, V_{OC}, internal and external QE, maximum power point. Review of semiconductor physics: bonds and bands in crystals; electrons and holes, valence/conduction bands, HOMO-LUMO concepts; n- and p-type doping; drift and diffusion; photogenerated carriers (direct vs. indirect gap); recombination mechanisms
Feb. 8	Detailed balance (in the dark, and under illumination); Band gap influence on efficiency; concentrator solar cells (effect on efficiency, practical considerations – tracking, direct insolation, thermal load); p-n homojunction, heterojunctions.
Feb. 15	More on the p-n junction and types of junctions (metal-semiconductor, semiconductor-semiconductor, organics)
Feb. 22	Crystalline and polycrystalline Si PV technology.
Mar. 1	Nanostructured semiconductor crystals: shapes, syntheses; surface chemistry, quantum confinement effects. CdTe solar cells (guest lecture by Prof. Al Compaan).
Mar. 8	Spring Break

Mar. 15	3/15:Special colloquium on Photovoltaivcs, Dr. Yanfa Yan of NREL 3/17: Nanotubes for Photovoltaics (Heben)
Mar. 22	Solar cell materials and device characterization. CIGS solar cell technology.
Mar. 29	a-Si solar cell manufacturing (Xunlight tour?). Introduction to thin film (CdTe, CIGS, CdS) semiconductor and metal-layer deposition techniques. Topics in high-efficiency epitaxial III-V multijunction PV.
Apr. 5	Evolving materials considerations: Earth-abundance, toxicity, manufacturability
Apr. 12	Molecular photoconversion and dye-sensitized solar cells (April 12 guest lecture by BGSU Prof. Felix Castellano). Nanostructured solar cells (incl. DSSC, OPV, coupled NC absorbers, and NC-Si).
Apr. 19	Project presentations
Apr. 26	High-efficiency concepts (hot carrier conversion, MEG, …)
May 3	Finals Week