ME 555 – Advanced Topics – Thin-Film Photovoltaics
3 unit, Two 75 min class periods per week (or 150 min / week)

Course Instructors: David Mitzi

Textbooks and Other Supplemental Materials:
pveducation.org (free internet resource)
The Physics of Solar Cells, Jenny Nelson, Imperial College Press, 2004 (recommended reading)
Selected journal readings to be selected with instructor

Course Information:
Catalog Description:
The earth receives approximately 120,000 terawatts (TWs) of solar energy annually (verses human consumption of ~15 TW), in a form that is renewable, reliable and geographically distributed. One particularly avenue for exploiting solar energy is the direct conversion of sunlight into electricity or photovoltaics (PV). This course will focus in on a promising class of solar cells based on thin-film absorbers, some of which are already commercialized (e.g., CdTe, CIGS), while others are on the cutting edge of new photovoltaics technology (e.g., perovskites). The course will employ a combination of lecture, directed reading and hands-on approaches to get a better appreciation of the advantages and challenges of this class of PV technologies. The hands-on component of the course will involve fabricating PV devices and employing contemporary characterization and modeling tools to evaluate device performance. Both the specific techniques employed, as well as the intellectual framework used in the course are more generally applicable to other solar cell and electronic device technologies. Note: 12 student limit on class size

Prerequisites by topic:
Graduate standing and undergraduate/graduate experience with electronic device physics.
Undergraduates with permission of instructor.

ME Elective Course

Grading:
   Homework: 20% (article readings/computer modeling/problems)
   Device/Lab project: 30% (lab project/report/presentation)
   Advanced topic presentation: 30% (in lieu of final)
   Midterms: 20%

Course Goals:
Explore the science and technology of solar energy conversion, with a goal of incorporating cutting-edge trends in the field. Using thin-film PV devices as an example, provide a combination of theoretical and hands-on experiences, giving the student a sense of approaches more generally applicable in contemporary photovoltaic device research.

Topics Covered:
1. Basics: Review of fundamentals of photovoltaic energy conversion
2. Thin-film solar cell designs
3. Important parameters governing solar cell performance
4. Materials science of thin-film solar cell materials
5. Characterization tools for solar cells and materials
6. Simulation software for modeling solar cell operation
7. Lab techniques for making thin-film solar cells
Syllabus (approximate… work in progress):

Week 1  – Review thin-film PV (Basics and semiconductor physics)
Week 2  – Review thin-film PV (p-n junctions under dark and light conditions)
Week 3  – Recombination and loss mechanisms
Week 4  – Basic measurement techniques and summary of thin film PV types
Sept 21  -- Midterm I
Week 5  – Detailed look at CIGS/CdTe (advanced topics announced)
Week 6  – Device modeling… and perovskite PV
Week 7  – Select advanced topics / Intro to Lab project (schedule group lab time)
Week 8  – Lab project
Week 9  – Lab project
Week 10 – Presentation of lab results (3 groups; 20/5 min each)
Week 11 – CZTS/earth abundant; more advanced characterization (lab reports due)
Week 12 – Amorphous Si + Organics, SQ limit, “3rd Gen”
Nov 16  -- Midterm II
Week 13 – Student presentations on advanced topic (20/5 min each)
Week 14 – Student presentations on advanced topic (20/5 min each)