

## Syllabus and Course Information

PHYS 4580: Molecular and Condensed Matter Physics Laboratory

PHYS 6/7280: Photovoltaic Device and Materials Physics Laboratory

*Tentative Meeting Times:* Lecture: Tuesday, 1:00 – 1:50 pm; Location: R1, 2000N

Lab: Tuesday, 2:00 – 5:50 pm; Location: R1, 1070

Instructors: Profs. R. Ellingson and M. Heben

Syllabus updated October 8, 2013

### General advice and things to remember

1. Keep current with the lecture material, lab experiments, and lab reports.
2. Complete reading assignments as soon as possible – these will help you follow the class.
3. Follow the University's Missed Class/Excused [absence policy](#).
4. Turn cell-phones and pagers off when in class and lab.
5. Know the University's class withdrawal rules:  
[http://www.utoledo.edu/offices/registrar/registration\\_dates\\_fall.html](http://www.utoledo.edu/offices/registrar/registration_dates_fall.html)

### GRADING and EXAMS

Only material covered in class or in lab experiments will be used for quizzes. Final grades will be based on:

1. Quizzes: We plan three quizzes during the semester, covering skills and information from preceding lectures, labs, and/or assigned reading. Quizzes will be short (10 min.), multiple choice, and closed book, closed notes.
2. Laboratory Notebooks: Bring your laboratory notebook with you to each class, and use it to carefully record notes on procedures, physical parameters during procedures and measurements, etc. -- to facilitate with the preparation of your lab report. Note how the measurement works in detail, your ideas about what is important, how the experiment fits in with earlier and later experiments, and what information you need to reach the experimental goals. Your notebook will be reviewed every two weeks, with scoring of 2, 1, or 0 points. Your notebooks will constitute 10% of your final grade.
3. Lab Reports: We encourage collaboration and significant interaction to support everyone learning as much as possible during the course. However, to ensure that you are learning as much as possible, each of you will prepare your own lab report, in your own words, and with your own graphs of what may (or may not) be based on data shared with teammates.

### Please include the following sections in each lab report:

1. **Title Section: including** (a) Title of your Report, (b) Your name and the names of lab partners (if any), (c) Date, and (d) Abstract (Purpose of Experiment(s) and major conclusions - approximately 100 - 200 words). The Title section should not be on a separate page – we like to conserve paper where possible.
  2. **Introduction**: information on the need for, and value of, the experiments, and discussion of the general approach.
  3. **Experimental**: details of samples and equipment, including a sketch of the layout and a few words on the function of each major component.
  4. **Results and Discussion**: analysis, appropriate graphs, a thoughtful explanation of the significance of the results, sources of uncertainty, and strengths and weaknesses of the measurement approach.
  5. **Conclusion**
  6. **References**
4. Final Project: Your final project will be based on a single 2-hour laboratory session in which you'll be asked to perform or describe specific measurements on a specific photovoltaic material or sample using the equipment,

capabilities, and skills you develop during the semester. Each student will be tested individually on all aspects of the hardware, software, and principles of the measurement system, as well as the materials physics relevant to photovoltaic devices. We may, or may not, need to use Finals week to schedule some of these Project exams.

### Grading

Grades will be determined according to: Quizzes = 15%, Notebook = 10%, Lab Reports = 55%, and Final Project = 20%.

### Projected Schedule:

<u>Weeks of</u>	<u>Topic(s)</u>
<b>Aug. 19 – Sept. 2</b>	Introduction to Hardware and Software – Optics, optics mounting, thermopile detector, optical chopper, data acquisition, LabVIEW for instrument control and data acquisition, Igor Pro graphing and analysis software.
<b>Sept. 9 – Sept. 23</b> (Quiz #1, Sept. 17)	Construction and application of a light measurement system. Characterization of transparent conductors: transmission and reflection measurements. Film thickness measurement (profilometry). Sheet resistance measurements (four-point probe).
<b>Sept. 30</b>	No class this week, though the lab can be opened for access. Sept. 30 and Oct. 1 <sup>st</sup> – Fall Break.
<b>Oct. 7 – 14</b> (Quiz #2, Oct. 15)	Optical and electrical characterization of semiconductor thin films (CdS, CdTe, c-Si). Absorption measurements and determination of wavelength-dependent absorption cross-section.
<b>Oct. 21 – 28</b>	Solar cell performance characterization: JV and efficiency measurements on silicon photodiode and CdTe devices: operation of solar cell, equivalent circuit behavior, ideal diode equation.
<b>Nov. 4 – 18</b> (Quiz #3, Nov. 19)	X-ray diffraction of semiconductor thin films; Hall measurements; Spectral response of a solar cell (quantum efficiency curves).
<b>Nov. 25</b>	No class (Thanksgiving Break Nov. 27-29).
<b>Dec. 2</b>	Final Review Dec. 3 <sup>rd</sup> ; Final project/exams scheduled individually Dec. 4, 5, 6.
<b>Dec. 10</b>	Finals Week (no exam)