ECE 341L – Solar Cells (Spring 2020)

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Class Hours: WF 3:05-4:20pm
Hudson Hall 222

Lab Hours: M 3:05-6:05pm
Teer 212

Office Hours: Tu 1-4pm
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Sakai: https://sakai.duke.edu/portal

Goal: The goal of this course is to provide a broad overview of solar cells, including solar radiation, device theory, materials options, device fabrication and characterization, and system-level issues. Students will also participate in hands-on laboratory exercises related to photovoltaic solar cells.

Prerequisites: Physics 152 or equivalent

Required Textbook: PVEducation.org

Objectives: By the end of this course the student should be able to…

1) …determine the radiant energy from the sun under different conditions relevant to solar cell operation.
2) …describe the operation of a pn-junction, including how such a junction is used in a photovoltaic solar cell.
3) …describe the basic operation of an organic photovoltaic solar cell and compare and contrast its properties with an inorganic solar cell.
4) …measure and calculate the device parameters that describe the performance of a solar cell.
5) … describe the advantages and disadvantages of different material options for solar cells.
6) …describe possible techniques for improving solar cell efficiency.
7) …describe system-level challenges related to solar modules and arrays.

Grading: Grades will be assigned according to the following components.
Weekly Quizzes – 20 %
Exams (2) – 20 %
Homework Assignments – 20 %
Lab Assignments – 20 %
Group Project – 20 %

Homework Policy: Homework and Lab Assignments are due at the beginning of class on the day indicated in the tentative schedule. Late assignments will not be accepted unless prior approval is obtained.

Students with Disabilities: Students requiring academic accommodations should register with the Student Disability Access Office (SDAO), (919) 684-5917 or http://www.access.duke.edu/studentIssues.asp. I am available to discuss appropriate accommodations, and requests should be made within the first week of joining the course.

Academic Integrity: As an engineer, group-working skills are very much needed, especially when working on the same project. Therefore, it is permissible for you to work with others on homework and lab assignments; however, it is highly recommended that you finalize your assignment from start to finish while working alone.

In this course, all assignments that are turned in for a grade must represent the student's own work. Copying work, all or in part, from peers or other sources (online or otherwise), will be considered a violation of the Duke Honor Code. Such violations will result in a reduced grade, and could lead to disciplinary action. If you have questions about whether something is an honor code violation, please ask the instructor or teaching assistant.

Honor Code: For your convenience, the Duke Community Standard, to which all students are expected to adhere, is listed below (http://www.integrity.duke.edu/index.html).

The Duke Community Standard

Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and non-academic endeavors, and to protect and promote a culture of integrity.

To uphold the Duke Community Standard:

1. I will not lie, cheat, or steal in my academic endeavors;
2. I will conduct myself honorably in all my endeavors; and
3. I will act if the Standard is compromised.

Tentative Lab Schedule:

Date	Lab Activities
January 27	Lab 1: Sun Dial/Light Source Characterization
February 10	Lab 2: Standard Si Solar Cell
17	Lab 3: BHJ Solar Cell
March 16	Lab 4: SMIF Safety/Group Project Planning
23	Lab 5: Group Project (Fabrication)
30	Lab 6: Group Project (JV & EQE Characterization)
April 6	Lab 7: Solar Cell Modules

Tentative Lecture Schedule:

Date	Topic	Assignments Due
January 10	Lecture 1: Introduction - NAE Grand Challenge, "Make Solar Energy Economical"	
15	Lecture 2: Properties of Sunlight (Basics of Light, Blackbody Radiation)	
17	Lecture 3: Properties of Sunlight (Solar Radiation – Space vs. Terrestrial)	Quiz 1
22	Lecture 4: Properties of Sunlight (Solar Radiation – Motion of Sun, Module Tilt)	
24	Lecture 5: Inorganic Semiconductors (Semiconductor Basics)	Quiz 2
29	Lecture 6: Inorganic Semiconductors (Generation & Recombination)	HW 1 Due
31	Lecture 7: Inorganic Semiconductors (Carrier Transport)	Quiz 3
February 5	Lecture 8: Inorganic Semiconductors (PN Junctions)	Lab 1 Due
7	Lecture 9: Organic Semiconductors (Semiconductor Basics)	Quiz 4
12	Lecture 10: Organic Semiconductors (Generation & Recombination)	HW 2 Due
14	Lecture 11: Organic Semiconductors (Carrier Transport)	Quiz 5
19	Lecture 12: Organic Semiconductors (Donor-Acceptor Interfaces)	Lab 2 Due
21	**EXAM I**	
26	Lecture 13: Solar Cell Operation (Ideal Solar Cells)	Lab 3 Due
28	Lecture 14: Solar Cell Operation (Solar Cell Parameters)	Quiz 6
March 4	Lecture 15: Solar Cell Operation (Resistance Effects on Solar Cell Performance)	
6	Lecture 16: Solar Cell Operation (Optical Effects on Solar Cell Performance)	Quiz 7
11	**SPRING BREAK**	
13		
18	Lecture 17: Solar Cell Operation (Tandem/Multi-junction Cells)	HW 3 Due
20	Lecture 18: Solar Cell Operation (Concentrators)	Quiz 8
25	**NO LECTURE**	Lab 4 Due
27	Lecture 19: Solar Cell Material Systems (Inorganic/Organic Semiconductors)	Quiz 9
April 1	Lecture 20: Concepts for Improving Solar Cell Efficiency	Lab 5 Due
3	Lecture 21: Solar Cell Modules and Arrays (Module Design, Interconnection, Life-Cycle)	Quiz 10
8	In-Class Group Activity: Installed PV System Cost	Lab 6 Due
10	**EXAM II**	
15	**GROUP PRESENTATIONS**	Lab 7 Due
17	**GROUP PRESENTATIONS**	
22	**GROUP PRESENTATIONS**	
NO FINAL EXAM		