

ECE 5237: Photovoltaics Laboratory

Course Description

Introduction to laboratory techniques for processing and fabrication of inorganic and organic solar cells, and photovoltaic testing and measurement techniques to characterize solar cells.

Transcript Abbreviation: PV Lab

Grading Plan: Letter Grade

Course Deliveries: Classroom

Course Levels: Undergrad, Graduate

Student Ranks: Junior, Senior, Masters, Doctoral

Course Offerings: Spring

Flex Scheduled Course: Never

Course Frequency: Every Year

Course Length: 14 Week

Credits: 4.0

Repeatable: No

Time Distribution: 2.0 hr Lec, 4.0 hr Lab

Expected out-of-class hours per week: 6.0

Graded Component: Lecture

Credit by Examination: No

Admission Condition: No

Off Campus: Never

Campus Locations: Columbus

Prerequisites and Co-requisites: Prereq: 3030 or MatScEn 3271, and enrollment in ECE or MatScEn major; or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.

Exclusions:

Cross-Listings:

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: No

The course is a GEC: No

The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001

Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
CpE	Computer Engineering
EE	Electrical Engineering

General Information

Introduction to the fabrication of solar cells

Course Goals

Introduce the student to the basic techniques for fabrication and measurement of photovoltaic cells

Learn computer tools for simulation of photovoltaic cell characteristics
Apply knowledge learned in prerequisite semiconductor devices courses to the fabrication and evaluation of PV cells and test structures
Obtain practical experience with contact and series resistance, spectral sensitivity, open circuit voltage, short circuit current, and quantum efficiency of photovoltaic devices and test structures by application to the devices fabricated in lab
Obtain practical experience with extraction of device parameters from and analysis and interpretation of solar cell measurement and test results
Obtain experience with cleanroom procedures, and with safe use of the hazardous materials and equipment used in photovoltaic device fabrication

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Solar energy and photovoltaic technologies, Lab safety, Overview of class PV processes	2.0							
Inorganic solar cell device physics	2.0							
Ohmic contact technologies for inorganic solar cells	2.0							
Inorganic solar cell design and simulation tools	2.0							
Electrical and optical parasitic losses	2.0							
Photovoltaic measurement techniques	4.0							
Cleanroom orientation, safety protocols and inorganic wafer introduction			4.0					
Inorganic solar cell mesa patterning			4.0					
Mesa etching and oxidation for inorganic solar cell			4.0					
Front side metal patterning of inorganic solar cell			4.0					
Front side metal deposition			4.0					
Backside metallization and anneal			4.0					
Inorganic solar cell testing - illuminated I-V, quantum efficiency, cell performance parameters			8.0					
Organic cell electrode patterning and etching			4.0					
Successive depositions of the organic layer stack followed by metalization			4.0					
Encapsulation	2.0		4.0					
Organic solar cell testing - illuminated I-V, quantum efficiency, cell performance parameters			8.0					
Organic semiconductor materials	2.0							
Organic semiconductor materials deposition techniques	1.0		2.0					
Organic semiconductor device architectures	3.0							
Optical and electrical properties of organic materials	2.0		2.0					
Testing and calibration of organic solar cells	2.0		2.0					

Representative Assignments

Several homework assignments based on solar cell theory and laboratory processes
Weekly laboratory reports
Solar cell simulation assignments
Final inorganic solar cell report compiling laboratory activities, observations and the results of device characterization
Final organic solar cell report compiling laboratory activities, observations and the results of device characterization

Grades

Aspect	Percent
Homework assignments	10%
Simulation Reports	25%
Inorganic PV Cell Report	30%
Organic PV Cell Report	30%
Lab Technique	5%

Representative Textbooks and Other Course Materials

Title	Author
<i>Lab manual</i>	

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	a	An ability to apply knowledge of mathematics, science, and engineering.
***	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
**	c	An ability to design a system, component, or process to meet desired needs.
**	d	An ability to function on multi-disciplinary teams.
**	e	An ability to identify, formulate, and solve engineering problems.
*	f	An understanding of professional and ethical responsibility.
**	g	An ability to communicate effectively.
*	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
*	i	A recognition of the need for, and an ability to engage in life-long learning.
*	j	A knowledge of contemporary issues.
***	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

CpE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
**	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
	3	an ability to communicate effectively with a range of audiences
**	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
*	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
***	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
**	7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

EE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
**	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
	3	an ability to communicate effectively with a range of audiences
**	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
**	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
***	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
**	7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Additional Notes or Comments

Update prereqs, goals and topics to match university format

Add MSE 3271 to prereqs, increase to 4 credits, 3 hours lecture and 1hour lab. Topics and times need to be updated to match new credit hours. BLA 3/13/17

A misunderstanding when raising the credit hours to 4 hours posted it as 3 hours lecture and 3 hours lab. It should mirror ECE 5037's lab/lecture sequence, which is 2 hours lecture and 4 hours lab.1-/10/17 PRB

Added contributions to new outcomes 6/15/2019

Prepared by: Betty Lise Anderson