ECE 6535: Semiconductor Optoelectronic Devices

Course Description

This course will cover the basics and physics of semiconductor optoelectronic devices including light-emitting diodes, semiconductor lasers, photodetectors, and solar cells.

Transcript Abbreviation: Semi Opto Devs
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Graduate
Student Ranks: Masters, Doctoral, Professional
Course Offerings: Spring
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
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: Grad standing in engineering or physics
Exclusions:
Cross-Listings:

Course Rationale: This course covers the fundamentals of advanced semiconductor optoelectronic devices. It

will help students prepare for the qualifying exam.

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
EE	Electrical Engineering

Course Goals

Master the understanding of optical processes in semiconductors
Master the principles of light emitters, semiconductor photodetectors and solar cells
Capable of designing an optoelectronic device (e.g. LED, Laser, Detector, Solar Cell) which can meet specified performance parameters

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
1. Compound Semiconductor Materials 1.1 Optoelectronic materials	1.5							
1. Compound Semiconductor Materials 1.2 Epitaxial growth techniques	1.5							
2. Recombination Processes and Heterostructures 2.1 Absorption, spontaneous emission and stimulated emission	0.5							
2. Recombination Processes and Heterostructures 2.2 Franz-Keldysh and Stark effect	1.0							
2. Recombination Processes and Heterostructures 2.3 Kramer-Kronig Relation	0.5							
2. Recombination Processes and Heterostructures 2.4 Radiative, non-radiative recombination	1.0							
2. Recombination Processes and Heterostructures 2.5 Measurement of absorption and luminescence spectra	0.5							
2. Recombination Processes and Heterostructures 2.6 Schottky barriers, heterojunctions	1.0							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.1 Structure and types of LEDs and their characteristics	1.5							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.2 LEDs for solid state lighting	1.5							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.3 UV LEDs	1.5							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.4 Guided waves and optical modes	1.5							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.5 Optical gain	3.0							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.6 Confinement factor, laser structures	1.5							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.7 Edge-emitting and VCSELs	1.5							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.8 Design of laser cavity	2.0							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.9 Threshold current, LI and IV characteristics	2.0							
3. Semiconductor Light Emitters (LEDs and Lasers) 3.10 Frequency response, relaxation oscillations and modulation bandwidth	1.5							
4. Semiconductor Photodetectors 4.1 Optical detection processes	1.0							
4. Semiconductor Photodetectors 4.2 Photoconductive and Photovoltaic detectors	2.0							
4. Semiconductor Photodetectors 4.3 Avalanche photodiodes	1.5							
4. Semiconductor Photodetectors 4.4 Noise in detectors	1.5							
4. Semiconductor Photodetectors 4.5 Figures of merit for detectors	1.5							
4. Semiconductor Photodetectors 4.6 Different types of detection schemes	1.5							

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
5. Solar Cells 5.1 Basic principles	1.0							
5. Solar Cells 5.2 Spectral response	1.5							
5. Solar Cells 5.3 Cascaded solar cells, Schottky barrier cells	1.5							
5. Solar Cells 5.4 Degradation	1.5							

Representative Assignments

Homework
Midterm exam and/or projects
Final exam

Grades

Aspect	Percent
Homework	30%
Midterm Exams and/or Projects	30%
Final Exam	40%

Representative Textbooks and Other Course Materials

Title	Author
Semiconductor Optoelectronic Devices by Pallab Bhattacharya (Second Edition)	Pallab Bhattacharya

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.

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

Prepared by: Hongping Zhao