ECE 5530 (Proposed): Fundamentals of Semiconductors for Microelectronics and Photonics

Course Description

Crystal structure, semiconductor energy band structure, electron transport and carrier recombination, heterostructures, and optical and dielectric properties.

Prior Course Number: 730
Transcript Abbreviation: Fnd Semiconductors
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad, Graduate
Student Ranks: Senior, Masters, Doctoral
Course Offerings: Autumn
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: Prereq: 3030 (432), or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences.
Exclusions: Not open to students with credit for 730.
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

Course Goals

Become knowledgeable of various technologically important semiconductor materials beyond silicon
Learn advanced semiconductor physics
Learn electronic and optical properties of semiconductors and heterostructures

Learn about quantum effects and engineered properties of semiconductors
Learn how advanced properties are used in state of the art microelectronics and optoelectronics

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Motivation	1.0							
Chemical bonding, crystallography, reciprocal lattice	3.0							
Free electron model, Density of states (1D, 2D, 3D), periodic boundary conditions, plane-wave states	3.0							
Nearly free electron model, Bloch theorem, periodic bandstructure and bandgap, band transport and effective mass, Fermi velocity and wavevector	5.0							
Statistics and doping, Fermi Dirac distribution, density of states for ellipsoidal bands, electrons and holes, donors and acceptors, deep donors and acceptors	3.0							
Electron transport, Boltzmann transport equation, excess carriers, recombination/generation, Ambipolar transport equation, drift diffusion equation, phonons, scattering	3.0							
Relaxation time, velocity saturation, high-field transport, inter-valley scattering, ballistic transport	2.0							
Surface defects and termination, electron affinity, ionization energy, work function, metal-semiconductor junctions, thermionic emission, tunneling	4.0							
P-n junction, band diagram and electrostatics, depletion approximation and limitations, current in a p-n junction, high level injection, SRH recombination theory, recombination in a p-n junction	5.0							
Heterojunctions, band diagrams and electrostatics, QW formation, 2DEG, quantum dots, occupation	4.0							
Wide bandgap semiconductors, piezoelectric and spontaneous polarization, polarization-induced doping	4.0							
Optical properties, absorption and emission, emission from quantum wells	3.0							

Representative Assignments

Homework

Grades

Aspect	Percent
Homework	20%
Design homework	10%
Two mid-term examinations	40%
Final examination	30%

Representative Textbooks and Other Course Materials

Title	Author
The Physics of Low-Dimensional Semiconductors	John H. Davies

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.

Additional Notes or Comments

updated prereqs, exclusions, goals and topics to match university format.

Change text to Li 3/27/14 BLA
Changed text to Davies. 3/25/15. CED

Change stars 6/16/16 BLA
Edited text info, 5/10/17, CED

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