

ECE 3030: Semiconductor Electronic Devices

Course Description

Semiconductor materials and devices. Crystals; bandstructure; charge carrier statistics; excess carriers, transport; PN junction; Schottky barrier; bipolar and field-effect transistors; optoelectronic devices; nanoscale devices.

Prior Course Number: 432 and parts of 331

Transcript Abbreviation: Electronic Devices

Grading Plan: Letter Grade

Course Deliveries: Classroom

Course Levels: Undergrad

Student Ranks: Sophomore, Junior, Senior

Course Offerings: Autumn, 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: Prereq: 2100, and Physics 1251, 1261, 133, or both 1240 and 1241; and Chem 1220, 1250, or 121; and enrollment in ECE, MSE, or EngPhysics major. Prereq or concur: Math 2415 (415) or 2174.

Exclusions: Not open to students with credit for 331 or 432.

Cross-Listings:

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: Yes

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: Baccalaureate Course

Programs

| Abbreviation | Description |
|--------------|------------------------|
| CpE | Computer Engineering |
| EE | Electrical Engineering |

Course Goals

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| Be familiar with the fundamentals of material structure (crystal, amorphous, polycrystalline) |
| Be familiar with the fundamentals of quantum mechanics |
| Acquire a physical understanding of the electronic properties of semiconductors |

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| Be familiar with the fundamental principles of operation of semiconductor devices |
| Master energy band diagram analysis |
| Understand the physical limits of operation (avalanche and zener breakdown, punch-through, self-heating) of semiconductor devices |
| Be exposed to a modern engineering simulation tool (2D device simulator) |
| Provide students with necessary background to understand the principle of new electronic devices as new technologies develop |

Course Topics

| Topic | Lec | Rec | Lab | Cli | IS | Sem | FE | Wor |
|--|-----|-----|-----|-----|----|-----|----|-----|
| Overview and motivation | 1.0 | | | | | | | |
| Microstructure & Crystal structure | 2.0 | | | | | | | |
| Electronic material synthesis, defects | 2.0 | | | | | | | |
| Principles of quantum mechanics | 3.0 | | | | | | | |
| Band structures | 3.0 | | | | | | | |
| Semiconductor statistics and charge carrier properties | 4.0 | | | | | | | |
| Excess carriers and transport | 3.0 | | | | | | | |
| PN junction, metal-semiconductor junctions, Diodes | 6.0 | | | | | | | |
| Field effect transistor (regular and HEMT) | 6.0 | | | | | | | |
| Bipolar Junction Transistor (regular and hetero) | 7.0 | | | | | | | |
| Optoelectronic Devices | 2.0 | | | | | | | |
| Overview of new materials, devices, and techniques | 1.0 | | | | | | | |

Representative Assignments

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| Homework |
| Online web quizzes |
| Computer aided design simulation of devices (PISCES or ATLAS) |

Grades

| Aspect | Percent |
|------------|---------|
| Homework | 15% |
| Midterm 1 | 25% |
| Midterm 2 | 25% |
| Final exam | 35% |

Representative Textbooks and Other Course Materials

| Title | Author |
|---|--|
| <i>Solid State Electronic Devices 6th Edition</i> | Ben G. Streetman and Sanjay Kumar Bannerjee ISBN-10: 013149726X ISBN-13: 9780131497269 |

ABET-EAC Criterion 3 Outcomes

| Course Contribution | College Outcome |
|---------------------|---|
| *** | a An ability to apply knowledge of mathematics, science, and engineering. |

| Course Contribution | | College Outcome |
|---------------------|---|---|
| | 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

Change prereq and exclusions to standard form.

Deleted text "Fundamentals of Semiconductor Devices" by Anderson and Anderson and replace it with Neamen. 3/29/12

Add Chem 1220 to prereqs 8/27/12

Add "or both 1240 and 1241" to physics prereqs 10/19/12

Add 2100 to preqreq, modify course goals and topics, change ABET Creittrion 3 item g to "no contribution". Result of internal ABET review 4/5/14 BLA

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