

ECE 416 – Electronic Materials & Devices

Catalog Description: Semiconductor fundamentals, and physical principles of diodes and transistors.

Credits: 3 **Terms Offered:** Fall

Prerequisites: ENGR 201

Courses that require this as a prerequisite: ECE 322, ECE417, ECE 418

Structure: Three 50-minute lectures per week

Instructors: J. Conley Jr (primary), P. Dhagat (secondary)

Course Content:

- Semiconductor fundamentals: bond model and energy band model of a semiconductor, doping, carrier concentrations, mobility and resistivity of a semiconductor.
- Carrier transport, generation and recombination in semiconductors: drift and diffusion of electrons and holes in semiconductors, electron-hole pair generation and recombination mechanisms.
- P-N junctions: fabrication, built-in voltage, electrostatics, and current-voltage (I-V) characteristics and SPICE models.
- Metal-semiconductor junctions: fabrication, built-in voltage, electrostatics and current-voltage (I-V) characteristics
- Bipolar transistors: physical principle of operation and four modes of operation.

Measurable Student Learning Outcomes:

At the completion of the course, students will be able to...

1. **Calculate** the carrier concentrations and resistivity of a semiconductor using the given doping concentration, and **design** a resistor of a given value (ABET outcomes a, c, m)
2. **Explain** carrier generation and recombination processes in semiconductors. (ABET outcomes needed)
3. **Analyze** charge carrier transport in one-dimensional semiconductor structures using drift-diffusion equations. (ABET outcomes needed)
4. **Derive** the current-voltage characteristics of p-n junction diodes, bipolar junction transistors and metal-semiconductor contacts from energy band structure and drift-diffusion equations. (ABET outcomes needed)
5. **Draw** the energy band diagram of a p-n junction diode, **extract** its SPICE model parameters from the given current-voltage (I-V) data, and **relate** the SPICE model parameters to the physical parameters of the device (ABET outcomes a, b, k, m)
6. **Identify** the four modes of operation of a bipolar junction transistor (ABET outcome a, m)

Learning Resources:

- *Semiconductor Device Fundamentals*, R.F. Pierret, Addison Wesley, 1996

Students with Disabilities:

Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 737-4098.

Link to Statement of Expectations for Student Conduct:

<http://oregonstate.edu/admin/stucon/achon.htm>

Revised: 2/15/11