

EC 471

Physics of Semiconductor Devices, Spring 2025

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Lectures: Tu/Th 1:30-3:15 pm CAS 227

Office hours: TBD PHO 535/Zoom

Description

The goal of this course is to provide a sound understanding of the physical principals of modern semiconductor devices and to develop the fundamental knowledge needed to understand next-generation devices.

By the end of the semesters, students will:

- Be familiar with concepts and definitions related to band diagrams
- Understand the physical mechanisms that contribute to the behavior of semiconductor devices
- Explain key concepts regarding device behavior
- Identify important material design parameters (e.g. doping, bandgap, mobility, physical dimensions...)
- Calculate the response for a variety of ideal device structures (e.g. diodes, MOSFETs, BJTs...)
- Qualitatively understand non-ideal behavior

Course Prerequisite

PY 313- Elementary Modern Physics or PY 354- Modern Physics

Textbooks and References

1. Required C.C. Hu, *Modern Semiconductor Devices for Integrated Circuits*, Prentice Hall, 2010 (available online at no cost)
2. Recommended: B.G. Streetman and S.K. Banerjee, *Solid State Electronic Devices, 7th Edition*, Pearson Education Inc, 2015

Grading Policy

- Homework: 10%
- Exam 1: 30%
- Exam 2: 30%
- Final Exam: 30%

Class Syllabus

Jan. 21	Crystal Structures	Chapter 1
Jan. 23	Introduction to Atomic Bonding and Quantum Mechanics	Chapter 1
Jan. 28	Energy Bands, Effective Masses, and Charge Carriers in Semiconductors	Chapter 1
Jan. 30	Energy Bands, Effective Masses, and Charge Carriers in Semiconductors	Chapter 1
Feb. 4	Bandstructure Review	
Feb. 6	Charge Carrier Concentration and Carrier Drift	Chapter 2
Feb. 11	Charge Carrier Concentration and Carrier Drift continued	Chapter 2
Feb. 13	Carrier Diffusion	Chapter 2
Feb. 20	Drift-Diffusion Review	Chapter 2
Feb. 25	Photoexcitations and Non-Equilibrium Excess Carriers	Chapter 2
Feb. 27	The Continuity Equation, Diffusion Lengths	Chapter 2
Mar. 4	Introduction to pn Junctions	Chapter 4
Mar. 6	Exam 1 Review	Covers up to Chapter 2
Mar. 8-16	Spring Break	
Mar. 18	Exam 1	Covers up to Chapter 2
Mar. 20	pn Junctions Continued	Chapter 4
Mar. 25	pn Junctions Continued	Chapter 4
Mar. 27	pn Junctions in Devices	Chapter 4
Apr. 1	pn Junctions: In-class Example Problems	Chapter 4
Apr. 3	Metal-Semiconductor Junctions and Heterojunctions	Chapter 5
Apr. 8	Exam 2 Review	Covers Chapters 4-5
Apr. 10	Exam 2	Covers Chapters 4-5
Apr. 15	The MOSFET	Chapter 6/7
Apr. 17	The MOSFET	Chapter 6/7
Apr. 22	Bipolar Junction Transistors	Chapter 8
Apr. 24	Bipolar Junction Transistors	Chapter 8
Apr. 29	Bipolar Junction Transistors	Chapter 8
May 1	Final Exam Review	Comprehensive Emphasizing Ch. 6-8