

Course Description

This is an introductory course for semiconductor materials and devices. The course content includes the following topics: the growth and properties of semiconductor crystals; the theory of the electronic structures of atoms and solids; the energy band and conduction mechanisms in semiconductors; the physics of junction diodes; excess carriers; bipolar junction transistors (BJT); metal oxide semiconductor field-effect transistors (MOSFET). *Prerequisite(s)*: ELEC 3500

List of Topics

Week 1	Introduction 1. Properties of Semiconductor Crystals
Week 2	1.1 Semiconductor materials 1.2 crystal lattices 2. Atoms and Electrons 2.1 quantum mechanics 2.2 bohr model 2.3 electronic structure and quantum numbers
Week 3	3. Band structures in solid 3.1 bonding forces and energy bands in solids 3.2 charge carriers and occupation statistics
Week 4	3.3 carrier concentration
Week 5	3.4 Drift of carriers in electric and magnetic fields 3.5 Behavior of the equilibrium Fermi level 4. Behavior of the Excess Carriers in Semiconductors 4.1 Optical absorption 4.2 Luminescence 4.3 Photoconductivity and carrier lifetime
Week 6	4.4 Diffusion of Carriers 5. Junctions and the pn Diodes 5.1 Fabrication of pn junction 5.2 Equilibrium conditions
Week 7	5.3 Forward- and reverse-biased junctions in steady state
Week 8	5.4 Junction breakdown 5.5 Junction capacitances 5.6 Transient response
Week 9	6. Bipolar Junction Transistors (BJTs) 6.1 Fundamental of BJT operation 6.2 Amplification with BJT 6.3 Minority carrier distribution and terminal currents 6.4 Generalized biasing and Ebers-Moll equations
Week 10	6.5 BJT-Switching

	6.6 Secondary Effects in the modeling of BJTs
Week 11	7. Metal-Oxide-Semiconductor Field Effect Transistors (MOSFETs)
	7.1 Basic operation of MOSFETs
	7.2 Ideal MOS capacitor
Week 12	7.3 Effects of real surface
	7.4 Threshold voltage
Week 13	7.5 I-V characteristics
	8. Introduction to Micro/Nano Fabrication

Statement of Objectives/Outcomes:

On successful completion of this course, students will be able to:

CO1 - understand the formation and properties of semiconductor materials

CO2 - be familiar with the theory of the electronic structures of atoms and solids

CO3 - be familiar with the energy band and conduction mechanisms in semiconductors

CO4 - associate the electronic structures and band theory to the properties of semiconductor materials

CO5 - understand the physics of excess carries in semiconductors

CO6 - understand the physics and operations of the basic semiconductor devices such as the junction diodes, bipolar junction transistors, and metal-oxide-semiconductor field-effect transistors

Textbook(s):

1. Lecture notes
2. B.G. Streetman and Sanjay Banerjee, *Solid State Electronic Devices*, Sixth Edition, Prentice Hall

Relationship of Course to Program Outcomes:

Please refer to the Report Section 4.3.2 (iii).

Grading Scheme:

Homework assignments	15% (2.5% × 6)
Midterm Examination	30%
Final Examination	55%