SEMICONDUCTOR DEVICES

(Core Subject)

Course Code:	10B11EC411	**Semester:**	4th Semester, B. Tech. (ECE)
Credits:	4	**Contact Hours:**	L-3, T-1, P-0

Course Objectives

1. The course will apply fundamental solid-state physics concepts to a specific material class, namely semiconductors.
2. The course will focus on aspects of semiconductors such as silicon germanium and gallium arsenide; all of them have commercial relevance.
3. Fundamental properties of semiconductors will be explored, as well as their device applications.

Course Outcomes

This course provides the knowledge of analog and digital communication system analysis and design. After study through lectures and assignments, students will be able to

1. Have thorough knowledge of physical and electrical conducting properties of semiconductors.
2. Understand the basic operating principles of semiconductor devices such as PN junction diodes, Bipolar junction transistor, Junction field effect transistor, MOSFET and MOS capacitor and how circuit models have been developed from these basic principles.
3. The ability to correlate the analytical models with the basic principles of the devices.
4. With the understanding of the basic operating principles of semiconductor devices, students are able to understand and exploit new devices and applications.

Course Contents

Unit	**Topics**	**References (chapter number, page no. etc)**	**Lectures**
1.	Introduction to Semiconductors: Elemental and compound semiconductors, energy band models, The density of state function, Effect of temperature on semiconductor material, Effective mass, Fermi- Dirac distribution, Equilibrium concentrations of electrons and holes, Intrinsic and extrinsic semiconductors, doping and ionization of impurities, Fermi level in semiconductors.	B.G. Streetman Chapter 1 Pg. 1 - 20	8
2.	Current flow in semiconductors: Drift of carriers in electric field and magnetic fields, carrier scattering, relaxation time, conductivity and mobility of semiconductor materials, Effect of temperature and doping on carrier mobility, Hall effect. Diffusion equations and Einstein relation,	B.G. Streetman Chapter 3 Pg 61 - 107	6

	High field conductivity and hot carrier effects.		
3	Excess carriers in semiconductors: Carrier injection and diffusion process, Rate of diffusion in one dimensional problem, Low and high level injection, Electron and hole diffusion coefficient and diffusion current, Total current density in semiconductor, Einstein relation and continuity equation, Diffusion length and physical significance of diffusion length.	B.G. Streetman Chapter 4 Pg. 124-143	6
4	Junctions and interfaces: PN junction under thermal equilibrium, Contact potential and Formation of depletion layer, Effect of bias on PN junction, Calculation of electric field and potential distribution, Break down mechanisms, Junction capacitance, Diode equation, Calculation of depletion width, I-V characteristics of PN junction diode and breakdown diode, Charge control equation and transient behavior of PN junction diodes, Metal semiconductor contacts and Schottky barrier diodes, Ohmic contacts and Heterojunctions.	B.G. Streetman Chapter 5 Pg 154 - 250	10
5	Field Effect Transistors: Principle of operation of JFET, I-V characteristics and cut-off frequency. The MOS capacitor, accumulation, depletion and inversion regions of operation, flat band voltage and threshold voltage, MOS transistor principle of operation and types of MOSFETs , derivation of I-V characteristics, high frequency performance, short-channel effects.	B.G. Streetman Chap-6 Pg 251- 303	7
6	Bipolar Junction Transistor: Operating principle and terminal currents, I-V characteristics, Ebers-Moll equations and regions of operations, charge control equations and cut-off frequencies, switching and power transistors.	B.G. Streetman Chap- 7 Pg 336 - 368	6
		Total Number of Lectures	**43**

Evaluation Scheme

1. Test 1 : 15 marks
2. Test 2 : 25 marks
3. Test 3 : 35 marks
4. **Internal Assessment** : 25 marks
    - 10 Marks : Class performance, Tutorials & Assignments
    - 10 Marks : Quizzes

- 5 marks : Attendance

Text Books

1. B.G. Streetman, “Solid State Electronic Devices, Prentice Hall”, 5th, Ed. 2000.

Reference Books

1. M.S. Tyagi, “Introduction to Semiconductor materials & Devices”, John Wiley, 1991.
2. S.M. Sze, “Semiconductor Devices: Physics & Technology”, John Wiley, 2002.