

EOPE3002 SEMICONDUCTOR DEVICES (3-0-0)

Course Objectives:

This course provides fundamental knowledge of semiconductor physics, covering energy bands, carrier concentration, and transport mechanisms (drift/diffusion). Students will analyze PN junctions, BJTs, MOSFETs, and photonic devices (LEDs, solar cells). Emphasis is placed on device operation, performance evaluation, and design considerations for electronic and optoelectronic applications.

Module-I: (08 Hrs)

Semiconductors: Energy Band and Charge Carriers in semiconductors, Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials. Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, Temperature dependence of carrier concentration, Compensation and charge neutrality. Conductivity and mobility, Effect of temperature, Doping and high electric field.

Module-II: (04 Hrs)

Excess Carriers in Semiconductor: Drift, Diffusion: Current equation, Einstein's Relationship, Continuity equation Generation & Recombination: Mechanisms, Minority Carrier Lifetime.

Module-III: (06 Hrs)

P-N Junctions: Principles, DC model, Capacitance of Reverse bias PN junction, store charge effects, Metal Semiconductor contacts: Schottky diode, Ohmic Contact MOS Capacitor MOSFET: Principles, C-V Characteristics, Second order effects.

Module-IV: (06 Hrs)

Bipolar Junction Transistors (BJT): Fundamentals of BJT operation. Minority carrier distribution, Solution of diffusion equation in base region, Terminal current, Current transfer ratio, Ebers-Moll equations, Charge control analysis. BJT switching: Cut off, Saturation, Switching cycle.

Module-V: (06 Hrs)

Photonics: LED: Radiative transition, Emission spectra, Luminous efficiency and LED materials, Solar cell and photodetectors: Ideal conversion efficiency, Fill factor, Equivalent circuit, Voc, Isc and Load resistance, Spectral response. Reverse saturation current in photodetector.

Course Outcomes:

Upon completion of the course, the students will be able to:

- CO1: Explain the atomic structure of solids and the basic physics of semiconductor materials.
- CO2: Describe various properties of semiconductor materials using mathematical equations.
- CO3: Apply the knowledge of semiconductors to illustrate the functioning of the different electronic devices.
- CO4: Evaluate the performance of the different electronic devices
- CO5: Describe the working and design considerations for the various photonic devices.

Text Books:

1. Streetman, B. and Banerjee, S., Solid State Electronics, Prentice Hall India, (2006)
2. Sze, S.M., Physics of Semiconductor Devices, John Wiley, (1981)

Supplementary Reading:

1. S. Dimitrijevic, Principles of Semiconductor Devices, Oxford University Press, 2005
2. M.S.Tyagi, Introduction to Semiconductor Materials and Devices, Wiley Student Edition