EC35101 Semiconductor Devices and Technology	L-T-P: 3-0-2; Cr: 04

Prerequisite:

(i) Elements of Electronics Engineering (ii) Basics of circuits

Course Objective:

This course is intended to provide a good understanding of basic properties of semiconductor devices, physical principles and operational characteristics of different semiconductor devices and circuits. The primary focus will be on silicon based devices.

COURSE CONTENT:

Unit 1: Semiconductor Physics, Carrier Modelling and Carrier Action (6 L)

Energy Bands and Charge Carriers in Semiconductors: E-k diagram, Charge carrier concentration; Intrinsic carrier concentration; Law of mass action; Carrier transportation: Drift, diffusion and tunnelling, recombination, surface effects; Continuity equation in steady state condition; Fermi level; quasi-Fermi energy level; Hall effect; Optical and thermal properties.

Unit 2: Classical diodes (4 L)

Shockley equation; Junction capacitance; Diffusion capacitance; Varactor diode; Tunnel diode; IMPATT diode; Gunn diode; Difference between rectifying contact and ohmic contact; Schottky Diode.

Unit 3: Physics of Operation of BJT (6 L)

Transistor as switch: Delay time, Rise time, Storage time, Fall time, Transit frequency (wr); Ebers moll model; Gummel Poon model; Amplifier; RC coupled amplifier.

Unit 4: Physics of FET (11 L)

JFET: Ohmic or triode region of operation, Saturation region of operation, Transfer characteristics, Output characteristics (Depletion Type Device or Normally-On device), Shockley Equation, Different parameters; MOS structure: Band diagram of an ideal MOS structure, Flat-band voltage, Region of operation, C-V characteristics; MOSFET: Region of operation, Transfer characteristics and Output characteristics for both *n* and *p* channel MOSFET (Enhancement and Depletion), Threshold voltage, body effect and channel length modulation, short channel effects, gradual channel approximation, Common source, Common gate and Common drain configurations.

Unit 5: Power Amplifiers, Power Devices & Display Devices (9 L)

Power amplifiers with applications: Class A, Class B / push-pull, Class AB / complementary symmetry and Class C, SCR; Diac; Triac; Power BJT- Power MOSFET, Direct and Indirect semiconductor: LED, Solar cell, Photodiode, LCD, Opto Coupler, CCD and its applications.

Unit 6: Introduction to VLSI Technology: (4 L)

VLSI Technology-An Overview-Wafer Processing, Oxidation, Epitaxial Deposition, Ion-implantation and Diffusion; The Silicon Gate Process- Basic NMOS Technology.

List of Experiments for Semiconductor Devices Lab :

Experiment No. 01: Study of Hall Effect.

Experiment No. 02: Assembly of RC coupled amplifier.

(a) To measure gain & bandwidth of degenerate amplifier.

(b) To measure gain & bandwidth of emitter bypass capacitor amplifier.

Experiment No. 03: Characteristics of n-channel MOSFET.

Experiment No. 04: Study of common source MOSFET amplifier.

Experiment No. 05: Resistivity measurement of a semiconductor using four probe method.

Experiment No. 06: Study of complementary symmetry amplifier.

Experiment No. 07: Study of class B push-pull amplifier.

Experiment No. 08: Study of class C amplifier.

Experiment No. 09: Study of SCR.

Experiment No. 10: Study of component testing of various Surface Mounting Devices (SMD).

Experiment No. 11: Study of ohmic and non-ohmic contacts (through software).

Experiment No. 12: Experiment based minor project on the topics covered.

Textbooks:

1. D. A. Neamen, Semiconductor Physics and Devices, 3rd Edition, McGraw Hill, 2003.
2. Sedra and Smith, Microelectronics Circuits: Analysis and design, 6th Edition, Oxford University Press.
3. Tsividis, Y., "The MOS Transistor, Indian Third Edition", 3rd edition, Oxford University Press,2011, ISBN 9780195170153, 2013

Reference Books:

1. B. G. Streetman and S. K. Banerjee, Solid State Electronic Devices, 7th Edition, Pearson.
2. S. M. Size, Physics of Semiconductor Devices, 2nd Edition, John Wiley & Sons, 1981.
3. Y. Tsividis, "Operation and Modeling of the MOS Transistor", 2nd Ed., Oxford University Press.
4. R.S. Muller and T.I. Kamins, Device Electronics for Integrated Circuits, Wiley, 1986.
5. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley
6. J.D. Plummer, M.D. Deal and P.B. Griffin, Silicon VLSI Technology: Fundamentals, Practice and Modelling, Pearson, 2000.

Course Outcomes:

Upon successful completion of this course, students should be able to: