Approval: 10th Senate Meeting

Course Name:	Device Electronics for Integrated Circuits
Course Number:	EE-311
Credits:	3-0-0-3
Semester:	Odd
Prerequisites:	IC121 (Mechanics of Particles and Waves)
Intended for:	2nd and 3rd year UG
Elective or Core:	Core for 2nd Yr. and 3rd Yr. Electrical Engineering

Preamble:

The objective of the course is to provide the fundamental knowledge for understanding the concepts of semiconductor devices .This course build the knowledge base of the physics of semiconductors as related to the characteristics and design of solid-state electronic devices. This is a required core-course for Electrical Engineering undergraduate students.

COURSE SYLLABUS

1. SEMICONDUCTOR ELECTRONICS [6]

i. Physics of Semiconductor Materials
ii. Band Model of Solids
iii. Carrier distribution functions
iv. Free Carriers in Semiconductors, Concept of electrons and holes,
v. Concept of equilibrium and non-equilibrium in semiconductor device
vi. Current Conduction mechanisms in semiconductors

2. *P-N* JUNCTIONS [12]

i. Fundamentals of *p-n* junction
ii. *p-n* junction under thermal equilibrium
iii. Operation of *p-n* junction under forward and reverse bias
iv. Different type of junctions including step junction, linearly graded junction and heterojunctions,
v. Junction Breakdown: Physics of avalanche and Zener breakdown mechanisms
vi. Generation and Recombination in a *p-n* junction
vii. Current-Voltage Characteristics of p-n junctions
viii. Devices based on p-n junction, Solar cells, LED and photodetectors

3. METAL-SEMICONDUCTOR CONTACTS [3]

i. Idealized Metal-Semiconductor junctions
ii. Physics of Schottky and Ohmic contacts
iii. Effect of surface states on Metal-Semiconductor Contacts,
iv. Devices based on metal-semiconductor contacts

4. BIPOLAR TRANSISTORS [9]

i. Physics and operation of bipolar junction transistors

ii. Current conduction mechanism in bipolar junction transistor
iii. Ebers-Moll Model
iv. Effects of Collector Bias Variation (Early Effect)
v. Small-Signal Transistor Model
vi. Operation of bipolar junction transistor under high frequency
vii. Devices based on bipolar junction transistor

5. FIELD-EFFECT TRANSISTORS (MOSFETs) [9]

i. The ideal MOS Structure
ii. Capacitance of the MOS System
iii. CV Behavior of a MOS System; Ideal condition, effect of oxide and interface charge
iv. Structure and operation of MOSFET devices
v. Improved Models for Short-Channel MOSFETs
vi. Devices based on MOSFET

6. ELECTRONIC DEVICES AND NANOELECTRONICS [3]

i. Electronic Device Materials: Silicon, Germanium, and Gallium Arsenide.
ii. Introduction to advanced device technology: Purification and growth, wafer production, epitaxy and deposition, oxidation and metallisation; lithography and implantation
iii. Emerging Device Technologies

TEXT BOOK:

SEMICONDUCTOR DEVICES- Physics and Technology, 3nd Edition, by S. M. Sze and M.K.

Lee (John Wiley & Sons, 2012)

REFERENCES:

1. “Physics of Semiconductor Devices” by S. M. Sze and Kwok K.Ng, 3rd, Edition, (John Wiley & Sons, 2002)
2. “Solid State Electronic Devices”, by Ben G. Steetman and Sanjay Banerjee 6th Edition, Prentice Hall, 2005
3. “Semiconductor Device Fundamentals”, by Robert F. Pierret, Addison-Wesley Publishing, 1996
4. “Semiconductor Physics and Devices”, by Donald A. Neamen, 3rd Eddition, McGrawHill, 2003
5. “Semiconductor Devices- Basic Principles”, by Jasprit Singh, John Wiley and Sons Inc., 2001