ECE216: Semiconductor Devices and Circuits

Programme: B.Tech. (ECE) Year: 2nd Yr Semester : 2nd Semester
Course : Core Course for ECE Credits : 3 Hours : 40 Hrs

Course Context and Overview (100 words):
The course intends to provide an overview of the behavior of carriers and material properties related to electrical behavior and Introduction to semiconductor devices, Characteristics and biasing of diodes and transistors. Design and analysis of circuits using diodes, bipolar transistors, and field effect transistors. This course also provides the knowledge to apply the concepts of semiconductor devices to design and analyze circuits and Apply fundamentals of semiconductor devices in electronics projects.

Prerequisites Courses: None

(Course name and course code)

Course outcomes(COs):

On completion of this course, the students will have the ability to:
CO1 Explain the behavior of carriers and material properties related to electrical behavior.
CO2 Understanding the characteristics of the p-n junction, the diode and some special function diodes and these diodes' application in electronic circuits.
CO3 Explain the operation of a MOSFET. It is also expected that non-ideal performance can be explained and methods to reduce the effects of non-ideal performance can be identified.
CO4 Explain the operation of a diode and BJT in terms of drift, diffusion, density of states, and carrier distribution. It is also expected that non-ideal performance can be explained and methods to reduce non-ideal effects can be identified.
CO5 Apply concepts of semiconductor devices to design and analyze circuits and Apply fundamentals of semiconductor devices in electronics projects

Course Topics:

Topics	**Lecture Hours**	
UNIT - I **1. Physics of Semiconductor Devices**	9	
1.1. Introduction of fundamentals, evolution and uniqueness of Semiconductor Technology	1	9

1.2. Column IV, III-V and II-VI, semiconductor materials and compounds. Basic fabrication steps.	1	
1.3. Device at thermal and electrical equilibrium, concept of electrons and holes, intrinsic/ extrinsic Semiconductors, carrier concentration, effective mass Fermi level, energy band models and direct/indirect semiconductors	3	
1.4. Concept of the Excess carriers, generation and recombination, Injection level, doping, lifetime, scattering, mobility, conductivity, scattering and temperature dependency	4	
UNIT - II **2. Analysis of Semiconductor Devices**	4	4
2.1 Analysis of the semiconductor devices,	1	
2.2 Drift/diffusion and thermal current,	1	
2.3 Device modelling using basic transport/ continuity equations and various approximations	2	
UNIT - III **3. p-n Junction Diodes and Hetero junction devices**	11	11
3.1 Device at equilibrium, Diode I-V characteristics, forward and reverse bias of the device and mathematical modelling of full operation of the PN junction.	5	
3.2 Avalanche/ zener breakdown, capacitance modelling,	2	
3.3 Small-signal equivalent circuit and switching characteristics.	2	
3.4 Schottky/ ohmic contacts and other type of the diodes like varactor, LED, zener, and Schottky diode.	2	
UNIT - IV **4. Bipolar Junction Transistor (BJT)**	8	8
4.1 History, Device structures and fabrication, Transistor action and amplification, Common base and common emitter DC characteristics	4	
4.2 breakdown operation, base width modulation and circuit level applications of the transistors	4	
UNIT-V **5. MOSFET**	7	
5.1 MOS Junction, Mos capacitance, equivalent resistance, C-V characteristics, threshold voltage calculation.	3	7
5.2 I-V characteristics of the MOSFET and second order effects like body effect, channel length modulation, velocity saturation. IDBL, GIDL, and mobility degradation.	3	
5.3 Differences between a MOSFET and a BJT.	1	
UNIT-VI **6.** State-of-the-Art Technology and summary of the course	1	1

Textbook references (IEEE format):
Text Book:

[1]. Ben G. Streetman, Sanjay Kumar Banerjee, *Solid State Electronic Devices*, Sixth Edition, Prentice Hall (2006).
[2]. Donald A. Neaman, *Semiconductor Physics and Devices*, Tata McGraw-Hill, 2003

Reference books:

[1]. S. M. Sze, *Semiconductor Devices: Physics and Technology*, John Wiley and Sons, 1985.
[2]. M.S. Tyagi, *Introduction to Semiconductor Materials and Devices*, M.S. Tyagi, Wiley India Pvt. Limited, 2008.
[3]. Jasprit Singh**,** *Semiconductor Devices- Basic Principles*, John Wiley and Sons Inc., 2001
[4]. Robert F. Pierret, *Semiconductor Device Fundamentals*, Addison-Wesley Publishing, 1996

Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):

Evaluation Methods:

Item	Weightage
Quiz1	20
Quiz2	
Quiz3	
Quiz4	
Midterm	30
Final Examination	50

Prepared By:
Last Update: 06-04-2015