The LNMIIT, Jaipur Dept. of Electronics and Communication Engineering	LNMIIT The LNM Institute of Information Technology

Subject Code: **ECE-216**	Course Title: **Semiconductor Devices and Circuits**	Total Contact Hours: **40**	**L: 3**	**T: 0**	**P: 0**	**C: 3**
Pre-requisite: **Analog Electronics**		Year: **2**	Semester: **Odd**			
Type of Course: **Program Core**						

***** L Lectures, T Tutorials, P Practical C Credit***

Learning Objective:

The objective of this course is to provide an overview of the behavior of carriers and material properties related to electrical behavior, as well as an introduction to semiconductor devices, their characteristics, and biasing of diodes and transistors. In addition, this course also includes the design and analysis of circuits employing diodes, bipolar transistors (BJTs), and field effect transistors (FETs). Moreover, this course also teaches students how to apply semiconductor device concepts to circuit design and analysis, as well as how to apply semiconductor device fundamentals to electronic projects.

Course outcomes (COs):

On completion of this course, the students will have the ability to:		**Bloom's Level**
CO-1	**Understand** the behavior of carriers in terms of drift, diffusion, and mobility and materials properties related to electrical behavior	**2**
CO-2	**Apply** the concepts of transport of the charge carriers in conjunction with drift and diffusion currents such as	**3**
CO-3	**Analyze** the current-voltage (I-V) characteristics of the p-n junction, the diode, and some special function diodes and these diodes' application in electronic circuits	**4**
CO-4	**Explain** the theory of BJT for gain, base-width modulation, and equivalent circuit modeling and non-ideal effects on the performance of BJT and the methods to reduce its impacts	**4**
CO-5	**Demonstrate** the operation of a MOSFET and the second-order effects on I-V characteristics of MOS devices	**3**

Course Topics	**Lecture Hours**	**CO**
UNIT – I: Physics of Semiconductor Devices	**09**	**CO1**
1.1 Introduction of fundamentals, evolution, and uniqueness of semiconductor technology	**1**	
1.2 Group-IV, III-V, and II-VI, semiconductor materials and compounds. Basic fabrication steps	**1**	
1.3 Device at thermal and electrical equilibrium, the 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: Carrier Transport in Semiconductor	**5**	**CO2**
2.1 Analysis of the semiconductor devices	**1**	

2.2 Drift/diffusion and thermal current	**1**	
2.3 Device modeling using basic transport/ continuity equations and various approximations	**3**	

UNIT – III: Analysis of p-n Junction Diodes and Heterojunction Devices	**11**	**CO3**
3.1. Device at equilibrium, diode I-V characteristics, the forward and reverse bias of the device, and mathematical modeling of full operation of the p-n junction	**5**	
3.2. Avalanche and Zener breakdown, capacitance modeling	**2**	
3.3. Small-signal equivalent circuit and switching characteristics	**2**	
3.4. Schottky/ ohmic contacts and other types of the diodes like varactor, LED, Zener, and Schottky diode	**2**	
UNIT-IV: Bipolar Junction Transistor (BJT)	**8**	**CO4**
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: Fundamentals of MOSFET	**7**	**CO5**
5.1 MOS Junction, MOS capacitance, equivalent resistance, C-V characteristics, threshold voltage calculation	**3**	
5.2 I-V characteristics of the MOSFET and second-order effects like body effect, channel length modulation, saturation velocity, DBL, GIDL, and mobility degradation	**3**	
5.3 Differences between a MOSFET and a BJT	**1**	

Textbook References:

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.)

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Evaluation Method			Associated COs
Item	**Weightage (%)**	**Exam duration (min)**	
CLA 1	10	90	CO1
CLA 2	10		CO2
CLA 3	10		CO3
CLA 4	10		CO4
Midterm	20	90	CO1, CO2, CO3
Final Examination	40	180	CO1-CO5

*Please note, as per the existing institute's attendance policy the student should have a minimum of 75% attendance. Students who fail to attend a minimum of 75% of lectures will be debarred from the End Term/Final/Comprehensive examination.

CO and PO Correlation Matrix for B.Tech with ECE

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1										1	1	
CO2	3	3	2										2	2	1
CO3	3	3	3										3	3	1
CO4	3	3	3										3	3	1
CO5	3	3	2										2	2	1
CO6	3	3	3										3	3	1

Last Updated On:

Updated By: HARSHVARDHAN KUMAR

Approved By: