FUNDAMENTALS OF SEMICONDUCTOR DEVICES

Course Code	19EC4801C	**Year**	IV	**Semester**	II
Course Category	Program Elective VI	**Branch**	ECE	**Course Type**	Theory
Credits	3	**L-T-P**	3-0-0	**Prerequisites**	10+2 physics
Continuous Internal Evaluation:	30	**Semester End Evaluation:**	70	**Total Marks:**	100

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Outline the atomic structure and basic concepts of crystals (L2)
CO2	Apply the knowledge on energy band theory, charge carrier concentrations and drift of carriers to describe the properties of materials (L3)
CO3	Develop small signal model of semiconductor devices and explain their characteristics (L3)
CO4	Solve the problems on biasing, switching and amplification circuits based on semiconductor devices (L3)
CO5	Analyse the functioning of basic electronic devices (L4)

Mapping of course outcomes with Program outcomes (CO/ PO/PSO Matrix)

Note: 1- Weak correlation 2-Medium correlation 3-Strong correlation

* - Average value indicates course correlation strength with mapped PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3									1		1
CO2	3		2									1		2
CO3	3		3									2		2
CO4	3		3									2		2
CO5	3		3									2		2
Average* (Rounded to nearest integer)	3		3									2		2

Syllabus		
Unit No.	**Contents**	**Mapped CO**
I	**Crystal lattices**: Periodic structures, Cubic lattices, Planes and directions, Diamond lattice. **Atoms and Electrons**: Introduction to physical models, Experimental observations: The photoelectric effect, Atomic Spectra. The Bohr model, Quantum mechanics: Probability and the uncertainty Principle, The Schrodinger Wave Equation, Potential well problem, Tunneling. Excess carriers in Semiconductors (Qualitative treatment).	CO1
II	**Energy Bands and Charge carriers**: Bonding forces and Energy bands in solids: Bonding forces in solids, Energy bands, Metals, Semiconductors, and Insulators, Direct and Indirect Semiconductors. Charge carriers in Semiconductors: Electrons and holes, Effective mass, intrinsic material, extrinsic material.	CO2

	Carrier Concentrations: The Fermi level, Electron and Hole concentrations at Equilibrium, Temperature dependence of carrier concentrations, Compensation and Space charge Neutrality. Drift of carriers: Conductivity and Mobility, Drift and Resistance, Effects of Temperature and Doping on Mobility, High Field effects, Hall Effect.	
III	**P-N Junctions**: Equilibrium conditions: The contact potential, Equilibrium Fermi levels, Space charge at a junction. Forward and reverse biased Junctions; Steady state conditions: Qualitative Description of current flow at a junction, Carrier Injection, Reverse bias.Reverse-Bias Breakdown: Zener Breakdown, Avalanche Breakdown. Transient and A-C conditions: Time variation of stored charge, Reverse recovery Transient, Switching diodes, Capacitance of p-n junctions. Deviations from the Simple theory	CO3, CO4 and CO5
IV	**Field Effect Transistor:** The Metal-Insulator-Semiconductor FET: Basic operation, The Ideal MOS Capacitor, Effects of Real Surfaces, Threshold voltage, MOS Capacitance-Voltage Analysis. The MOS Field-Effect Transistor: Output Characteristics, Transfer characteristics, Mobility models, Short channel MOSFET I-V Characteristics, Control of Threshold voltage, Substrate Bias Effects, Sub threshold characteristics, Equivalent circuit for the MOSFET	CO3, CO4 and CO5
V	**Bipolar Junction Transistors**: Fundamentals of BJT Operation, Amplification with BJTs, Minority carrier Distributions and Terminal Currents: Solution of the diffusion equation in the base region, Evaluation of terminal currents, Approximations of the terminal currents, Current transfer ratio. Generalized Biasing: The coupled-diode model, Charge Control Analysis. Switching: Cutoff, Saturation, the Switching Cycle, and Specifications for Switching Transistors. Small-signal Equivalent circuit.	CO3, CO4 and CO5

Learning Resources
Text Books
1. Ben G. Streetman, Solid State Electronic Devices, Sixth Edition, Prentice Hall India, 2009. 2. Robert F. Pierret, Semiconductor device fundamentals, Pearson Publications, 2006.
Reference Books
1. Yuan Taur, Tak.H. Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, 1998 2. Donald Neamen, Semiconductors Physics and Devices, Tata Mc Graw Hill, 2003 3. Tyagi, Introduction to Semiconductor Materials and Devices, Wiley Publications, 2002. 4. S.M. Sze (Ed), Physics of Semiconductor Devices, 2nd Edition, Wiley Publications, 1998 5. Jasprit Singh, Semiconductor Devices, Basic Principles, Wiley Student Edition, 2001
e- Resources & other digital material
1. https://onlinecourses.nptel.ac.in/noc20_bt17/preview 2. https://www.youtube.com/watch?v=9h10p6M3Jo8
