

**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**  
**HYDERABAD CAMPUS**  
**FIRST SEMESTER 2023-2024**  
**Course Handout Part II**

**Date: 11/08/2023**

In addition to part -I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No.	:	EEE F214 / ECE F214/ INSTR F214
Course Title	:	Electronic Devices
Instructor-in-Charge	:	Sayan Kanungo
Lecture Instructors	:	Sayan Kanungo, & Parikshit Sahatiya
Tutorial Instructors	:	Sayan Kanungo, Parikshit Sahatiya & Surya Shankar Dan

**1. Scope and Learning Outcome:**

- i. Understanding the relationship between atomic structure and physical properties of semiconductors.
- ii. Interpreting electronic band structure using quantum mechanics.
- iii. Identifying the semiconductor properties that determine the performance of electronic devices.
- iv. Calculating the carrier concentrations and conductivity of a semiconductor using given doping concentrations.
- v. Understanding the basic physics of charge carriers in solids and carrier transport in semiconductors.
- vi. Deriving equations of charge transport in semiconductors under normal operating conditions.
- vii. Applying the charge transport equation to electronic devices and deriving their I-V characteristics.
- viii. Utilizing defect densities and carrier recombination processes to calculate generation and recombination rates in semiconductor devices.
- ix. Understanding the basics of optoelectronic devices.

**2. Text Book:**

- T1. B. G. Streetman, and Sanjay Banerjee, "Solid State Electronic Devices", 6<sup>th</sup> Ed., PHI, 2006.  
T2. D A. Neaman, "Semiconductor Physics and Devices", 4<sup>th</sup> Ed, Tata Mc Graw Hill.

**3. Reference Book:**

- R1. Yannis P Tsividis "Operation and Modeling of MOS Transistor" Oxford University Press.  
R2. Mark Lundstrom "Fundamental of nano-transistors Lessons from Nanoscience" World Scientific Book.

**4. Course Plan:**

<b>Lecture No.</b>	<b>Topics to be covered</b>	<b>Learning objectives</b>	<b>Chapter in the Text Book</b>
1	Introduction to the subject and course details		
2-3	Review of semiconductor fundamentals	Basic overview of atoms, molecules, and crystals, E-k diagram	3.1.2 - 3.1.4 (T1) + 3.1.1, 3.1.3 (T2)
4-9	Charge carriers in semiconductors	Intrinsic and Extrinsic Semiconductors, Direct and Indirect Band-gap Semiconductors, Effective Mass, Fermi level, Density of states, Equilibrium carrier concentrations, Band Diagram, Temperature dependence	3.2.1-3.2.5, 3.3.1, 3.4.1-3.4.2, 3.5.2-3.5.3, 4.1.1-4.1.4, 4.2.1-4.2.3, 4.3.1-4.3.2, 4.3.4, 4.5.2, 4.6.2 (T2)
10-13	Excess carriers in semiconductors	Interaction of photons with semiconductors, generation and recombination mechanisms of excess carriers, quasi-fermi levels in non-equilibrium	4.1.1, 4.3.1-4.3.3 (T1) + 6.1.1-6.1.2 (T2)
14-16	Charge carrier transport	Drift and Diffusion Transport, Mobility, Velocity Saturation, Conductivity	3.4.1- 3.4.4, 4.4.1 - 4.4.3, 4.4.6 (T1)
17-24	PN Junctions	PN junctions, Equilibrium, Biasing, I-V characteristics, Reverse bias breakdown, Tunnel Diode	5.2 – 5.4, 10.1 (T1) + 7.2-7.3, 8.1, 8.4 (T2)
25-27	Metal-Semiconductor Junctions (Ohmic/Schottky)	Ohmic & Schottky junctions: Equilibrium, Biasing for both p- and n-type semiconductors	5.7 (T1) + 9.1.1-9.1.4, 9.2.1-9.2.2 (T2)
28-30	Heterojunctions and Basic Concepts of BJT	Heterojunction Energy Band Structure, Working Principle of BJT	9.31-9.3.2 (T2) + 7.1 (T1)
31-38	Metal Oxide Semiconductor Field Effect Transistors	MOS Capacitor, Flat band Condition C-V Characteristics, Working principle of MOSFET, I-V characteristics, Short Channel Effects, Velocity Saturation Effect, Overview of nanoscale MOSFET Design	11.1.1 - 11.1.6, 11.2.1 - 11.2.3, 11.3.1 - 11.3.2, 12.1.1 -12.1.4, 12.3.1 (T2) + relevant sections from reference book
39-40	Optoelectronic devices	Solar cells, Photodiode	14.2.1-14.2.2, 14.3.2- 14.3.3 (T2)

## 5. Evaluation Scheme:

Component	Duration	Weightage	Marks (200) (%)	Date & Time	Nature of Component
Quizzes	30 min	30%	60	TBA	Open Book
Mid-semester Exam.	90 mnts	30%	60	14/10 - 2.00 - 3.30PM	Closed Book
Comprehensive Exam.	180 mnts	40%	80	21/12 FN	Closed Book
Total		100%	200		

**6. Chamber Consultation hours:** To be announced in the class.

**7. Notices:** All notices for the course will be announced in the class and displayed only on the CMS.

**Make-up Policy:** Requests for make-up examination will be conducted ONLY for genuine cases for mid-semester and comprehensive examination.

**Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-Charge**  
**Sayan Kanungo**