**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:**

1. Understanding the relationship between atomic structure and physical properties of semiconductors.
2. Interpreting electronic band structure using quantum mechanics.
3. Identifying the semiconductor properties that determine the performance of electronic devices.
4. Calculating the carrier concentrations and conductivity of a semiconductor using given doping concentrations.
5. Understanding the basic physics of charge carriers in solids and carrier transport in semiconductors.
6. Deriving equations of charge transport in semiconductors under normal operating conditions.
7. Applying the charge transport equation to electronic devices and deriving their I-V characteristics.
8. Utilizing defect densities and carrier recombination processes to calculate generation and recombination rates in semiconductor devices.
9. Understanding the basics of optoelectronic devices.

**2. Text Book:**

T1. B. G. Streetman, and Sanjay Banerjee, “Solid State Electronic Devices”, 6th Ed., PHI, 2006.

T2. D A. Neaman, “Semiconductor Physics and Devices”, 4th 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:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Lecture No.** | **Topics to be covered** | **Learning objectives** | **Chapter in the Text Book** |
| 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 Principe 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**