EE 207 (D)

SPRING 2025

Instructor, Timings, Resources

- Instructor: Prof. Swaroop Ganguly
  - Email: swaroop.ganguly@gmail.com; sganguly@ee.iitb.ac.in
  - Phone: 9867759249 (Whatsapp)

- Timings
  - Class: Slot-1 (Mon 0830; Tue: 0930; Thu: 1035)
  - Make-up/ extra: Sat 1100 (by prior announcement)
  - Office hour: By appointment

- Resources:
  - References: Textbooks –
    - Modern Semiconductor Devices for Integrated Devices, Chenming Hu
    - Solid State Electronic Devices, Streetman & Banerjee
  - Simulation Platform: www.nanohub.org

EE 207

Proposed syllabus

DESCRIPTION

Semiconductor physics: crystal structure; basic bandstructure concepts; density of states; carrier statistics; semiclassical equations; scattering and mobility; diffusion; carrier recombination and generation; quasi-Fermi levels; current continuity; the Poisson equation.

Semiconductor process technology: Introduction to fabrication processes

P-N junction diode: Outline of fabrication flow; homo and hetero-junctions; intrinsic barrier; current and capacitance in forward and reverse bias; non-ideal effects e.g. high-level injection; small-signal models; breakdown mechanisms – avalanche, band-to-band tunneling, punchthrough; basics of related devices e.g. Schottky diode, tunnel diode, photodiode, solar cell, LED, laser diode.

Field-effect transistor: Basic operation of JFET, MESFET, HEMT; MOS capacitor – regions of operation, C-V characteristics, non-ideal effects e.g. oxide and interface charge; MOSFET – outline of fabrication flow, I-V characteristics, small-signal models, CMOS scaling and challenges e.g. gate leakage, short-channel effects, basics of advanced CMOS devices e.g. FinFET.

Bipolar junction transistor: Basic operation and I-V characteristics; second order effects e.g. base-width narrowing, high-level injection, current-crowding; small-signal models; basics of heterostructure bipolar transistor.

Course Objectives

- ❑ **Explain** essential concepts in crystal structure; **Calculate** areal and volume atomic densities; **Explain** essential concepts of bandstructure (in 1D); **Derive** density-of-states and filling (xD)

- ❑ **Describe** and **Calculate** transport (drift-diffusion, continuity, generation-recombination) and space-charge in semiconductors; **Apply** the same to **Analyze** phenomena such as – barrier lowering, carrier response times

- ❑ **Explain** regimes of operation of foundational device types (p-n diode, MOSCAP, MOSFET, BJT); **Apply** semiconductor phenomenology to **Analyze** and **Interpret** their characteristics; to **Evaluate** and **Create** designs; with special emphasis on **Drawing Band Diagrams** to these ends

- ❑ **Describe** and **Explain** qualitatively the operation of other devices (Schottky diode, LED, solar cell, FinFET)

TAs for the course

23D0540 Aaqib Husain Sheikh – 7780961219

23M1122 Sayan Dutta - 9051761433

24D0524 Sukhendu Roy - 6291854292

200070065 Rahul Choudhary - 8769275373

24D0535 Mani Bharathi S - 9080906931

24M1214 Abhishek Arya - 8448755604

Course Policies

- Pre-requisite
  - **TBD**
- Attendance is mandatory (TBD with SAFE)
- Dishonesty (plagiarism in reports, cheating in quizzes, exams) will be dealt with utmost harshness
- Grading
  - 3 Quizzes (including mid-sem) : 3 x 15% = 45%
  - End-sem Exam : 45%
  - Prep quizzes : 10%
  - Homeworks : 0%