P490—Physics of Solid State Devices  

Outcomes

You will acquire a detailed understanding of the physics underlying the operation of semiconductor based electronic and opto-electronic devices.

Course Content

• Fundamental Concepts in Semiconductor Physics.
• The Ideal p-n Junction.
• Comprehension of the Principles of Device Operation and Limitations; that is, Engineering a Device Junctions.
• Student Presentation and Discussion of a Device.

Lectures

Fundamentals:

• Description of Solids: Unit Cells, FCC vs Hex, Miller Indices. (wk 1)
• Bonding: Ionic, Covalent, Metallic, v.d. Waals, Hydrogen. (wk 1)
• Modelling of Solids: Brillouin vs Tight Binding, Electron effective mass, Holes, reduced Band scheme. (wk 2)
• Statistics & Potentials: N(E), f(E), Work Functions, Galvani, Volta, Double Layer, Vacuum, equilibrium/dynamic Fermi concepts. (wks 2-3)
• Doping: p - and n - type, Traps vs Recombination vs Scattering Centers, N(E)f(E) vs T. (wk 3-4)
• Dynamics: Diffusion, Drift, Mobility, Electro Thermal Magnetic Effects, Scattering, Hall and Shottky Expt’s. (wk 4)
• Excitations: Photons, Phonons, Carrier Life and Relax times. (wk 5)
**Ideal p-n Junction:**

- **Choices:** Homo vs Hetro Junctions, Iso vs Aniso, Continuity equ, Einstein relation. (wk 5-6)
- **Dynamics:** Fick's Laws, Diffusion, Drift, Peltier effect, Barrier Potential. (wks 6)
- **Schottky:** Energy/Bands, Poisson's equ, Barrier depletion width approx, Mott-Schottky plots. (wks 7)

**Devices:**

- **Applications:** Diodes (IMPATT, PIN, Photodiode, Zener), Transistors (BJT, FET's), LED, Opto-Electronics, Solar Cell, CCD's, etc. (wk 8-9)
- **More Devices:** Optoelectronics, etc. (wk 10)
- **Engineering:** LED vs Diode Laser, etc. (wk 11)
- **Future:** Quantum Wells and Dots, SET's, Nanowire Sensors. (wks 12)

**Project:** In-Class Presentation of a Device - Student Marked (wk 13)

**Text:** Streetman & Banerjee: "Solid State Electronic Devices"; additional topics eg Quantum Dots or SET's by class interest and notes provided.


**Marks:**

- **Final Exam:** Either 60%, 85% or 100%
- **Project:** 15%
- **Problem Sets:** 25% from about 8 Assignments.
- **Midterm:** Take Home and counts as a 7th & 8th, 'double' Problem Set and consists of previous Final Exam Questions.
- **Final Grade:** The highest of (60% + 25% + 15%) or (85% + 15%) or 100%

**Who, Where, When**

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- I'll be definitely in my office at times to be arranged in class.
- Nevertheless, feel free to drop by to see me anytime!