
EE566 Solid State Devices

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Dept of Electrical Engineering

University of Notre Dame

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Assignment 1

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Due: 01/23/2004

Reading

Chapter 1 of Shur

Problem 1

Sketch the typical *bandstructure* (Energy E vs. Momenta k) and write down *typical* values of the atomic density, mobile carrier density, and electrical conductivity for the following classes of materials.

- a metal
- a semiconductor
- an insulator

Considering that all three can be pure and crystalline, what leads to the large differences in the electronic/optical properties between the three?

Problem 2

Sketch the following

- Bandstructure* (Energy E vs. Momenta k), with the typical *shallow* Donor and Acceptor energy levels (E_D and E_A),
- Density of states ($g(E)$ vs E) including donors and acceptors, and
- Carrier concentration for Fermi level at mid-gap and $T \sim 300K$

for

- a direct bandgap semiconductor (e.g. GaAs), and
- an indirect bandgap semiconductor (e.g. Si).

Your sketches should be three plots with the same energy axis, vertically stacked. Depict the filled states by shading.

Problem 3

Sketch and *explain* the electrical resistivity ρ as a function of temperature for a typical metal¹ and a doped semiconductor for $0K < T < 300K$. Use the sketches from Problems 1 and 2 to explain the trends.

¹ Neglect superconducting effects.