6.012 Microelectronic Devices and Circuits

Tutorial #1

Problem 1 – Multiple dopants in Silicon

A sample is doped with the following – P 10^{16} cm^{-3}.

a) Estimate the electron and hole concentrations in equilibrium (n_o & p_o) at room temperature (T=300K)?
b) What is the majority carrier at 300K?
c) What is the doping type at 300K?

The above sample is then doped with an addition of Ge 10^{16} cm^{-3}.

d) Estimate the electron and hole concentrations in equilibrium (n_o & p_o) at 300K?
e) What is the majority carrier at 300K?
f) What is the doping type at 300K?

The above sample is then doped with an addition of B 10^{18} cm^{-3}.

g) Estimate the electron and hole concentrations in equilibrium (n_o & p_o) at 300K?
h) What is the majority carrier at 300K?
i) What is the doping type at 300K?

Problem 2 — Intrinsic Carrier Concentration Dependence on Temperature

The intrinsic carrier concentration n_i varies with temperature as

$$n_i(T) = AT^{3/2}\exp\left[-\frac{E_G}{2kT}\right]$$

where A = 3.32 x 10^{15} $cm^{-3}/K^{3/2}$, $k = 8.62\times10^{-5} eV/K$, T is the temperature in K, and E_G is the bandgap in eV (for Si E_G=1.1 eV). Assume that E_G does not change with temperature and n_i=1x10^{10} cm^{-3} at 300 K. A sample is doped with P 10^{14} cm^{-3}. At T=900K, is the sample intrinsic or extrinsic?

Problem 3 — Web lab demo

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