VE320 Intro to Semiconductor Devices

Summer 2024 – Problem Set 2

Due: 11:59pm, June 7th

1. (a) Determine the total number (#/cm^3) of energy states in silicon between E_C and $E_C + 2kT$ at (i) T = 300K and (ii) T = 400K. (b) Repeat part (a) for GaAs.

2. (a) For silicon, find the ratio of the density of states in the conduction band at $E = E_C + kT$ to the density of states in the valence band at $E = E_V - kT$. (b) Repeat part (a) for Ge.

3. Consider the energy levels shown in Figure 1. Let T = 300K. (a) If $E_1 - E_F = 0.20$eV, determine the probability that an energy state at $E = E_1$ is occupied by an electron and the probability that an energy state at $E = E_2$ is empty. (b) Repeat part (a) if $E_F - E_2 = 0.40$ eV.

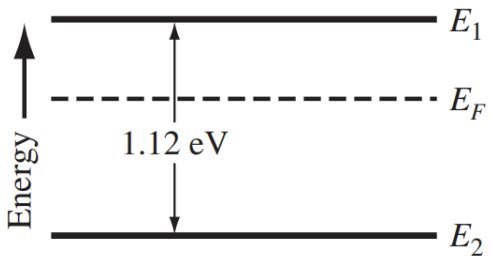

Figure 1. Energy levels for problem 3

4. (a) The carrier effective masses in a semiconductor are $m_n^* = 1.21m_0$ and $m_p^* = 0.70m_0$. Determine the position of the intrinsic Fermi level with respect to the center of the bandgap at T = 300K. (b) Repeat part (a) if $m_n^* = 0.80m_0$ and $m_p^* = 0.75m_0$.

5. Semiconductor A has a band gap of 1 eV, while semiconductor B has a band gap of 2 eV. What is the ratio of the intrinsic carrier concentrations in the two materials (n_{iA}/n_{iB}) at 300 K. Assume any differences in the carrier effective masses may be neglected.

6. The value p_0 in Silicon at T = 300K is 2×10^{16}cm^{-3}. (a) Determine $E_F - E_v$. (b) Calculate the value of $E_C - E_F$. (c) What is the value of n_0? (d) Determine $E_{Fi} - E_F$.

7. The electron concentration in silicon at T = 300K is $n_0 = 2 \times 10^5 cm^{-3}$. (a) Determine the position of the Fermi level with respect to the valence band energy level. (b) Determine p_0. (c) Is it n- or p-type material?