ELEC 321/4-H	INTRODUCTION TO SEMICONDUCTOR MATERIALS AND DEVICES	Winter 2018

Homework due on March 15th 2018

No late homework will be accepted

1. Calculate the intrinsic carrier concentration n_i at T = 300 and 500 K for (i) germanium, and (ii) gallium arsenide.

2. Assume that silicon, germanium and gallium arsenide each have dopant concentration of $N_d = 10^{13}$ cm^{-3} and $N_a = 2.5 \times 10^{13}$ cm^{-3} at T = 300 K. For each of the three materials calculate n_0 and p_0.

3. (a) If $g_C(E) = K$ where K is a constant. Derive the expression of n_0 assuming Boltzmann approximation.
(b) In a sample of GaAs at T = 200 K, it is found that $n_0 = 5p_0$. Calculate n_0, p_0 and N_d. Assume that all dopants are ionized.

4. For a particular semiconductor, Eg = 1.5 eV, $m_p^* = 10 m_n^*$, T = 300 K, and $n_i = 10^5$ cm^{-3}.
(a) Determine the position of the intrinsic Fermi energy level with respect to the center of the bandgap. (b) Impurity atoms are added so that the Fermi energy level is 0.45 eV below the center of the bandgap. What is the concentration of the impurity atoms added?

5. Silicon at T = 300 K is doped with $N_a = 7 \times 10^{15}$ cm^{-3}. (a) Determine $E_F - E_v$. (b) Calculate the concentration of additional acceptor atoms that must be added to move the Fermi level a distance kT closer to the valence-band edge.

6. Silicon at T = 300 K is doped with 10^{16} arsenic atoms cm^{-3}. (i) Calculate the position of the Fermi energy with respect to the Fermi energy E_{Fi} in intrinsic Si. (ii) The above Si sample is further doped with 10^{17} Boron atoms cm^{-3}. Calculate the position of the Fermi energy with respect to the Fermi energy E_{Fi} in intrinsic Si.