UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering and Computer Sciences

EECS 130 **Professor Chenming Hu**
Spring 2006

HOMEWORK SET NO. 2
Due: Thursday, 2nd February, 2006

1. (a) Semiconductor is doped with an impurity concentration N such that N>> n_i and all the impurities are ionized. Also, $n = N$ and $p = n_i^2/N$. Is the impurity a donor or an acceptor? Explain.
   (b) In a germanium sample maintained under equilibrium conditions near room temperature, it is known that $n_i = 10^{13}$ cm^{-3}, $n = 2p$, and $N_A = 0$. Determine n and N_D.

2. (a) The electron concentration in a piece of Si maintained at 300 K under equilibrium condition is 10^5 cm^{-3}. What is the hole concentration?
   (b) For a silicon sample maintained at T = 300 K, the Fermi level is located 0.301 eV above the E_v. What are the hole and electron concentrations?

3. A sample of silicon is doped with $N_d = 10^{16}$ cm^{-3} and $N_a = 10^{15}$ cm^{-3}.
   (a) Find n_o and p_o assuming complete ionization of the dopants.
   (b) Locate E_f.
   (c) Sketch the energy band diagram. Identify E_c, E_v, E_f and $E_{i.}$ on your drawing. Indicate the band gap.

4. An electron is moving in a piece of lightly doped silicon under an applied field at 300K so that its drift velocity is one-tenth of its thermal velocity. What is the applied electric field? Calculate the average number of collisions it will experience in traversing by drift a region 1 μm long.

5. A sample of N-type silicon is at room temperature. When an electric field with strength of 1000V/cm is applied to the sample, the hole velocity is measured and found to be $2x10^5$ cm/sec.
   (a) Estimate the equilibrium electron and hole densities, indicating which the minority carrier is.
   (b) Find the position of E_f with respect to E_c and E_v.
   (c) The sample is used to make an integrated circuit resistor. The width and height of the sample are 10um and 1.5um, respectively, and the length of the sample is 20um. Calculate the resistance of the sample.