# ECSE-2210 Microelectronics Technology

**Homework 3**

1. A Si sample is doped such that it has $10^{17}$ $cm^{-3}$ electrons in its conduction band (i.e. $n = 10^{17}$ $cm^{-3}$) at both 300 K and 200 K. Calculate the hole concentrations at 300 K and 200 K. Figure 2.20 has the $n_i$ values for various temperatures.

2. (Problem 2.17 in text) Determine the equilibrium electron and hole concentrations inside a uniformly doped sample of Si under the following conditions:

   (a) $T = 300$ K, $N_A << N_D$, $N_D = 10^{15}$ $cm^{-3}$.

   (b) $T = 300$ K, $N_D << N_A$ , $N_A = 10^{16}$ $cm^{-3}$.

   (c) $N_A = 9 \times 10^{15}$ $cm^{-3}$, $N_D = 10^{16}$ $cm^{-3}$, $T = 300$ K.

   (d) $N_D = 10^{14}$ $cm^{-3}$, $T = 450$ K.

   (e) $N_D = 10^{14}$ $cm^{-3}$, $T = 650$ K.

3. (Problem 2.18 in text) For each of the conditions specified in Problem 2, determine the position of $E_i$, Compute $E_F - E_i$ , and draw a carefully dimensioned energy band diagram for the Si sample. Note: $E_G$ (Si) = 1.08 eV at 450 K and 1.015 eV at 650 K. Also, read exercise 2.4 in text (page 55).