ECSE-2210 Microelectronics Technology
Class Activity 3

1) Intrinsic Si has 1×10^{10} cm^{-3} electrons in its conduction band at 300 K. What will be the number of holes in the valence band?

2) Consider three intrinsic semiconductors: Ge, Si and GaAs.

   a. Which one has the largest number of electron-hole pairs at room temperature? Explain briefly.

   b. Which one has the highest resistivity at 300K? Explain.

   c. Suppose each one is doped with a donor concentration of 10^{16} cm^{-3}. The donor binding energy (or ionization energy) is 0.06 eV. Make a guess of the electron concentration in each sample at 300 K? Are they the same or different? Explain.

   d. If each one of the doped semiconductors is heated slowly above 300 K, which one will convert to "intrinsic" first? Which one will convert to intrinsic last? (For all practical purposes, "intrinsic" means the electron and hole concentrations are almost equal).

3) Calculate the ionization energy of a donor atom in Si. Assume $\varepsilon_s / \varepsilon_0 = K_s = 11.8$ and $m_n^*/m_0 = 1.18$ for Si. You can start from the fact that the electron binding energy within the hydrogen atom is 13.6 eV as calculated in Class Activity 2.

4) Mention two n-type dopants and two p-type dopants in Si. Draw the band diagram of an n-type Si sample. Draw the band diagram of a p-type Si sample.

5) Electrons in a filled band cannot participate in current flow. Explain why.