ECE 340 Homework VIII Spring 2003

Due: Monday, March 10, 2003

1. An abrupt Si p-n junction is formed by alloying a uniformly doped n-type silicon bar where $N_d = 8x10^{16}/cm^3$ in the beginning. During the alloying process, a uniform counter doping of acceptors of $N_a = 1.4x10^{17}/cm^3$ is introduced in the region for x<0. Basically, x<0 is the p-side and x>0 is the n-side.
   (a) Calculate the Fermi level positions at 300 K in the p and n regions.
   (b) Draw an equilibrium band diagram for the junction and determine the contact potential V_o from the diagram.
   (c) Compare the results of part (b) with V_o as calculated from Eq. (5-8).
   (d) Using Eq. (5-8), calculate and plot V_o versus temperature ranging from 250 K to 500 K.

2. Refer to problem 1, the silicon bar has a cross section with diameter 20 μm. Assume that the depletion approximation holds. (a) Calculate W, X_{no} and X_{po} at 300 K. (b) Determine the total positive ion charge in the depletion region. (c) Sketch to scale the charge density $\rho(x)$, electrical field $\mathbf{E}$ (x), and electrostatic potential V(x) in the depletion region. Assume that the electrostatic potential is zero at x= 0. (d) Draw the energy band diagram for the device.

3. Refer to problem 1 again. In reality, the alloying process will introduce a much higher concentration of acceptor. Assume that the uniform counter doping is $N_a = 3x10^{19}/cm^3$ instead. Determine and plot the contact potential V_o and depletion widths W, X_{no} and X_{po} versus temperature ranging from 250 K to 500 K.