ECE 340 Homework X Spring 2003

Due: Friday, March 21, 2003

1. A n^+-p Si junction with a long p-region has the following properties: $N_a = 1.5 \times 10^{16}/cm^3$; μ_n = 1020 cm^2/V-s; μ_p = 380 cm^2/V-s; τ_n = 1 μs. If we apply 0.7 V forward bias to the junction at 300 K, what is the electric field in the p-region far from the junction? Draw a band diagram in the p-region far from the junction assuming that the junction is at x=0 and the p-side is in x>0.

2. Consider the following Si p-n junctions operating at 300 K.
   (a) Using Eq. (5-8), calculate the contact potential V_o for $N_a = 5 \times 10^{14}$ and $5 \times 10^{18}/cm^3$, with $N_d = 10^{15}$, 10^{17}, $10^{19}/cm^3$ in each case and plot V_o vs. N_d.
   (b) Plot the maximum electric field $\mathbf{E_o}$ vs. N_d for the junctions described in (a).
   (c) Plot the width of the depletion region W vs. N_d for the junctions described in (a).
   (d) Given that $N_a = 10^{14}$ (and repeat for $10^{19}/cm^3$) and $N_d = 10^{19}/cm^3$, determine the reverse bias needed to yield a maximum electric field $\mathbf{E_o}$ in the junction which exceeds 5×10^5 V/cm. and what is the depletion width under the reverse biasing?

3. A p^+-n silicon diode (V_o = 0.926 volts) has a donor doping of $10^{17}/cm^3$ and an n-region width = 1 μm. Assume that the diode has a uniform cross sectional area of 0.001 cm^2. Refer to Fig. 5-22 for the following questions.
   (a) Does it break down by avalanche or punchthrough? Determine the depletion capacitance when the breakdown happens.
   (b) If the doping is only $1 \times 10^{16}/cm^3$, what is the minimum n-region width for punchthrough not to take place?