

ELEG 646; ELEG 446 - Nanoelectronic Device Principles – Spring 2005
Homework #5 - due Tuesday, 5 April 2005, in class

1. The donor and acceptor concentrations on the n- and p-sides of a Si abrupt p-n junction are equal to 10^{16}cm^{-3} . The whole semiconductor is illuminated uniformly such that the hole concentration in the neutral n-region rises to 10^{13}cm^{-3} . No current is allowed to flow. What will be the reading of a voltmeter whose positive terminal is connected to the p-side at 290K? (Hint: use law of the junction).
2. A Si abrupt p-n junction has $N_0 = 3 \times 10^{18}\text{cm}^{-3}$ on the p-side and an area of $1.6 \times 10^{-3}\text{cm}^2$. The junction capacitance is 18 pF at a reverse bias of 3.2 V and 12 pF at 8.2 V. Calculate the built-in voltage and the donor concentration on the n-side.
3. A long-base Si abrupt p-n junction diode with a junction area of 10^{-2}cm^2 has $N_D = 10^{18}\text{cm}^{-3}$, $N_A = 10^{17}\text{cm}^{-3}$, $\tau_p = 10^{-8}\text{sec}$, $\tau_n = 10^{-6}\text{sec}$, $D_p = 5.2\text{cm}^2\text{sec}^{-1}$, and $D_n = 20\text{cm}^2\text{sec}^{-1}$. At 300 K, calculate the diode current with a forward bias of 0.5 V, and then with a reverse bias of 5 V. Include the generation-recombination current and assume $\tau_0 = 10^{-7}\text{sec}$ within the depletion region.
4. A long-base Ge p-n junction diode has an abrupt junction with uniformly doped regions. The p-side has a resistivity of $1\ \Omega\text{-cm}$ and the n-side has a resistivity of $0.2\ \Omega\text{-cm}$. (a) Calculate the concentrations of minority carriers at the edges of the depletion region with a forward bias of 0.207 V, and sketch the majority and minority carrier current densities as functions of distance from the edges of the depletion region on each side of the junction. (b) Calculate the locations of the planes at which the majority and minority carrier currents are equal in magnitude. Assume $\tau_p = 10^{-7}\text{sec}$, $\tau_n = 10^{-5}\text{sec}$, and $T = 300\text{K}$ in your calculations.

Homework assignments will appear on the web at:
<http://www.ece.udel.edu/~kolodzey/courses/eleg646s05.html>

Note: On each homework and report submission, you must please give your name, the due date, assignment number and the course number.