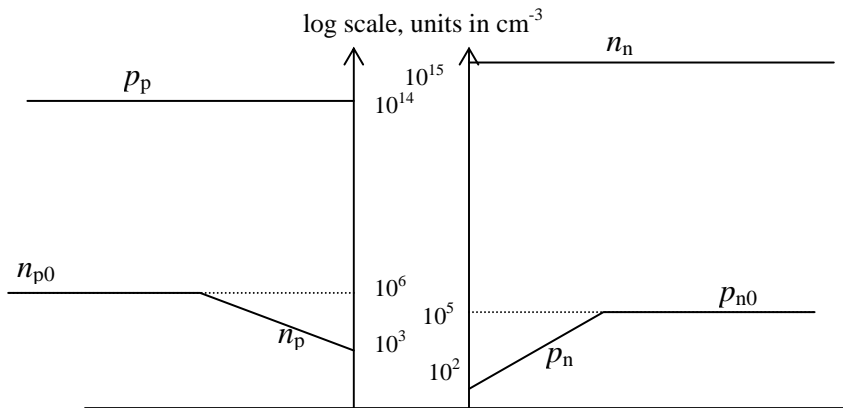


ECSE-2210 Microelectronics Technology
Fall 2005 Homework 5

Reading Assignment: Pages 235-282

1. (Problem 6.10 in text). The figure below is a dimensioned plot of the steady state carrier concentration inside a p-n junction diode at 300 K.
 - a. Is the diode forward biased or reverse biased? Explain.
 - b. Do low-level injection conditions prevail in the quasi-neutral regions? Explain.
 - c. What are the p-side and n-side doping concentrations?
 - d. Determine the applied voltage, V_A .



2. An abrupt silicon p-n junction diode has the following characteristics. P-side:
N-side:

$$\begin{aligned} N_A &= 10^{16} \text{ cm}^{-3} & N_D &= 4 \times 10^{16} \\ \mu_n &= 1000 \text{ cm}^2/\text{Vs} & \mu_p &= 350 \text{ cm}^2/\text{Vs} \\ \tau_p &= 10^{-7} \text{ sec} & \tau_n &= 10^{-7} \text{ sec} \\ \text{Area } A &= 10^{-2} \text{ cm}^2 \end{aligned}$$

Calculate the following (a-d) quantities:

- Reverse saturation hole current component.
- Reverse saturation electron current component.
- Minority carrier concentrations at the edge of the depletion layer, $n_p(0)$ and $p_n(0)$, for a forward voltage of 0.6 V.
- Electron and hole current for the bias condition of (c).
- Make a rough sketch of the minority carrier concentration profile in the quasi-neutral regions for the bias condition of (c).
- Suppose the forward voltage is increased to a value such that the injected minority carrier concentration at the n-side depletion layer edge is equal to the doping concentration (i.e., $4 \times 10^{16} \text{ cm}^{-3}$). Calculate this forward voltage. Compare this voltage to the built-in voltage. Comment on the results.
- Suppose the critical electric field at breakdown for this diode is 10^6 V/cm , and then calculate the breakdown voltage of this diode.