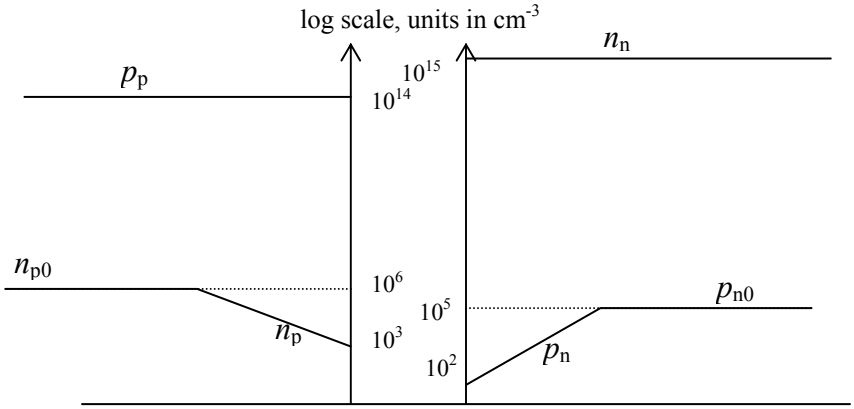
ECSE-2210 Microelectronics Technology
Homework 5

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:

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

Calculate the following (a-d) quantities:

(a) Reverse saturation hole current component.
(b) Reverse saturation electron current component.
(c) 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.
(d) Electron and hole current for the bias condition of (c).
(e) Make a rough sketch of the minority carrier concentration profile in the quasi-neutral regions for the bias condition of (c).
(f) 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., $4 \times 10^{16}\ cm^{-3}$). Calculate this forward voltage. Compare this voltage to the built-in voltage. Comment on the results.
(g) Suppose the critical electric field at breakdown for this diode is 10^6 V/cm, and then calculate the breakdown voltage of this diode.