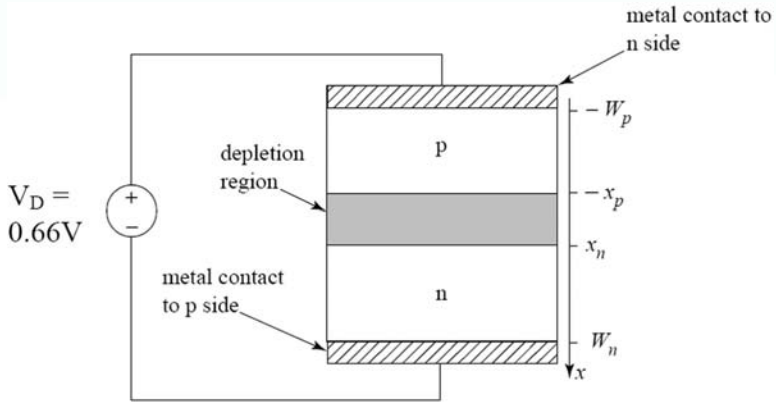
Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science
6.012 Microelectronic Devices and Circuits
Homework #5

Problem 1

You are given a P-N junction diode with the device data shown below. We forward bias the diode at $V_D = 0.66V$.

Device Data

$N_a = 10^{17}\ cm^{-3}$
$N_d = 10^{16}\ cm^{-3}$
$\mu_n = 1400\ cm^2/V\text{-}sec$
$\mu_p = 500\ cm^2/V\text{-}sec$
Area = 50μm X 50μm
$W_n = W_p = 2\mu m$



a) Calculate the total depletion region width, x_D, for this forward biased diode.

b) Calculate the minority carrier concentration at $-x_p$ and x_n.

c) Calculate the majority carrier concentration at $-x_p$ and x_n.

d) Calculate J_n^{diff} (diffusion current density) at $x=-x_p$

e) Calculate J_p^{diff} at $x = x_n$.

f) Find the ratio of J_p^{diff}/J_n^{diff}.

g) Calculate I_o

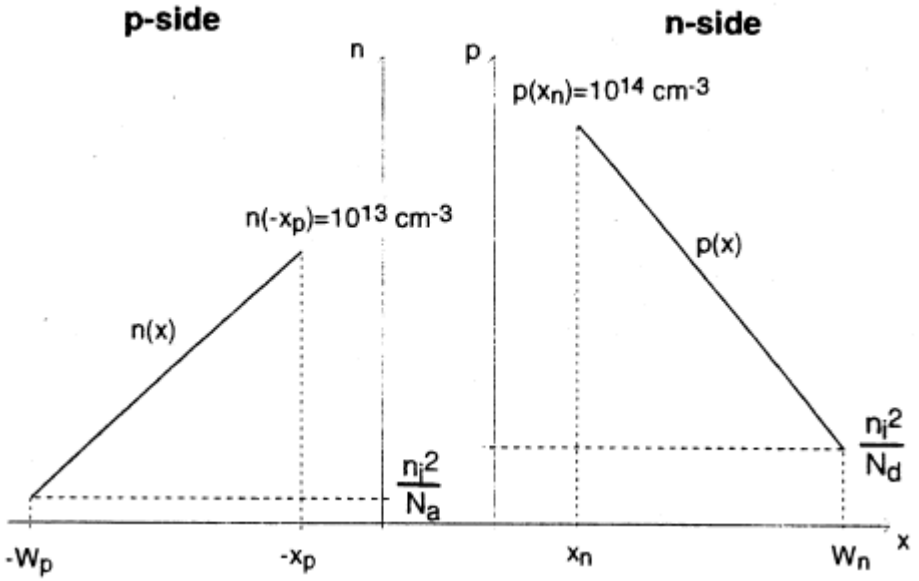
h) Calculate the depletion capacitance.

i) Calculate the diffusion capacitance.

j) Calculate the conductance g_d.

Problem 2

Below is a sketch not to scale of the minority carrier distribution across the quasi-neutral regions of a forward biased p-n diode. For this diode, $W_p - x_p = 4\ \mu m$, $W_n - x_n = 3\ \mu m$, $D_n = 25\ cm^2/s$ and $D_p = 10\ cm^2/s$. The area of the junction is $10\ \mu m^2$.



a) What is the ratio of the doping levels across the junction: Na/Nd?

b) Calculate the hole current injected into the n-side of the diode.

c) Calculate the electron current injected into the p-side of the diode.

d) Calculate the diffusion capacitance associated with the carrier storage on the n-side of the diode.

e) Calculate the diffusion capacitance associated with the carrier storage on the p-side of the diode.

f) How much should the voltage across the junction increase if we wish to double the total current through the diode?

g) Compute the diffusion capacitance of the diode when we increase the voltage in the manner suggested in the previous question.

Problem 3 Howe and Sodini P6.12

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