EECS 320 Spring 2012 Midterm 2: Take-home Part

Issued: Monday 6/11/12 11 am

Due: Friday 6/15/12 in class.

This part of the exam is under the College of Engineering Honor Code. You may use any research resources you wish (books, internet documents, computer codes, etc.) but you are not allowed to consult with any other humans in any form (direct interaction, e-mail, internet chat lines, billboards, etc.)

Problem 1

For the case of problem 1on the in-class exam

a) Quantitatively plot the electric field vs. x, electrostatic potential vs. x, and the band diagram vs. x. Indicate electron and hole quasi-Fermi levels on the band diagram.
b) What is the applied bias for this situation.
c) If this device is at equilibrium (V_a=0), we will get $x_n < 0.5\mu m$. Show that in equilibrium, in the region $x_n < x < 0.5\mu m$ we will have a electric field of approximately $F \approx \frac{kT}{qx}$
d) In equilibrium (V_a=0), How would we find x_n and V_{bi}? (challenging question).

Problem 2

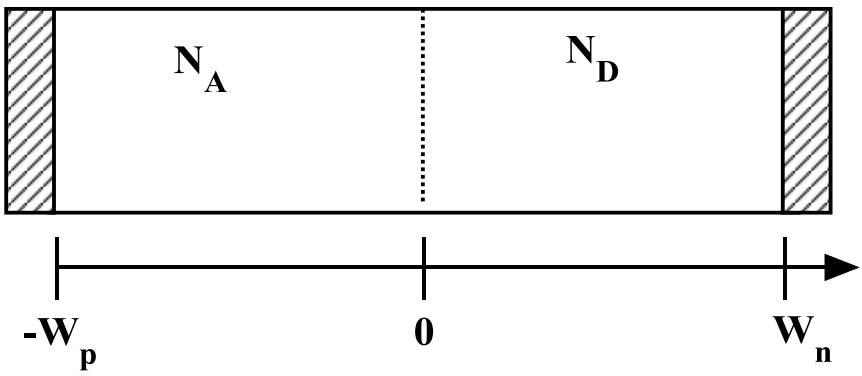
We have a Ge diode exactly like the case of problem 3 on the in-class exam except now $\tau_{\min} = 5ns$ throughout the device.

a) Find and plot the excess minority carrier distributions in the neutral regions when the device is forward biased with v_a=0.4V.
b) Find the capacitance per unit area of the device when it is forward biased with v_a=0.4V.
c) Find and plot the total current density for the device for v_a=-10 to 0.4V include G-R current in the depletion region.

Problem 3

We have a uniform doping, abrupt Si diode at 300K which is doped on the p side with Boron (B, $E_A=E_V+45meV$) to $N_A=8x10^{18}cm^{-3}$ and Arsenic (As, $E_D=E_C-54meV$) on the n-side to $N_D=3x10^{19}$ cm^{-3}.

Region	Doping Conc (cm^{-3})	Dopant Energy
p-side	$N_A=8x10^{18}cm^{-3}$	$E_A=E_V+45meV$
n-side	$N_D=3x10^{19}$ cm^{-3}	$E_D=E_C-54meV$



a) Find the built-in potential V_{bi} for this diode.

b) Find the depletion width when the peak junction field is 300KV/cm. Would you expect the breakdown mechanism to be avalanche multiplication or tunneling and why?