Part I : PN Junction Questions (45 points total)

1. A pn junction is uniformly doped with acceptor atoms in the region $x < 0$ and with donor atoms in the region $x > 0$. Under reverse bias, the charge density in the depletion region on the p-side is mainly due to (circle one)

[5 pts]

holes and electrons

donors

acceptors

both holes and acceptors

2. A silicon pn step junction is under reverse bias at room temperature in the dark. The peak electric field in the depletion region is 10^5 V/cm. If $N_D = 7\text{x}10^{17}$ cm^{-3} and $N_A = 1\text{x}10^{16}$ cm^{-3}, how far does the depletion region extend into the p-type material?

[10 pts]

4:00

3. (Parts A – C constitute the question for **ABET Outcome #4**)

A silicon pn junction has the following parameters:

$N_D = 1\text{x}10^{17}$ cm^{-3}	$\mu_N = 1000$ cm^2/Vs	$\tau_N = 1\ \mu$s
$N_A = 5\text{x}10^{15}$ cm^{-3}	$\mu_P = 500$ cm^2/Vs	$\tau_P = 1\ \mu$s

A. What is the built-in potential in volts? [5 pts]

B. If the applied voltage $V_A = 0.7$ V, what is the total band bending across the junction in electron-volts? [5 pts]

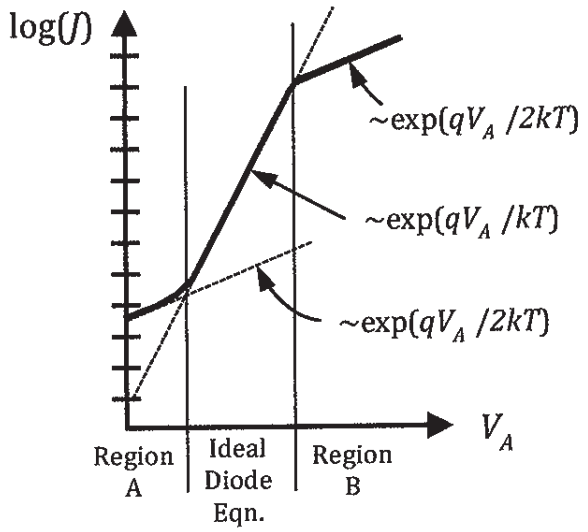
6:00

C. Asuming low-level injection, calculate the "ideal" current density if $V_A = 0.7$ V.

[10 pts]

16:00

4. Experimentally, the current in a pn diode is found to deviate from the ideal diode equation at both low and high current, as shown in the plot below.



A. The deviation at low currents (region A) is due to (circle one answer): [5 pts]

generation in the neutral regions

generation in the depletion region

recombination in the neutral regions

recombination in the depletion region

none of the above

B. The deviation at high currents (region B) is due to (circle one answer): [5 pts]

recombination in the neutral regions

recombination in the depletion region

high-level injection

low-level injection

none of the above

17:00