EECS 2077 Test #1, Winter 2015 Name:_____

#1 ____/25 pts **Allowed materials: 1 page of a 1-sided equations sheet, writing utensil, calculator.**
#2 ____/25 pts **Remember – we use cgs units! Centimeter/gram/second.**
#3 ____/25 pts kT = 0.026 eV (300K) ε_0=8.854x10^{-14} F/cm
#4 ____/25 pts q= 1.6x10^{-19} C n_i=1.5x10^{10} / cm^3

Optional Feedback
Rate the length of this test: ***short*** ☐ ***long*** ☐ ***OK*** ☐
Rate the difficulty of this test: ***easy*** ☐ ***hard*** ☐ ***OK*** ☐

1) [25 pts.] An ideal p+n junction at 300K, made out of an unknown material (is not Si) has the following parameters (you might not need them all).

p-side:	n-side:	General parameters
Na=10^{17}/cm^3	Nd=10^{15}/cm^3	ε=6.8
Dn=50 cm^{2}sec	Dp=100 cm^{2}sec	n_i=1.5x10^{10} / cm^3
Ln=20x10^{-3} cm	Lp=50x10^{-3} cm	

a) [10 pts] What are the DRIFT and DIFFUSION current densities (A/cm^2) across the junction at an applied reverse bias of -5V?

Calculations:

Answer for DRIFT: _____

Answer for DIFFUSION: _____

b) [10 pts] What is the DRIFT AND DIFFUSION current density (A/cm^2) across the junction at a forward bias of 0.6? V?

Calculations:

Answer for DRIFT: _____

Answer for DIFFUSION: _____

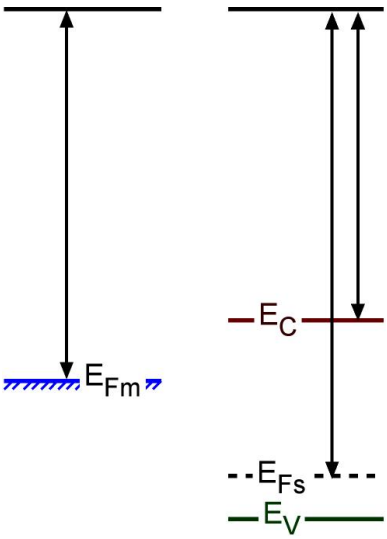
c) [5 pts] Under reverse bias, what type of carrier dominates? Circle one: electrons / holes / neither

2.) A metal-semiconductor diode!

(a) [9 pts] draw the resulting band diagram after the materials are contacted. Make sure you label the contact potential on your band diagram.

(b) [8 pts] redraw the diagram for reverse bias, and draw with an arrow where the current is coming from.

(c) [8 pts] challenge problem :) Draw the E-field plot for this device for both the cases of no-voltage and reverse-bias voltage (make sure you label which is which!).



3.) Some multiple choice:

[5 pts] A diode at 300K with no voltage on it has this type of current:

DRIFT DIFFUSION BOTH NEITHER

[5 pts] If we decrease doping, then (choose one):

[ ] carrier lifetime decreases and diffusion length increases
[ ] carrier lifetime increases and diffusion length decreases
[ ] carrier lifetime decreases and diffusion length decreases
[ ] carrier lifetime increases and diffusion length increases

[5 pts] The depletion region:

[ ] contains charges such as carriers and ionized dopants
[ ] contains charges such as ionized dopants
[ ] contains charges such as carriers
[ ] contains no charges at all

[5 pts] The units for this mystery equation are (is made up, is not a real one for this course!):

$$? = N_a \frac{kT}{q} \ln \frac{N_a N_d}{n_i^2} (L_n)^2$$

[ ] cm^3/V
[ ] V/cm
[ ] V
[ ] C/cm^3

[5 pts] If I increase doping on both sides of a diode.

[ ] all types of currents decrease
[ ] all types of currents increase
[ ] drift increases
[ ] diffusion increases

4) 25 pts - Some mish-mash wrap-up questions….

a) [5 pts] Drift current requires which of the following (check all that apply):

___ carriers with electrical charge
___ temperature to drive the current
___ electric field to drive the current
___ concentration gradient to drive the current

b) [5 pts] heavily doped diodes (p+ and n+) will typically be dominated by this type of breakdown.

TUNNELING (ZENER) AVALANCE BOTH NEITHER

c) [15 pts] A Si bar is 0.4 cm long and 100 μm^2 in cross-sectional area is doped with 10^{17} boron, resulting a mobility for holes of 500 (cm/s)/(V/cm). What is the DRIFT current (current I_p, not current density J_p) with 4V applied? *Problem is from the homework!*

Extra Space