EECS 2077 Test #1, Spring 2014 Name:_____

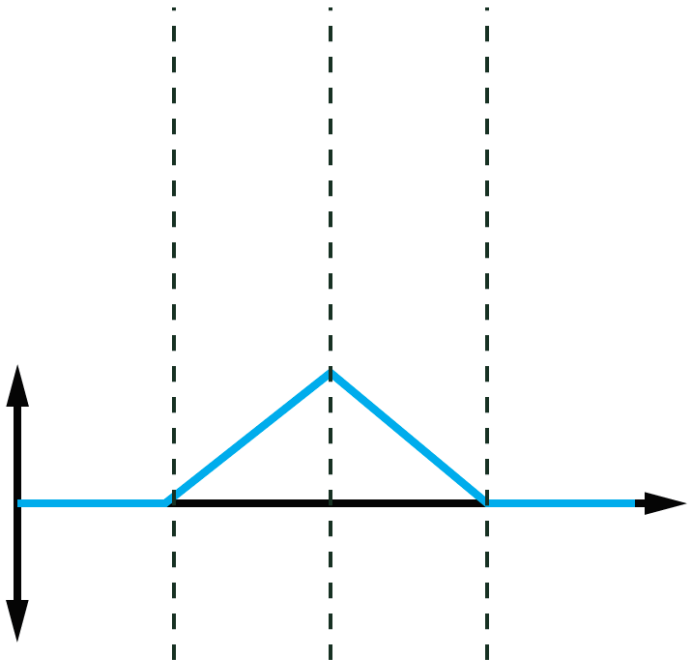
#1 ____/25 pts
#2 ____/25 pts
#3 ____/25 pts
#4 ____/25 pts

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

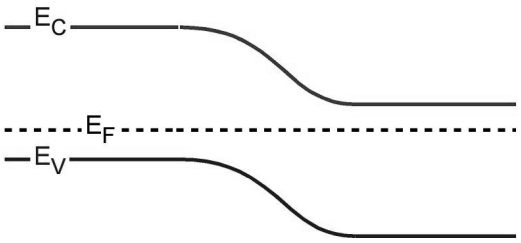
Optional Feedback

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

1.) [10 pts] Draw the band-diagram (just conduction and valance bands) for the following E-field profile. (Y-axis is E-field with positive E-field above the X-axis, X-axis is positive distance).



2.) [10 pts] Assume you have a GROUND wire and a NEGATIVE VOLTAGE wire. To get a large current flow (forward bias) out of the diode below, label which side is GROUND and which side is NEGATIVE VOLTAGE.



c) [5 pts] Simplify and rewrite the equation below for the case of a n+p diode.

$$qA\left(\frac{L_p}{\tau_p}p_n+\frac{L_n}{\tau_n}n_p\right)\left(e^{qV/kT}-1\right)$$

2.) 25 pts. Some short answer questions.

a) [5 pts] Drift current requires (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. (5 pts.)

TUNNELING (ZENER) AVALANCE BOTH NEITHER

c) [5 pts] if I increase doping for a diode:
___ all currents increase
___ both drift and diffusion currents decrease
___ only drift decreases
___ only diffusion decreases

b) [10 pts] I have some weird new unknown semiconductor device, which gives current as a function of voltage according to the following equation. A is the area in cm^2. The rest you should recognize. What are the units for the unknown term 'H'?

$$I(A) = q\,A\,H\,\mu\,\ln(qV/kT)$$

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3) 25 pts. An ideal Si p+n junction at 300K has the following parameters (you might not need them all).

p-side:	n-side:	General parameters
$Na=10^{17}/cm^3$	$Nd=10^{15}/cm^3$	$\varepsilon_{Si}=11.8$
$Dn=18\ cm^{2/}sec$	$Dp=25\ cm^{2/}sec$	
$Ln=10^{-3}$ cm	$Lp=10^{-2}$ cm	

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

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 0.5? V?

Calculations:

Answer for DRIFT: _____

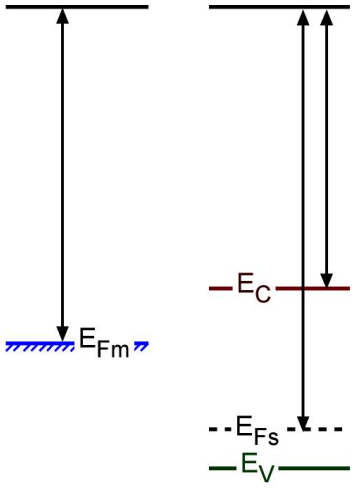
Answer for DIFFUSION: _____

4.) 25 pts. Ironman blah blah blah…. Sorry, just kidding, not superhero problem on THIS test…

4.) 25 pts. You should be able to get this one… you have seen it before! But it is not easy!

a) [10 pts] Draw the band diagram, and label the depletion region width.
b) [10 pts] Draw the IV plot, remember the plot should be drawn with respect to voltage on the LEFT side of the device (the metal side).
c) [5 pts] When the current increases exponentially, it will be due to diffusion across the junction. What type of carriers will it be?

__ electrons
__ holes
__ both
__ not enough information



Extra Space