EECS 2077 Test #1, Summer 2013 Name:_____

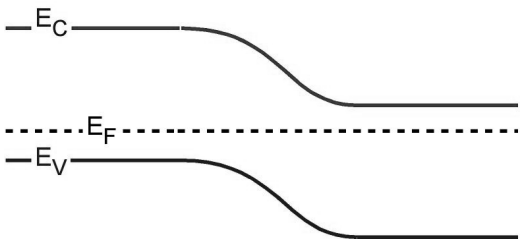
#1 ____/25 pts **Allowed materials: 1 page of a 1-sided equations sheet, writing utensil, calculator.**
#2 ____/20 pts **Remember – we use cgs units! Centimeter/gram/second.**
#3 ____/25 pts kT = 0.026 eV (300K) ε_0=8.854x10^{-14} F/cm
#4 ____/25 pts q= 1.6x10^{-19} C n_i=1.5x10^{10} / cm^3

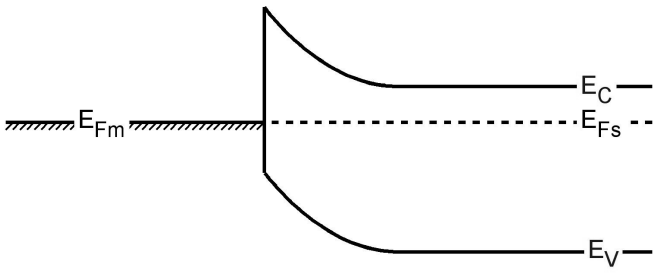
Optional Feedback
Rate the length of this test: ***short*** ☐ ***long*** ☐ ***OK*** ☐
Rate the difficulty of this test: ***easy*** ☐ ***hard*** ☐ ***OK*** ☐

1.) 30 pts. Two junctions are provided below. Assume ideal behavior (no breakdown, etc.)

For both of these junctions:

(a) apply negative voltage to the left side and draw with an arrow which way the bands will move;
(b) next, draw the source (starting location) and direction (with arrows) of all carriers that cause current flow:
(c) assume you then apply even more negative voltage, and write below each 'increased current' or 'no change in current'.





2.) 20 pts. Lets play the drift versus diffusion game! Circle the correct answer for each:

a) Increases for a <u>forward biased</u> diode as doping increases. (4 pts.)

DRIFT DIFFUSION BOTH NEITHER

b) Decreases for a <u>reverse biased</u> diode as doping increases. (4 pts.)

DRIFT DIFFUSION BOTH NEITHER

c) For a semiconductor, will increase as mobility increases. (4 pts.)

DRIFT DIFFUSION BOTH NEITHER

d) Write out the proper units for EACH term in the current density (A/cm^2) equation below. (4 pts)

$$q\mu_p p(x)\,\mathsf{E}(x)$$

e) Write out the proper units for EACH term in the current density (A/cm^2) equation below. (4 pts)

$$qD_p \frac{dp(x)}{dx}$$

3.) 20 pts. Some more basic/fundamental semiconductor questions:

a) Increasing doping will change what types of carriers in a semiconductor? (4 pts)

MAJORITY MINORITY BOTH NEITHER

b) Recombination is at least partly what determines (effects) which of these semiconductor parameters? (4 pts)

LIFETIME DIFFUSION LENGTH BOTH NEITHER

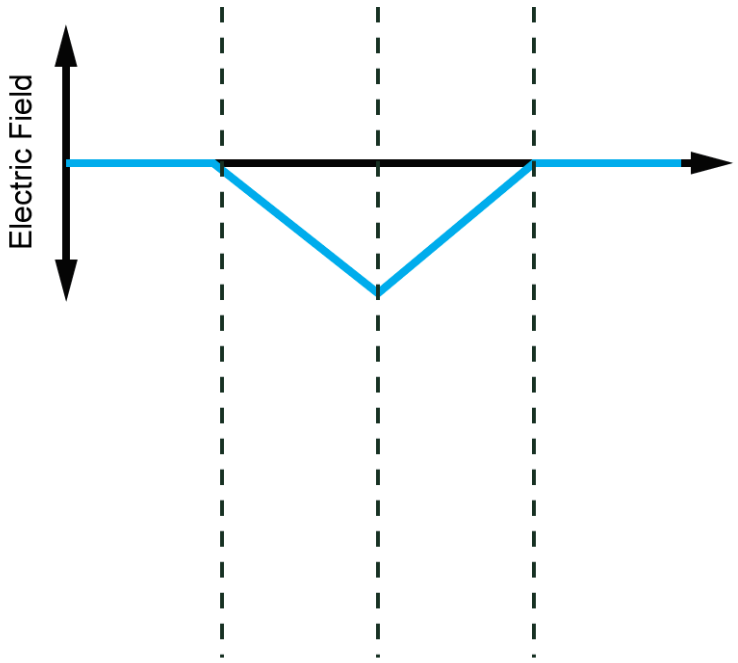
c) To dope a Silicon semiconductor p-type, I need an element with how many valence electrons? (4 pts)

ZERO ONE TWO THREE FOUR FIVE SIX

d) As you increase the bandgap of a semiconductor (Si -> GaAs -> GaN, for example), what should happen typically to the intrinsic carrier concentrations if the semiconductors are at 300K? (4 pts)

INCREASES DECREASES STAYS THE SAME

e) Draw the band-diagram (just conduction and valance bands) for the following E-field profile. (8 pts)



4) [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) What is the drift current density (A/cm^2) across the junction at an applied reverse bias of -2V? (10 pts)

b) What is the diffusion current density (A/cm^2) across the junction at a forward bias of 0.5? V? (10 pts)

c) If you wanted to decrease the reverse breakdown voltage (easier to breakdown) for this diode (now you may assume non-ideal behavior), of all the parameters listed above, which one (and only one) would you change and how? (5 pts)

Extra Space