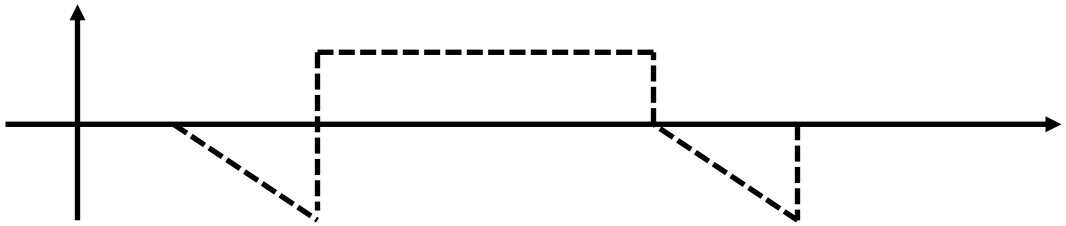
EECS 2077 Test #1, Fall 2014 Name:_____

#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*** ☐

1a) [10 pts] Draw the band-diagram (just conduction and valance bands) for the following E-field profile. Draw the band-diagram directly below the E-field profile so I can match them up. (The dotted line is the E-field, Y-axis is E-field with positive E-field above the X-axis, X-axis is positive distance).



1b) [15 pts] A Si bar is 0.2 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 1V applied? *Problem is from the homework!*

$$I_p = q\mu_p p_0 E A = 1.6\times10^{-19} C \times 500 \frac{cm/s}{V/cm} \times 10^{17}/cc \times \frac{1V}{0.2\,cm} \times 10^{-6} cm^2 = 40\ \mu A$$

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2.) 25 pts. Some short answer questions.

a) Requires that particles have a charge in order to be moved. (5 pts.)

DRIFT DIFFUSION BOTH NEITHER

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

ZENER AVALANCE BOTH NEITHER

c) What are the units for this equation: qV/kT ? (5 pts.)

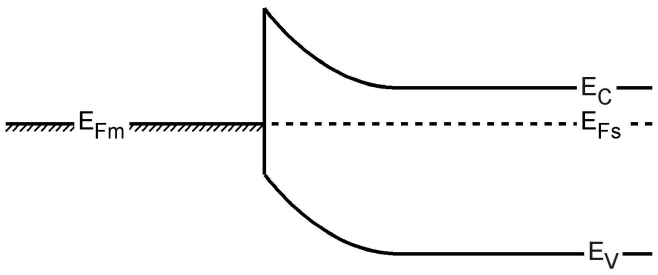
VOLTS (V) COULOMBS (C) VOLTS SQUARED (V^2) UNITLESS (NO UNITS)

d) If I increase doping for a diode, my total diode current in forward bias: (5 pts)

INCREASES DECREASES STAYS THE SAME NOT ENOUGH INFO

e) Exists for the Schottky diode shown below for the case of negative voltage applied to the metal. (5 pts)

DRIFT DIFFUSION BOTH NEITHER



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
$Na=10^{18}/cm^3$	$Nd=10^{15}/cm^3$	$I_0= 1x10^{-15}A$

This question is easy, if you really understand how the diode and diode equation works…

a) [5 pts] What is the total current density (A) across the junction at a forward bias of 0.7? V?

b) [10 pts] What is the diffusion current density (A) for holes across the junction at 0V?

c) [10 pts] Using ONLY the information have provided above, give your best calculation/estimate for the magnitude of the amount of reverse saturation current that is due to electron drift. I understand you are missing some other variables to get the exact answer, but I my goal is to see if you really understand the diode equation.

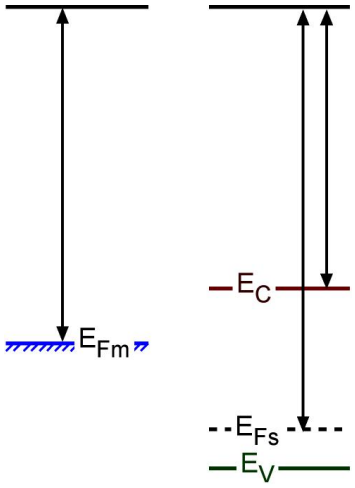
4.) 25 pts. You should be able to get this one… you have seen it before! But it is not easy! *From the test last spring!*

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