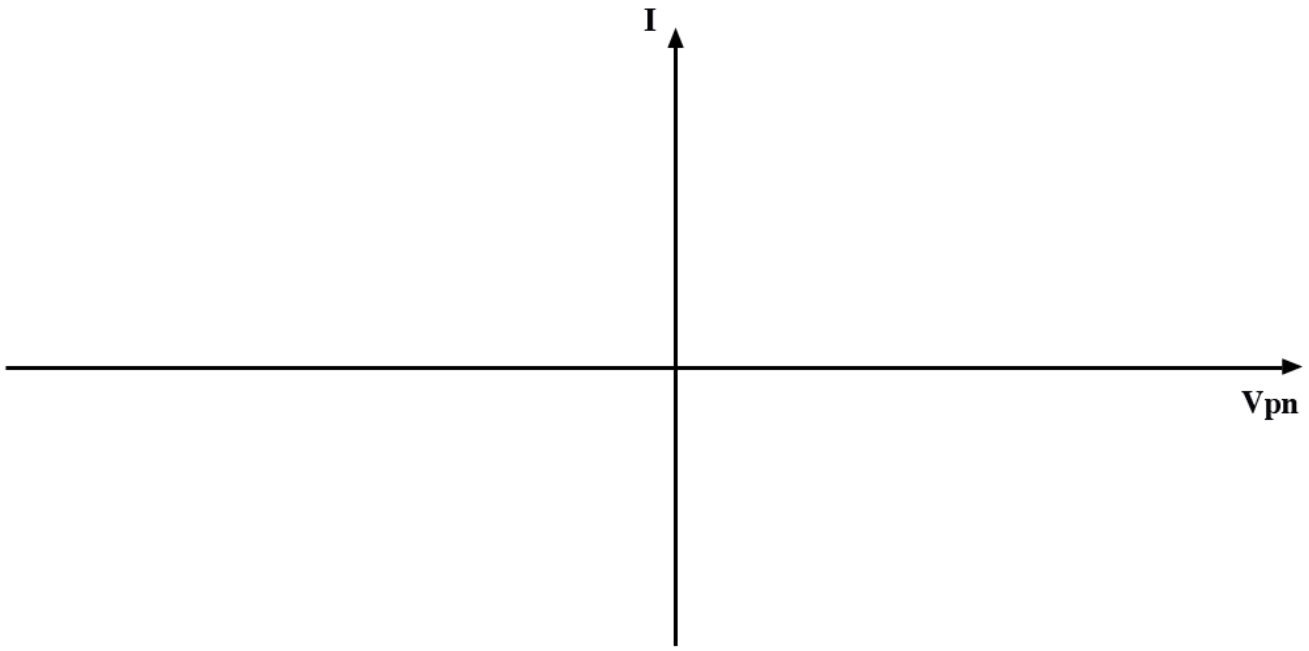
EECS 2077 Test #1, Fall 2013 Name:_____

#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. Questions related to ideal diodes. Read all parts before you start to draw.

a) [8 pts] Using a solid line, draw the reverse and forward IV characteristic for a pn diode.
b) [8 pts] Using a dotted line, draw the reverse and forward IV characteristics for a p+n diode.



c) [9 pts] Simplify and rewrite the equation below for the case of a n+p diode.

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

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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 q/kT in the equation shown below? (5 pts.)

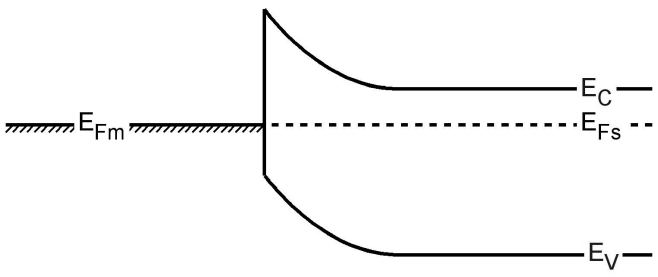
qV/kT, units are: _____

d) Write out the proper units for EACH term in the current density (A/cm^2) equation below. (5 pts)

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

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

DRIFT DIFFUSION BOTH NEITHER



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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).

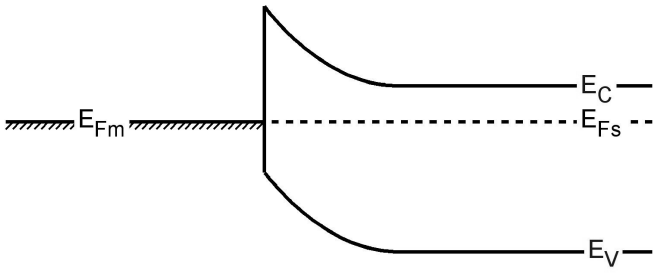
p-side:	n-side:	General parameters
$Na=10^{17}/cm^3$	$Nd=10^{15}/cm^3$	$\varepsilon_{Si}=11.8$
$Dn=18\ cm^{2/}sec$	$Dp=25\ cm^{2/}sec$	
$Ln=10^{-3}$ cm	$Lp=10^{-2}$ cm	

a) [15 pts] What is the current density (A/cm^2) across the junction at an applied reverse bias of -3V?

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

4.) 25 pts. Some more basic/fundamental semiconductor questions:

a) Below the device below, plot E-field vs. the distance, assume the same axis for distance (moving from left to right). (10 pts)



b) When we dope Si with Boron, explain in 1-2 sentences maximum how/why we get a hole (10 pts)

c) Explain with ONE word, and one word only, why when we dope a semiconductor heavily p-type, the minority carrier electrons decrease. (5 pts)

Extra Space