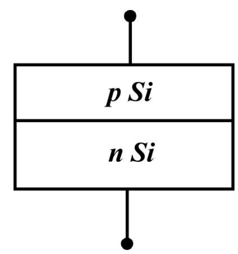
EECS 2077 Test #2, Fall 2013 Name:______________________________

#1 ____/25 pts **Allowed materials: 2 pages of 1-sided equation sheets, writing utensil, calculator.**
#2 ____/30 pts **Remember – we use cgs units! Centimeter/gram/second.**
#3 ____/20 pts kT = 0.026 eV (300K) ε_0=8.854x10^{-14} F/cm ε_r(Si)=11.8
#4 ____/25 pts q= 1.6x10^{-19} C n_i(Si)=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** Si pn+ junction at 300K has the following parameters (you may or may not need them all).

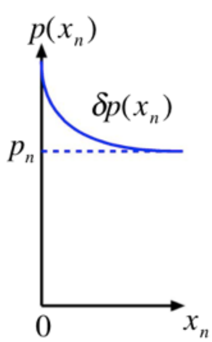


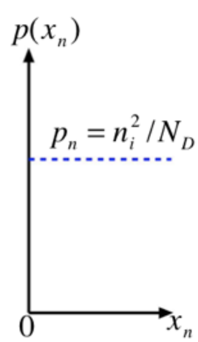
p-side:	n-side:	General parameters
Na=10^{15}/cm^3	Nd=10^{17}/cm^3	$\varepsilon_{Si}\varepsilon_0$=1x$10^{-12}$ F/cm (11.8 x ε_0 F/cm) reverse saturation current = 4.5x10^{-14} A

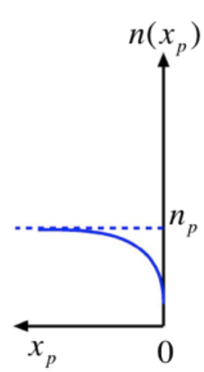
a) [10 pts.] What are the ideal values for drift (I_{drift}) and diffusion (I_{diff}) currents across the junction at an applied forward bias of +0.5V?

b) [10 pts.] Calculate the width of the depletion region (W) for the case of zero applied voltage.

c) [5 pts] Here are 3 plots, circle the plot which is representative of the case reverse bias.







2.) [30 pts] True or false, for a PNP BJT setup for normal amplification. Circle your answer.

(a) TRUE / FALSE : Collector current changes exponentially (non-linearly) with change in base current.

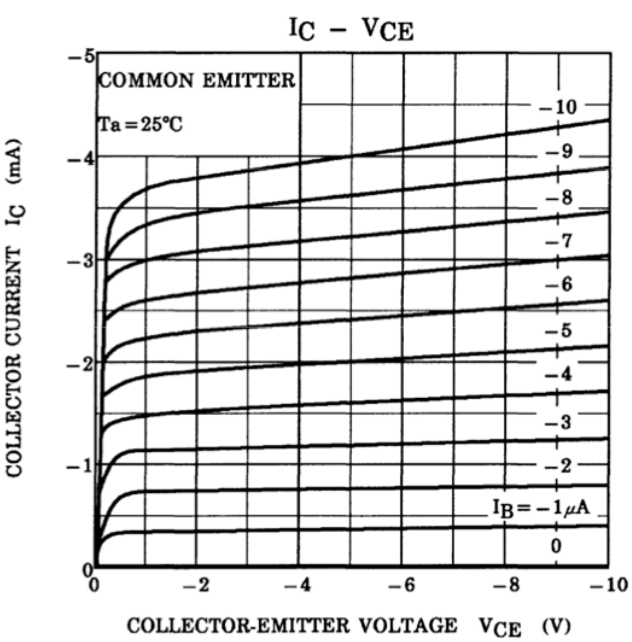
(b) TRUE / FALSE : I_C plotted vs. V_{BE} should look like a diode plot because that is how holes are injected into the base.

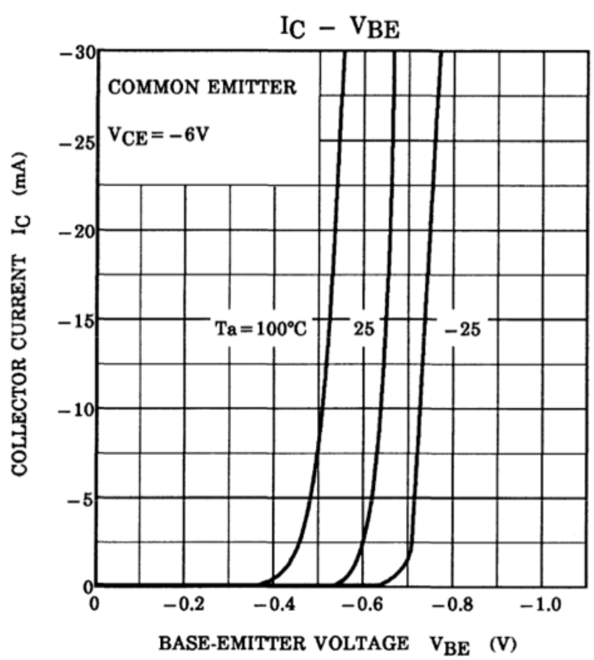
(c) TRUE / FALSE : If you double the amount of electrons in the base, the collector current will also double.

(d) TRUE / FALSE : Even though the BJT is an amplifier, the number of extra holes and electrons in the base are equal.

(e) TRUE / FALSE : If the hole lifetime in the base decreases then the base current increases also.

(f) TRUE / FALSE : I_C saturation with increasing V_{CE} occurs because once you have the base-collector reverse biased the collector is all setup to collect holes as drift current.





3.) [20 pts.] Lets play the drift versus diffusion game! Circle the correct answer for each:

a) Causes source-to-drain current flow through the channel of a JFET. (4 pts.)

DRIFT DIFFUSION BOTH NEITHER

b) Type of current that dominates in the collector of a BJT in normal forward active mode. (4 pts.)

DRIFT DIFFUSION BOTH NEITHER

c) Is why we need to keep feeding electrons into the base terminal of a PNP BJT in normal forward active mode. (4 pts.)

DRIFT DIFFUSION BOTH NEITHER

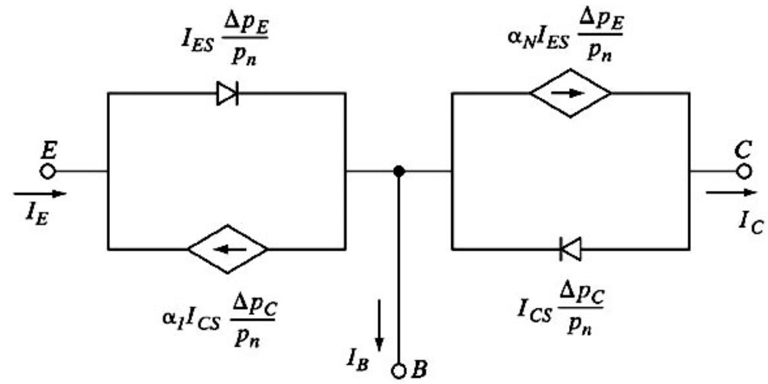
d) Dominates the flow of electrons across the base of a NPN BJT in normal forward active mode. (4 pts.)

DRIFT DIFFUSION BOTH NEITHER

e) To turn off a JFET or MESFET, some current is required, and it is this type of current. (4 pts)

DRIFT DIFFUSION BOTH NEITHER

4.) [25 pts] Consider a PNP BJT at 300K with the following characteristics. <u>You should assume normal forward active mode for all the problems listed below.</u>



$$qA\frac{D_p}{L_p}p_n = 0.2\,pA$$

$$\text{ctnh}\frac{W_b}{L_p} = 100$$

$$I_{Ep} \approx qA\frac{D_p}{L_p}\Delta p_E \;\text{ctnh}\frac{W_b}{L_p}$$

$$I_C \approx qA\frac{D_p}{L_p}\Delta p_E \;\text{csch}\frac{W_b}{L_p}$$

$$I_B \approx qA\frac{D_p}{L_p}\Delta p_E \tanh\frac{W_b}{2L_p}$$

(a) [5 pts] The amplification factor is 10,000, and the emitter current is 2 mA. Calculate the approximate difference between the emitter current and the collector current.

(b) [5 pts] The amplification factor is 10,000, and the emitter current is 2 mA. Calculate $\tanh\frac{W_b}{2L_p}$

(d) [10 pts] If I increase W_b … (check all that apply):

[ ] – the base and emitter current will become closer in magnitude
[ ] – the base and emitter current will become more different in magnitude
[ ] – the emitter and collector current will become closer in magnitude
[ ] – the emitter and collector current will become more different in magnitude

(e) [5 pts] Calculate the value for I_{ES} in the coupled diode model.

EXTRA SPACE