EECS 2077
Semiconductor
Devices

6 Non-Ideal Diode & Test Review Name:____________________________

Note – today you only have two in-class problems, that you do NOT need to turn in. After you finish these problems, you may spend the rest of class asking me questions for the test. If for some reason these problems take a long time, please make sure you save at least 30 minutes at the end of class to look at old test examples so you can ask me about anything that you do not understand or which is unclear.

In-Class Problems

(1) A Si p+n diode is reverse based up to the point of electrical breakdown. The n-type doping is $N_D = 10^{15}$/cc.

(a) using the figure below, determine the breakdown voltage

(b) at the point of breakdown, what is the depletion region width?

$$W = \sqrt{\frac{2\varepsilon kT}{q^2}\left(\ln\frac{N_A N_D}{n_i^2}\right)\left(\frac{1}{N_A}+\frac{1}{N_D}\right)} \qquad V_0 = \frac{kT}{q}\ln\frac{N_a N_d}{n_i^2}$$

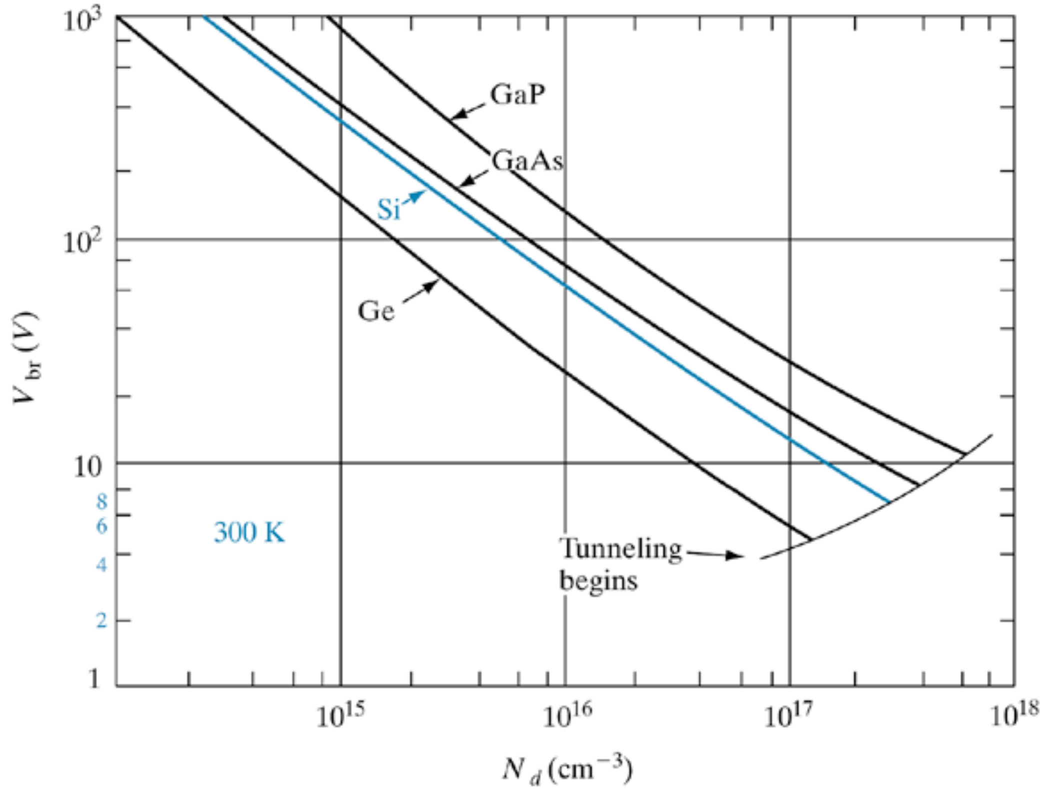
Hint – you could use the above equations from Lecture 3, and notice that contact potential is already inside the equation for W. If you were to do so, and account for reverse bias voltage too, you would get the followign which is from Lecture 5. Remember, Vapp is negative!

$$W = \left[\frac{2\varepsilon\left(V_0 - V_{app}\right)}{q}\left(\frac{N_a + N_d}{N_a N_d}\right)\right]^{1/2}$$

(c) at the point of breakdown, using a simple (rough calculation), how much E-field is across the depletion region? *Remember, in reality the E-field peaks at the physical PN junction, but for this calculation assume it is constant.*

Instructor – Prof. Jason Heikenfeld

(d) if we were to design the diode such that breakdown was always Zener breakdown, what would the new N_D value be?



(2) More diode current practice… Everyone should do well on the test on this, make sure you are solid on it, you know one of these WILL show up in one form or another!

An <u>ideal</u> 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 are the DRIFT and DIFFUSION current densities (A/cm^2) across the junction at an applied reverse bias of -2V?

b) What are the DRIFT AND DIFFUSION current density (A/cm^2) across the junction at a forward bias of 0.5? V?

Review Session

I'll answer any question until the end of class! Use this time wisely and come prepared with questions you want to ask!