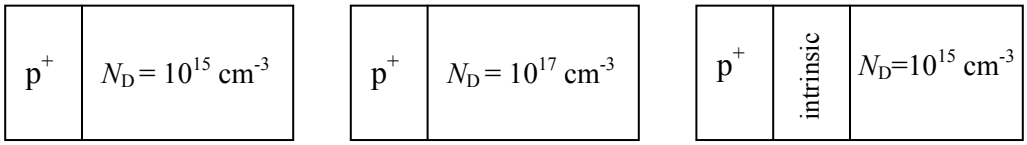
ECSE-2210 Microelectronics Technology
Class Activity 15

1. Consider a planar p^+-n Si step junction diode with an n-side doping of $N_D = 10^{15}$ cm^{-3} at $T = 300$ K.
   a. Estimate the approximate breakdown voltage of the diode. You have to read this off from figure 6.11 in the textbook.

   b. Calculate the depletion layer width at the breakdown voltage estimated above.

   c. Calculate the maximum value of the electric field in the depletion region at breakdown.

2. Consider three p^+-n junctions as shown below. Which one will have the highest breakdown voltage? Which one will have the lowest breakdown voltage? Which one will have the highest R-G related current ($I_{R\text{-}G}$) at reverse bias? (Try to understand the physical reasoning).



3. Consider the following Si p-n junction at 300 K. Assume the junction area is $A = 1$ cm^2.

p-side	**n-side**
$N_A = 10^{16}$ cm^{-3}	$N_D = 10^{16}$ cm^{-3}
$D_n = 25$ cm^2/s	$D_p = 10$ cm^2/s
$\tau_p = 5 \times 10^{-7}$ s	$\tau_n = 5 \times 10^{-7}$ s
$\tau_0 = 5 \times 10^{-7}$ s	

   a. Calculate the ideal reverse saturation current at –5 V reverse bias.

b. Calculate the generation-recombination current at –5 V reverse bias. Note that this current is many orders of magnitude higher than the expected ideal reverse current for Si diodes. Diodes fabricated on lower band gap materials obey the ideal diode behavior more closely.

4. Suppose $I_0 = 10^{-14}$A and $R_s = 2\ \Omega$ in a diode at $T = 300$K when high-level injection is negligible. Suppose you want to pass 50 mA through the diode.
   a. Determine the voltage that has to be applied to the diode to get the above current.

   b. Suppose the diode series resistance is 20 Ω, and you applied the voltage you got in part (a). What will be the current through the diode? Note the effect of parasitic series resistance on the diode current.