Homework # 4

EE 3161 - Spring 2008

Due Friday, March 28 in class

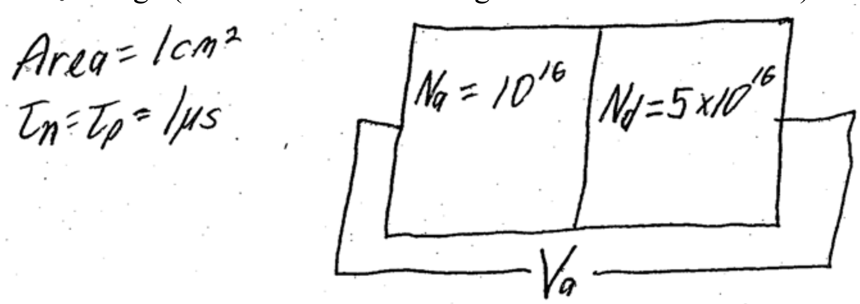
1) Problem 6.10 of Pierret.

2) Assume the *ideal* silicon diode below.

a) Make a quantitative sketch of the carrier concentrations across the diode for forward and reverse bias.

b) For a small forward bias of 0.2V, what is the total excess hole charge injected into the n-region if the area of the diode is 1 cm^2? Is this equal to the total excess electron charge in the p-region?

c) What is J_0 for the diode? If we increase the doping of the p-region to $N_a = 1\times10^{19}$ cm^{-3}, how does J_0 change (state which terms change and in which direction)?



3) A *real* silicon p-n junction has $N_a = 5\times10^{16}$ cm^{-3} in the p-region and $N_d = 2\times10^{16}$ cm^{-3} in the n-region. Assume the diode area is 1 cm^2 and $\tau_n = \tau_p = 1\mu s$.

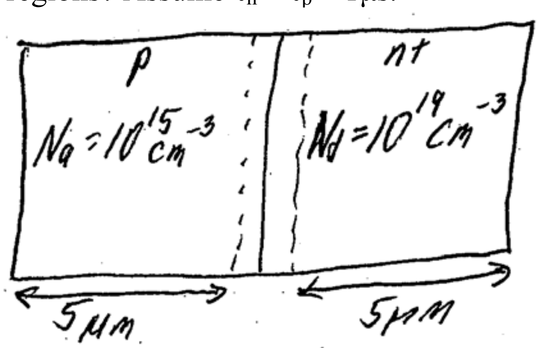
a) If we apply a reverse bias of 5V, what is the junction leakage current? What is the source of this current?

b) Can you derive a condition where the ideal diode equation leakage dominates?

c) What is the reverse bias breakdown voltage for this diode?

d) What is W at V_{br}?

4) A p-n^+ diode (shown below) has an n+ region doped at 10^{19} cm^{-3} and a p region doped at 10^{15} cm^{-3}. At what level of forward bias would an appreciable amount (0.1V) of voltage be dropped across the bulk regions? Assume $\tau_n = \tau_p = 1\mu s$.



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5) [*Problem 2, midterm exam #2, spring 2007*]

In the reverse-biased diode below, a narrow beam of light is scanned across a p-n junction. The recombination/generation time is 0.1µs.

a) Sketch the current produced by the light as a function of *x* across the entire device.

b) The light has a cross-sectional area of 1µm^2 (ignore diffraction). The diode is 10µm wide (along *y*) and 10 µm thick (along *z*), and is doped at 10^{16} cm^{-3} on both sides. Estimate the current through the device if i) the light is off and ii) if the light is centered on the depletion region and generates $G_L=10^{23}$ cm^{-3} s^{-1}.