ECSE-2210 Microelectronics Technology
Fall 2005
Class Activity 10

1. The equation below is called minority carrier diffusion equation for electrons.

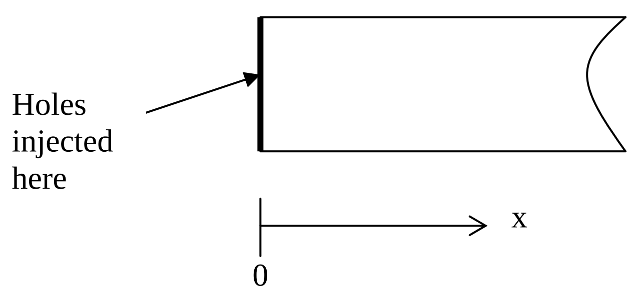
$$\frac{\partial \Delta n_P}{\partial t} = D_N \frac{\partial^2 \Delta n_P}{\partial x^2} - \frac{\Delta n_P}{\tau_n} + G_L$$

(a) Why is it called a *diffusion equation*?

(b) Why is it referred to as a *minority carrier equation*?

(c) The equation is valid only under low-level injection conditions. Why?

2. Consider an n-type Si bar doped with N_D donors with a cross sectional area A of 1 cm^2 as shown below. Let us assume that holes are injected from the left by some means such that the excess minority carrier concentration maintained at $x = 0$ is $\Delta p_{no}$with $\Delta p_{no} << N_D$. There is no other generation of carriers taking place inside the bar. Assume that the hole lifetime is τ_p and the hole diffusion length is L_p.



a. Write down the general form of the minority carrier diffusion equation. Make appropriate simplifications to get the simplified differential equation that should be solved to get the carrier profile inside the bar under steady state conditions.

b. Write down the general form of the solution to the above equation and the appropriate boundary conditions.

c. Establish the expression for the minority carrier profile inside the bar.

d. Integrate the equation in (c) to get the total number of minority carriers stored inside the bar. Hence, find the total amount of stored charge inside the bar.

e. Differentiate the equation in (c) to get the hole diffusion current at $x = 0$. (Hint: See the equation for the diffusion hole current).

f. Note that the total amount of steady state stored charge divided by the lifetimes gives the diffusion current at x = 0. Can you give an explanation to this?