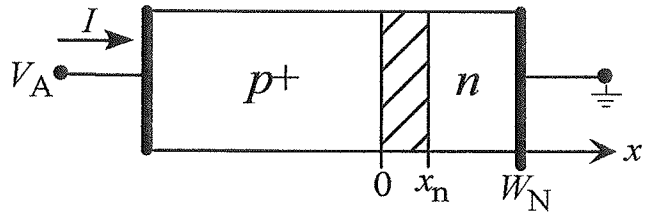
# MN-2
# August 2010 QE

The Si $p^+$-$n$ step-junction diode pictured below with a cross-sectional area $A$ and maintained at room temperature has the following special properties:
(1) $W_N << L_P$, where $W_N$ is the total width of the $n$-region and $L_P$ is the hole diffusion length is the quasineutral $n$-region.
(2) For all biases of interest, $x_n$, the $n$-side depletion width, is less than $W_N$.
(3) $\Delta p_n = 0$ at $x = W_N$.




Part A

Complete the following steps to obtain an $I$–$V_A$ expression for the diffusion current (the ideal diode current) expected from the diode.

(10%) (a) Given special property #1, write down the simplest form of the minority carrier diffusion equation that must be solved to obtain $\Delta p_n(x)$ in the quasineutral $n$-region.

(10%) (b) What is the general solution to the part (a) equation?

(10%) (c) Write down the boundary conditions that must be applied to determine the specific $\Delta p_n(x)$ solution for the problem at hand.

(30%) (d) Invoking appropriate simplifications, complete the derivation of the diffusion current (the ideal-diode current) expected from the diode.

Part B

The diode pictured above is subsequently illuminated such that $G_L$ electron-hole pairs/cm$^3$-sec are generated uniformly throughout the diode.

(15%) (a) Derive an expression for the additional current, $I_{La}$, flowing in the diode because of photogeneration in the depletion region.

(25%) (b) Derive an expression for the additional current, $I_{Lb}$, flowing in the diode because of photogeneration in the quasineutral $n$-region. NOTE: Photogeneration in the quasineutral $n$-region perturbs the minority carrier distribution in the region.

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