

ECEn 450, Winter 2009
Homework #6
Due February 17, 5:00 pm

From the text Semiconductor Devices, Physics and Technology, do the following problems:

Chapter 3, problems 14, 17, 18

Chapter 11, problems 5, 9

Also complete the following problems:

6.1 Consider a semiconductor in which $n_0 = 10^{15} \text{ cm}^{-3}$ and $n_i = 10^{10} \text{ cm}^{-3}$. Assume that the excess-carrier lifetime is 10^{-6} s . Determine the electron-hole recombination rate if the excess-hole concentration is $\Delta p = 5 \times 10^{13} \text{ cm}^{-3}$.

6.2 Light is incident on a silicon sample starting at $t=0$ and generating excess carriers uniformly throughout the silicon for $t>0$. The generation rate is $G = 5 \times 10^{21} \text{ cm}^{-3}\text{s}^{-1}$. The silicon ($T=300 \text{ K}$) is n type with $N_d = 5 \times 10^{16} \text{ cm}^{-3}$ and $N_a = 0$. Let $n_i = 1.5 \times 10^{10} \text{ cm}^{-3}$, $\tau_{n0} = 10^{-6} \text{ s}$, and $\tau_{p0} = 10^{-7} \text{ s}$. Also let $\mu_n = 1000 \text{ cm}^2/\text{V-s}$ and $\mu_p = 420 \text{ cm}^2/\text{V-s}$. Determine the conductivity of the silicon as a function of time for $t \geq 0$.

Hints and helps:

3.14 $U = \frac{p_n - p_{n0}}{\tau_p} \cong v_{th} \sigma_p N_{st} (p_s - p_{n0})$, where p_s is the hole concentration of the surface and p_n here equals to p_s . $p_s = 2 \times 10^{15} / \text{cm}^3$

6.1 Recombination rate $R = \frac{\Delta p}{\tau_{p0}}$