

ECEn 450, Winter 2009
Homework # 9
Due March 10, 5:00 pm

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

Chapter 4, problems 9, 12

Chapter 13, problems 16

Also complete the following problem:

9.1 Consider a p^+n silicon diode at $T=300\text{K}$ with doping concentrations of $N_A = 10^{18} \text{ cm}^{-3}$ and $N_D = 10^{16} \text{ cm}^{-3}$. The minority carrier hole diffusion coefficient is $D_p = 12 \text{ cm}^2/\text{s}$ and the minority carrier hole lifetime is $\tau_{p0} = 10^{-7} \text{ s}$. The cross-sectional area is $A = 10^{-4} \text{ cm}^2$. Calculate the reverse saturation current and the diode current at a forward-bias voltage of 0.50 V .

9.2 An n^+p silicon diode at $T=300\text{K}$ has the following parameters: $N_D = 10^{18} \text{ cm}^{-3}$, $N_A = 10^{16} \text{ cm}^{-3}$, $D_n = 25 \text{ cm}^2/\text{s}$, $D_p = 10 \text{ cm}^2/\text{s}$, $\tau_{n0} = \tau_{p0} = 1 \mu\text{s}$, and $A = 10^{-4} \text{ cm}^2$. Determine the diode current for (a) a forward-bias voltage of 0.5 V and (b) a reverse-bias voltage of 0.5 V .

9.3 Consider two ideal pn junctions at $T=300\text{K}$, having exactly the same electrical and physical parameters except for the bandgap energy of the semiconductor materials. The first pn junction has a bandgap energy of 0.525 eV and a forward-bias current of 10 mA with $V_A = 0.255 \text{ V}$. For the second pn junction, “design” the bandgap energy so that a forward-bias voltage of $V_A = 0.32 \text{ V}$ will produce a current of $10 \mu\text{A}$.

Homework Helps and Hints:

4.12 $D_n = 21 \text{ cm}^2/\text{s}$, $D_p = 10 \text{ cm}^2/\text{s}$