

ECSE-2210 Microelectronics Technology
Fall 2005 Homework - 6

Reading list: Chapters 7, 8 and 10(pages 301-318, 327-338, 371 - 386). Hand in your solutions in class.

1. An abrupt, one-sided p⁺-n junction has the following characteristics on the n-side.

N-side:

$$N_D = 4 \times 10^{16} \text{ cm}^{-3}$$

$$D_n = 25 \text{ cm}^2/\text{s}; D_p = 10 \text{ cm}^2/\text{s}$$

$$\tau_p = \tau_n = 10^{-7} \text{ s}$$

$$\text{Area } A = 1 \text{ cm}^2$$

Answer the following:

- a. The diode is biased in the forward direction such that the forward voltage $V_A = 0.6 \text{ V}$. Calculate the low-frequency diffusion capacitance, and the low frequency conductance of the diode. Draw the equivalent circuit of the diode at low frequency.
- b. The diode is biased in reverse such that the applied voltage $|V_A| = 20 \text{ V}$. Calculate the reverse bias capacitance (Hint: you can neglect V_{bi}). Draw the equivalent circuit, assuming an ideal diode. Explain briefly how the circuit will change if we start considering the non-ideal behavior of the diode.
2. Problem 7.4 in text. The IN4002 is one of the popular 4000-series general-purpose diodes. C-V data from an IN4002 p⁺-n junction diode is listed in Table below. Before analyzing the data, subtract 3 pF from each capacitance value to account for the stray capacitance shunting the encapsulated diode. Assume area of the diode is $6 \times 10^{-3} \text{ cm}^2$. Make a $1/C^2$ -versus- V plot (as described in text) to determine the doping concentration in the lightly doped side. Also, determine the built-in voltage, V_{bi} from the graph.

<u>V_A (V)</u>	<u>C (pF)</u>	<u>V_A (V)</u>	<u>C (pF)</u>	<u>V_A (V)</u>	<u>C (pF)</u>
0.0	38.709	-2.2	20.254	-9.0	12.639
-0.2	33.717	-2.6	19.248	-10.0	12.163
-0.4	30.567	-3.0	18.405	-11.0	11.746
-0.6	28.319	-4.0	16.762	-12.0	11.373
-0.8	26.598	-5.0	15.548	-13.0	11.037
-1.0	25.170	-6.0	14.599	-14.0	10.734
-1.4	23.060	-7.0	13.834	-15.0	10.458
-1.8	21.490	-8.0	13.189		