PROBLEM SET #4

Issued: Friday, September 14, 2018
Due: Friday, September 21, 2018, 12:00 noon via Gradescope.

1. Sedra & Smith, Problem 2.116
2. Sedra & Smith, Problem 2.118
3. Sedra & Smith, Problem 2.122
4. A diode is doped with $N_A = 10^{19}/cm^3$ on the p-type side and $N_D = 10^{18}/cm^3$ on the n-type side.
   (a) What is the depletion-layer width $w_d$?
   (b) What are the values of $x_p$ and $x_n$?
   (c) What is the value of the built-in potential of the junction?
   (d) What is the value of $E_{MAX}$?
5. A diode has $I_S = 10^{-17}A$ and $n = 1$.
   (a) What is the diode voltage if the diode current is $100\mu A$?
   (b) What is the diode voltage if the diode current is $10\mu A$?
   (c) What is the diode current for $v_D = 0$?
   (d) What is the diode current for $v_D = -0.06V$?
   (e) What is the diode current for $v_D = -4V$?
6. What is the zero-bias junction capacitance per $cm^2$ for a diode with $N_A = 10^{15}/cm^3$ on the p-type side and $N_D = 10^{20}/cm^3$ on the n-type side? What is the diode capacitance with a $5V$ reverse bias if the diode area is $0.01cm^2$?
7. Calculate the worst-case output voltage for the circuit in Figure PS4.1 if $V_{os} = 1mV$, $I_{B+} = 100nA$, and $I_{B-} = 95nA$. What would the ideal output voltage be? What is the total error in this circuit? Is there a better choice for the value of $R_1$? If so, what is the value?
8. The op amp in the circuit of Figure PS4.2 has an open-loop gain of 10,000, an offset voltage of $1mV$, and an input-bias current of $100nA$.
   (a) What would be the output voltage for an ideal op amp?
   (b) What is the actual output voltage for the worst-case polarity of offset voltage?
   (c) What is the percentage error in the output voltage compared to the ideal output voltage?
$$R_2 = 100M\Omega$$

$$R_1 = 100k\Omega$$

$$R_3 = 100k\Omega$$

$$v_o$$

$$1k\Omega$$

$$100k\Omega$$

$$1.1k\Omega$$

Figure PS4.1

Figure PS4.2