Homework Problems
Diodes

Oct. 2, 2008

1. Here are two data points from the current versus voltage function of a diode.
   V_{D1} = 0.55 Volts, I_{D1} = 120 uA
   V_{D2} = 0.63 Volts, I_{D2} = 900 uA

   Determine n and Is for the diode if the data was taken at 20 degrees C.

2. A diode is characterized at 30 degrees C with n = 1.78 and Is = 2.7 nA. Find the voltage across the diode and the diode current if it is in a series circuit (forward bias) with a 2 Volt source and a 4000 Ohm resistor.

3. A diode is characterized at 25 degrees C with n = 1.71 and Is = 4.2 nA. Find the current through the diode and the power dissipated for the following applied voltages: 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0. By what factor does the current increase for each 0.1 Volt increase in the applied voltage?

   This problem is a bit simplistic since it assumes that the operating temperature of the diode remains constant as the current is increased. Obviously, it will not! Also, Is is not constant either but is a function of temperature. Typically, Is doubles for each 6 degree C rise in temperature. A more interesting problem but beyond the scope of EE351 is to incorporate the temperature rise of the diode into the answer.

4. A diode is characterized at 25 degrees C with n = 1.85 and Is = 3.5 nA. Find the forward voltage drop across the diode for the following currents: 1 uA, 10 uA, 100 uA, and 1 mA. How much does the voltage change for each factor of ten change in current?

5. A diode is characterized at 18 degrees C with n = 1.8 and Is = 3.3 nA. Find the dynamic resistance at the following currents: 1 uA, 10 uA, 100 uA, and 1 mA.

6. For problem 5, for each nominal current, determine the maximum peak-peak sine wave voltage that can be superimposed across the diode such that at the positive peak (maximum current) the dynamic resistance is 1% less than nominal and at the negative peak (minimum current) the dynamic resistance is 1% more than nominal. Use the smaller magnitude of the two peaks. Expect the answers to be in the low millivolt range.

The answers are on the next page.

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1. Note that V_T is 25.1 mV. n = 1.58, Is = 116 pA

2. Using Newton's method, VD = 0.575264 Volt, I = (2 - .575) / 4000 = 356 uA
   This problem converges very fast (about 3 iterations) using the method in the notes.

3.

25	C		
4.20E-09	Is		
1.78	n	0.045494543	nVT
V	**I**	**P**	
0.2	336.6E-9	67.3E-9	
0.3	3.1E-6	919.6E-9	
0.4	27.6E-6	11.1E-6	
0.5	249.0E-6	124.5E-6	
0.6	2.2E-3	1.3E-3	
0.7	20.2E-3	14.1E-3	
0.8	182.0E-3	145.6E-3	
0.9	1.6E+0	1.5E+0	
1	14.8E+0	14.8E+0	

   Factor = 9.11. Note that this factor is essentially constant over the range.

4. Note that nV_T = 47.3 mV

I	V
1 uA	267 mV
10 uA	376 mV
100 uA	485 mV
1 mA	594 mV

   Change in voltage with a factor of 10 current increase is 109 mV -- and constant.

5. Note that nV_T = 44.9 mV

I	rd
1 uA	44.9K
10 uA	4.49K
100 uA	449 Ohms
1 mA	44.9 Ohms

6. This is an interesting problem about small signal linearity.
   As stated the problem is more difficult than it should be.
   Forget the smaller magnitude of the two peaks. Rather, subtract the voltage for the current 1% below nominal from the voltage for the current 1% above nominal. This is the peak to peak voltage.

   1 uA: V@ 1.01 uA = .2254, V@ .99 mA = .2246, Vpp = 0.791 mV
   Answers for 10, 100, and 1000 uA all round to 0.788 mV
   Note that the voltage is essentially independent of current.