EC201-ANALOG CIRCUITS : PROBLEM SET 1

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Problem 1

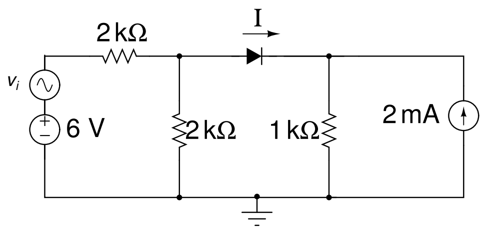

Figure 1: Circuit for Problem 1

For the circuit of Figure 1, assume that v_i is an incremental voltage source. Determine the operating point of the network. The diode is ideal - that is, the voltage drop across the diode is zero when forward biased. Determine the small signal voltage across the 1 kΩ resistor.

Now rework the problem assuming a real diode. To compute the operating point, assume that the nominal voltage drop across the diode is 0.65 V.

Problem 2

In this problem, we delve deeper into the notion of "small signal". Consider two nonlinear amplifiers, with input-output characteristics given by $V_{out} = \frac{V_{in}^2}{V_A}$ and $V_{out} = V_A \exp(\frac{V_{in}}{V_A})$.

- An incremental gain of 10 is desired of both amplifers. Determine the operating points so that this gain may be achieved.
- We saw in class that the "small signal" approximation is valid only when the higher order terms in the Taylor series can be safely neglected in relation to the linear term. Compare the second order derivative of the two amplifers around the operating point. What can you say about the relative magnitudes of the incremental inputs for each of the amplifiers which qualify as small signals ? Which amplifier is more "linear" ?

Problem 3

The circuits of Figs. 2 and 3 are identical as far as the 2 ports are concerned. Determine y_1, y_2, y_3 and g_m in terms of y_{ie}, y_{re}, y_{fe}, y_{oe}.

Problem 4

Determine the composite y-parameters of the block within the box.

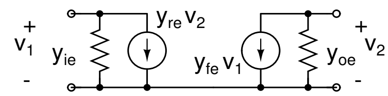

Figure 2: Problem 3

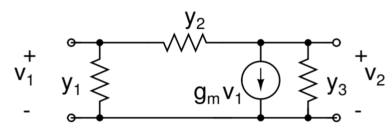

Figure 3: Problem 3

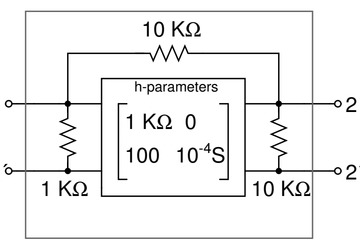

Figure 4: Circuit for Problem 4.

Problem 5

The operational amplifier shown in Figure 5 is ideal. Determine the signs on the input terminals of the opamp for negative feedback operation. Assuming negative feedback operation, find $\frac{v_{out}}{v_{in}}$.

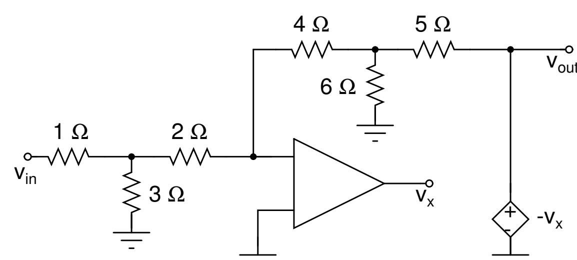

Figure 5: Circuit for Problem 5

Problem 6

The nominal voltage across a forward biased diode can be assumed to be 0.7 V in the circuit of Fig. 6. v_s is a small signal. Determine the quiescent voltages and currents in the circuit. What is the small signal voltage at the node marked X ? What happens when the positions of the ±8.7 V batteries are interchanged ?

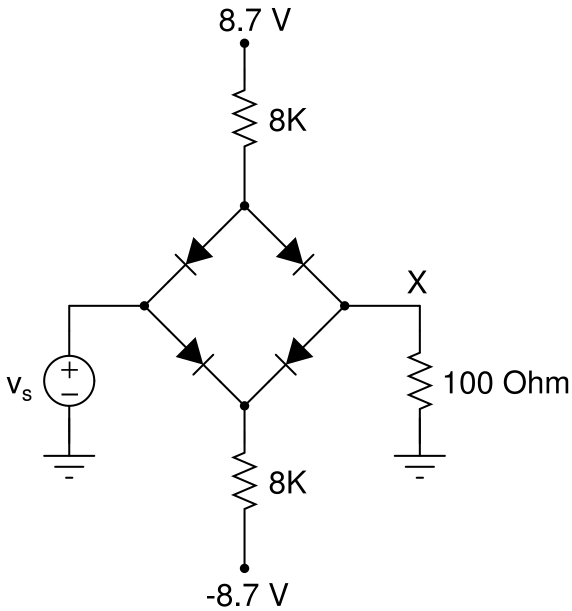

Figure 6: Circuit for Problem 6.

Problem 7

The nominal voltage across a forward biased diode can be assumed to be 0.7 V in the circuit of Fig. 7. v_s is a small signal. Determine the quiescent voltages and currents in the circuit. What is the small signal voltage at the node marked X ?

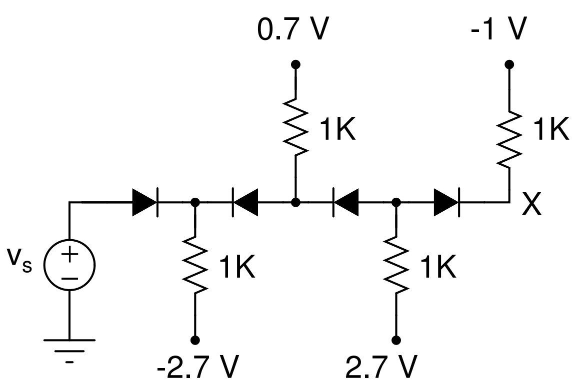

Figure 7: Circuit for Problem 7.