ELEC301 - Problem set 1

1. Find the Thevenin equivalent of the circuit shown in figure 1. Let the 2 kΩ resistor be the load (i.e., do not include it in the Thevenin equivalent circuit).

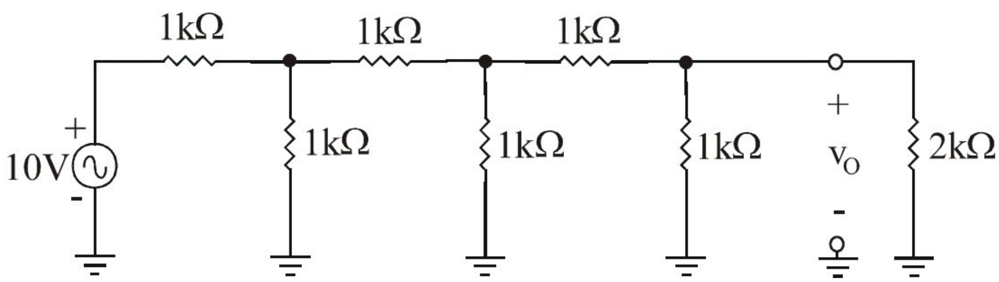

Figure 1.

2. Find both the Thevenin and Norton Equivalents of circuit shown in figure 2. Let the 1 kΩ resistor be the load.

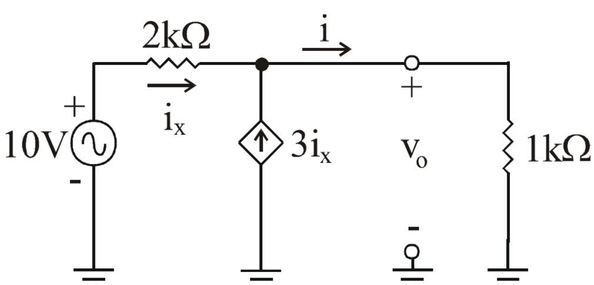

Figure 2.

3. A voltage source provides and open circuit voltage of 10 V and a short circuit current of 1 mA, what is the internal resistance of the source? (answer: 10 kW).

4. A voltage source produces 1 V when loaded by a 100 kΩ resistor and 0.5 V when loaded by a 10 kΩ resistor. Calculate the Thevenin voltage, the Norton current, and the internal resistance. (answers: V_T = 1.125V, I_N = 0.09 mA, and R_S = 12.5 kΩ).

5. Use Miller's theorem to find the transfer function for the circuit shown in figure 3

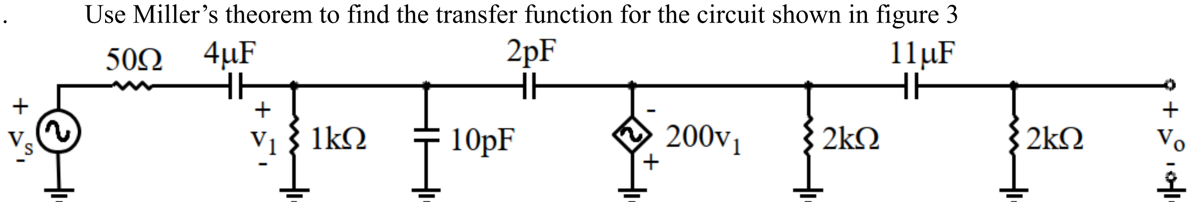

Figure 3

6. For the circuit shown in Figure 4, use Thevenin and Miller's theorems at high frequencies to transform the 1 pF capacitor to two equivalent capacitances correctly located at the input and output stages.

   a) Draw the transformed input and output stages.

b) Find the mid band gain, A_M , in decibels and the phase at mid band, ϕ_M, in radians for the new, transformed circuit.

c) Find the location of each pole and each zero for the new, transformed circuit.

d) Find the transfer function for the circuit shown in figure 4 and estimate ω_{L3dB} and $\omega_{H\,3dB}$

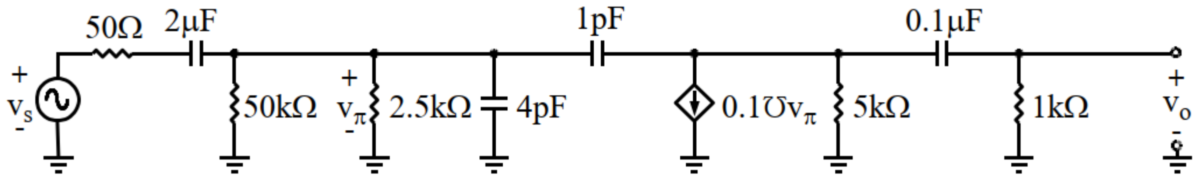

Figure 4

7. For the circuit shown in figure 5 do the following:

a. Derive the transfer function exactly.

b. Derive the transfer function using the method of open-circuit and short-circuit time constants.

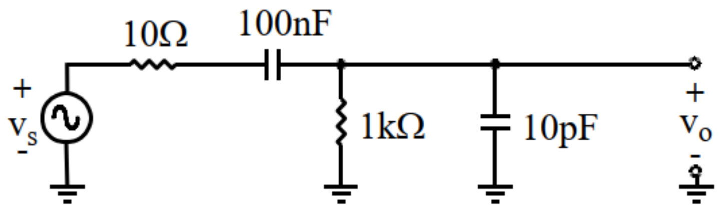

Figure 5

8. For the circuit shown in figure 6, use the 1/3rd rule with $V_B = V_{CC}/3$ to find R_{B1}, R_{B2}, R_C, and R_E given that V_{CC}= 15V and I_C= 2mA.

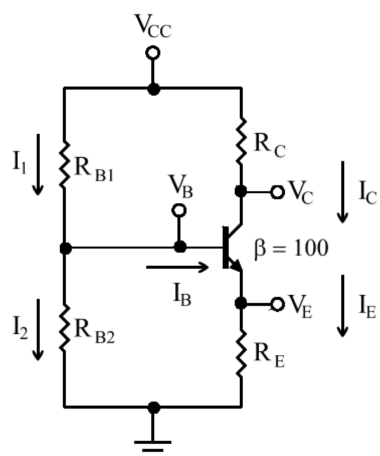

Figure 6

9 For the circuit shown in figure 1, use the 1/3rd rule with $V_E = V_{CC}/3$ to find R_{B1}, R_{B2} , R_C, and I_C, given that R_E= 8kΩ and V_{CC} = 12V. (Answers: $RB1 \approx 146\,k\Omega$, $RB2 \approx 104\,k\Omega$, $RC \approx 8\,k\Omega$, and $IC \approx 0.5$ mA)

10. What are g_m and r_π for the transistors in P8 and P9 above?

(Answers: P1 $g = 80\,m\Omega^{-1}$ and $r_\pi = 1.25\,k\Omega$;

for P2: $g = 20\,m\Omega^{-1}$ and $r_\pi = 5\,k\Omega$)

11. Assuming that a small-signal a.c. voltage source with a 50Ω source impedance is coupled to the amplifier

of P9 above via a 10μF coupling capacitor and that R_E is by-passed using a 50μF capacitor, and that the hybrid-π model has the following parameters: C_π=10pF, C_μ=2pF and $r_o=\infty$, what are A_M, ω_{3dbL}, and ω_{3dBH}?
(Anserws: AM≈−158, ω_{3dbL}≈400rad/s, and ω_{3dBH}≈44Mrad/s)