ELEC 301 Problem Set #2

1) Use Miller's theorem to find the transfer function for the circuit shown in figure 1.

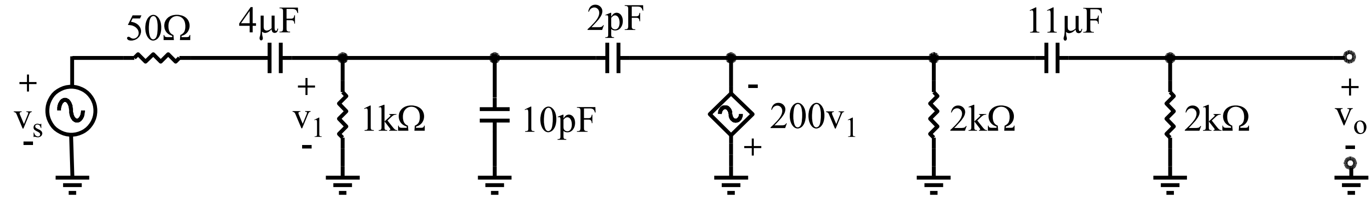

Figure 1.

2) For the circuit shown in figure 2, 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 ω_{H3dB}.

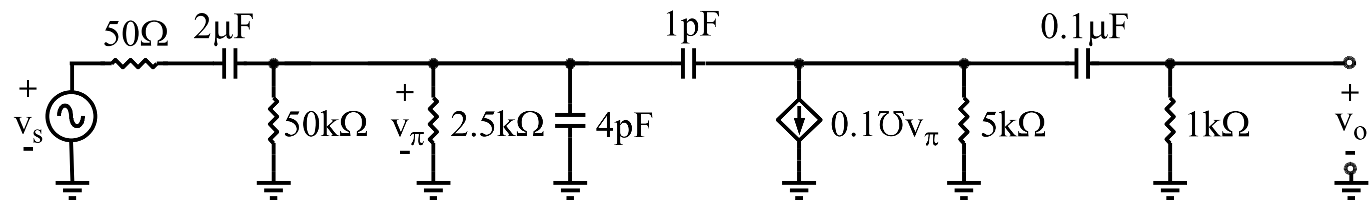

Figure 2.

3) The low frequency response of an amplifier has $\omega_{z1_L}=100/s$, $\omega_{z2_L}=0/s$, $\omega_{p1_L}=200/s$ and $\omega_{p2_L}=50/s$. Estimate ω_{L3dB}.

(Answer: $\omega_{L3dB}\approx 150/s$)

4) For the circuit shown in figure 3 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.

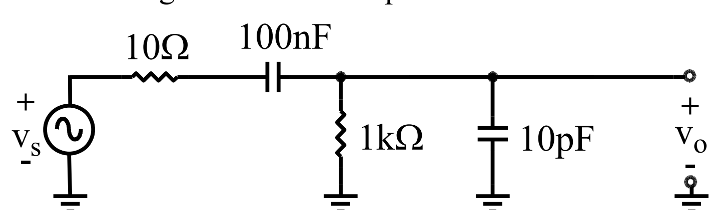

Figure 3.

5) Using the method of open circuit and short circuit time constants, estimate $\omega_{L3\text{dB}}$ and $\omega_{H3\text{dB}}$ for the circuit shown in figure 4.
(Answers: $\omega_{L3\text{dB}} \approx 1400/\text{s}$; $\omega_{H3\text{dB}} \approx 90\times10^6/\text{s}$)

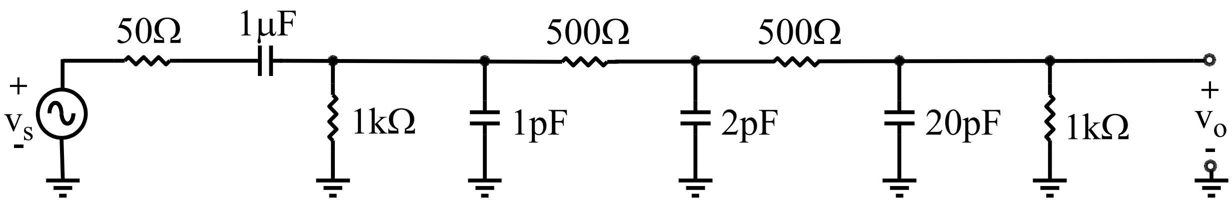

Figure 4.

6) a) Show that in the transfer function $\dfrac{V_o(s)}{V_i(s)} = \dfrac{\dfrac{s}{R_1C_2}}{s^2 + \left[\dfrac{1}{R_2C_2} + \dfrac{1}{R_1C_2} + \dfrac{1}{R_1C_1}\right]s + \dfrac{1}{R_1R_2C_1C_2}}$, as derived for the band pass filter in handout 6, the sum of the poles is the sum of the inverse short circuit time constants.

b) Show that the transfer function above can be rearranged to give
$\dfrac{V_o(s)}{V_i(s)} = \dfrac{R_2C_1s}{1 + [R_1C_1 + R_2C_1 + R_2C_2]s + R_1R_2C_1C_2s^2}$ and show that the sum of the open circuit time constants is the sum of the inverse poles.

7) Redo problem 5 by estimating the locations of the all of the poles and all of the zeros.

8) $\dfrac{V_o(s)}{V_s(s)} = 0.25 \times \dfrac{s}{s+10} \times \dfrac{s}{s+100} \times \dfrac{s}{s+1000}$ is the transfer function for the circuit shown in figure 5.
Use the method of open-circuit/short-circuit time constants as taught in class, and the constraint that $C_1 > C_2 > C_3$, to estimate values for each of the capacitors.
(Answers: $C_1 \approx 50\,\mu\text{F}$; $C_2 \approx 6.7\,\mu\text{F}$; $C_3 \approx 0.75\,\mu\text{F}$)

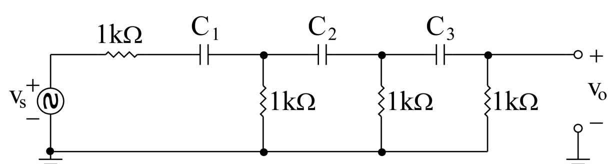

Figure 5.