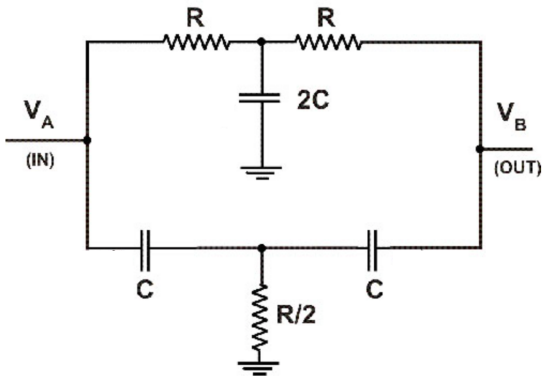
ELE 215 – Lab 7 – Notch Filter

Objectives

- More practice on generating a Bode plot, this time with a notch filter.

Notes

- The "twin T" notch filter is shown here:



A notch filter is a circuit that removes (or zeroes out) one particular frequency from the input signal (the "notch" frequency) while passing all of the others. As the analysis is a bit tricky, I will tell you that the transfer function for the above circuit is

$$H(f) = \frac{V_B}{V_A} = \frac{1 - (2\pi fRC)^2}{(1 + j2\pi fRC)^2}$$

Procedure

1. Prelab completion:

   Show your theoretical Bode plot to the TA (each team should have just one plot).

2. Setup:

   a) Collect 6 each of the resistor and capacitor values assigned to your team from the bins; measure the R and C values, keeping those 4 of each device closet in value (it turns out that this circuit is more sensitive to component mismatch than prior circuits and we want to minimize that). For the circuit itself, you are to make the "2C" capacitor from two capacitors of size C in parallel and the "R/2" resistor from two R resistors in parallel.

   b) Measure the 3 resistance (R, R, and R/2) and 3 capacitances (C, C, and 2C), recording their values on the summary sheet on the blank lines, and build the circuit. Connect the signal generator to provide a 4-volt (8 V peak-to-peak) sinusoid for the input; connect the scope to observe $v_{in}(t)$ on channel 1 and $v_{out}(t)$ on channel 2; configure the scope's

measurement menu to show the frequency of channel 1, the two amplitudes, and the phase shift from channel 1 to channel 2 (CH2-CH1).

3. Take data:

   Just like in lab last week, but now looking for the minimum rather than the maximum magnitude response:

   a) Experimentally find the notch frequency, f_n, the point at which the ratio of the output to input amplitudes is a minimum, hopefully close to your prelab value. Record the frequency as well as the two amplitudes and phase difference on your summary sheet. In your theoretical analysis this minimum was zero; with real and slightly mismatched components you should get something small but non-zero.

   b) Experimentally locate the two -3 dB frequencies (in general when the amplitude ratio is 0.707 of the very low or very high frequency values (which should be 1), one below f_n and one above f_n. Record the amplitudes and phase data on your summary sheet. Repeat for the two -20 dB frequencies (amplitude ratio 0.1). All of these should be close to your prelab values.

   c) Finally, fill in a few more data points for a comparison of theory to practice. Pick two frequencies between the -20 dB and -3 dB pairs below and above the notch and another pair between the two -3 dB points and f_n.

4. Reporting:

   a) You now have 9 pairs of magnitude and phase values; it's time to generate a nice Bode plot. Specific ally, modify your prelab script to do the following:
      - Regenerate the Bode plot from your prelab exercise, using the average of your R and the average of your C values for R and C, respectively; this should appear as a solid line.
      - Add your measured data using clearly visible symbols (NO connecting line).

      Due to the mismatch of the R and C values this might only be close. Exercise 4 will explore this in more detail. To be able to do this exercise, keep a copy of your individual R and C values as shown in your figure from the first section of the summary sheet and your experimental data.

   b) Regarding teamwork, last week I asked you what you did well as a team. This week, tell me one thing that you could have done better as a team. And I want something concrete, not just "we should have met to finish the work".