ENG 100 Lab #3
Passive Second-order Filter Circuits
Band-Pass Filter

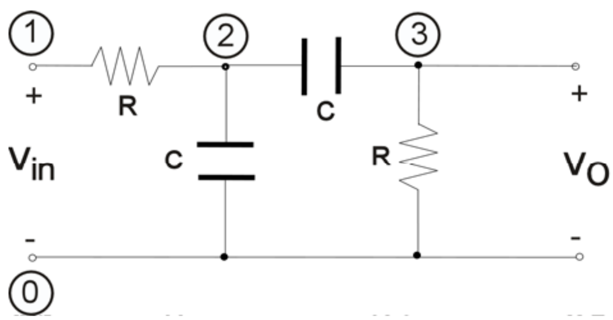
A band-pass filter is defined as one which allows signals to pass through, relatively unattenuated in magnitude, only within a range of frequencies from ω_1 to ω_2. Signals greater than ω_2 or less than ω_1 are attenuated in magnitude, hence the idea that the circuit is a "filter". The bandwidth of the band-pass filter is defined as $\omega_2 - \omega_1$. The frequencies ω_1 and ω_2 correspond to the frequencies where the transfer function amplitude is 0.707 times the peak value of the transfer function amplitude. The general form of the transfer function for a second-order band-pass filter can be written as:

$$H(s) = \frac{V_O(s)}{V_I(s)} = \frac{Ks}{s^2 + \left(\frac{\omega_o}{Q}\right)s + \omega_o^2}$$

where Q is the "quality factor" of the circuit and K is a constant.

<u>Lab Work:</u>

The circuit shown below is a passive RC band-pass filter, consisting of a low-pass section in series with a high-pass section. It is the same circuit as in the Prelab.



You will measure the amplitude and phase response of this filter.

Procedure:

1. Using your prototype board, construct the RC bandpass circuit. Use R = 1500 Ω and C = 0.01 μF.

2. Drive the input of your circuit with the function generator, and also connect the input to channel 1 on the oscilloscope (this will be your reference).

3. Set the function generator to generate a sinusoid and display it on channel 1 of the oscilloscope. Adjust the frequency to 1 kHz, and the amplitude to 1 Vpp.

4. To measure the output amplitude, connect the output voltage of the circuit to channel 2 of the oscilloscope.

5. To measure phase, adjust the oscilloscope to display both channel 1 and channel 2 simultaneously

6. To measure phase, measure the time delay between the input signal and output signal. From the time delay, you can calculate: Phase = $-360^o t_d/T$, where T is the period of the sinusoid and t_d is the time delay. The time delay t_d can be measured as the time from a positively-sloped zero crossing of the input to the nearest positive-sloped zero crossing of the output. (Note: t_d can be positive or negative).

7. Repeat above procedure for all the frequencies in the table in the Prelab. Fill in the table with your measured data. <u>Try to keep the input amplitude roughly at 1 Vpp for all input frequencies.</u> Measure the input amplitude at each frequency, as it may not be exactly 1 Vpp always.

8. Plot your measured magnitude (or amplitude) response |H| (in dB) and phase response (in degrees) versus frequency (in Hz on a log scale). (This can be done after the lab period ends). Put each measured plot on the same graph as the corresponding calculated plot.

9. To see a time-domain response, adjust the function generator to generate a square wave with a frequency of 2 kHz with peak value of 1V. Display the square-wave input and the output of your circuit using the scope. Draw a plot of the input and output waveforms for one period.