LCR CIRCUITS

Equipment:

Oscilloscope, signal generator, 3 BNC to alligator wire connectors, inductor, capacitor, resistor, bread boards, LCR multimeter (C = 1 microfarad, R = 100 ohm, L found for coil from LCR multimeter.)

Background:

Inductors, capacitors and resistors can be used to make filters which determine the range of frequencies which pass through a circuit. More sophisticated examples of the circuits provided here are used to select a radio signal from among all the radio waves impinging on the antenna of a radio.

The object of this lab is to measure the transmission voltage amplitude for a large range of frequencies using a constant input voltage amplitude. This should give you the resonance frequencies and the cut-off frequencies which you can compare with theory values given in circuits table 1.

Set-Up

1) Signal Generator: Plug the output BNC to the 50 ohm output port. Set the internal impedance to 50 ohms, set for sine wave generation, 1000 hertz initially, near minimum amplitude initially.
2) Oscilloscope: plug the 2 other BNC cables into the 2 channel input ports. Set the mode to both, norm and chop. Set channel 1 to 5 volts/div and set channel 2 to .1 volts/div. Set both channels to DC input. Set the time dial to 2 millisecond/div. Set to trigger from channel 1 and set triggering to P-P auto mode. Attach: The signal generator to the input of the circuit, the channel one to the input of the circuit and channel 2 to the output from the circuit. Adjust the intensity, focus, then the volts/div and time/ div dials until you can easily discern the amplitudes of the 2 signals. Make sure the grounding of all 3 BNC cables is common (the black wires).

Procedure:

For each of the circuits drawn below, you are given the input and output connection positions, the resonance frequency equation (or cut off equation for the low and high pass filters) and width of resonance. It is recommended that you calculate these frequencies for each of the circuits before starting. This helps you to choose the range of frequencies to check in order to make a plot. Use the LCR meter in the front of the room to get these values. It is recommended that you check 5 frequencies below the resonant frequency, frequencies near the resonant frequency and 5 frequencies far above the resonant frequency. Think Logarithmically when you choose the frequencies to check. In other words small changes in frequency for smaller frequencies and larger changes in frequency for large frequencies.

Do the following steps to get a data point of peak to trough voltage vs. frequency.

Step 1) Change the frequency on the signal generator.

Step 2) Adjust the seconds/division dial on the oscilloscope so that you can easily see the peak to trough voltage. (Having about 5 to 10 wave lengths across the screen helps to identify the peaks and troughs more easily.)

Step 3) **Reset the peak to trough voltage on the input signal** back to the same original value by using the amplitude dial on the signal generator. (The input voltage will be a function of the frequency so you must adjust the input voltage in order to keep it constant over the range you are measuring the output voltage.)

Step 4) Adjust the volts/div for the output voltage signal on the oscilloscope so that you can see the peak to trough voltage more clearly. (Make sure you **do not** adjust the volts/div for the input signal because you are trying to keep that constant!)

Step 5) Write down the new output peak to trough voltage and frequency.

Make a plot of Peak to trough output voltage Vs ln(frequency) for each circuit. Identify the cut off frequencies, resonance frequencies and the band widths on each of the graphs, where applicable.

Questions:

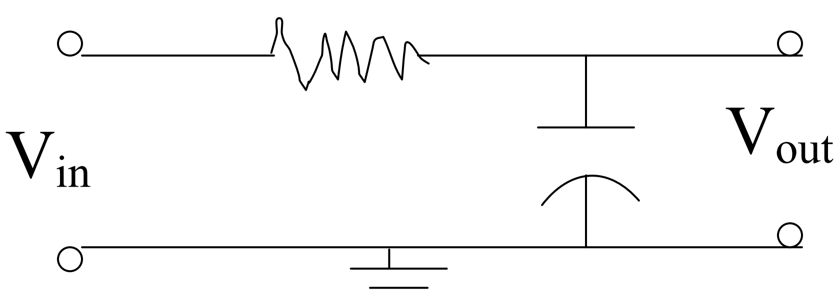
1) Did the resonant frequencies and cut off frequencies occur where they were predicted.
2) Was the width of the resonance as wide as predicted by theory? Could it be that the internal impedance of the signal generator needs to be included in the calculation of the resonance width. Does including this resistance improve comparison of theoretical width with experimental width of resonance?

Circuits: Table 1

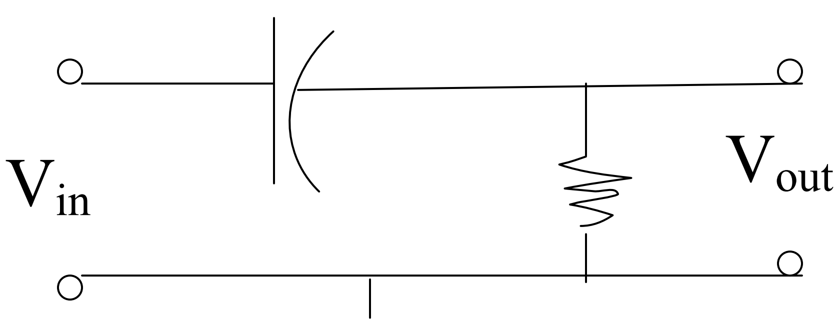
Filter type	**resonance/cutoff**	**Width**
Low-pass	$V = .707\ V_{DC}$ when $f = 1/(2\pi RC)$	
High-pass	$V = .707\ V_{large\ f}$ when $f = 1/(2\pi RC)$	
Band-Pass	$f_R = 1 / [2\pi\ Sqrt(LC)]$	$\Delta f = R / (2\pi L) = 2\pi\ f/Q$ When $V = .707\ V_{Resonant}$
Band Stop	$f_R = 1 / [2\pi\ Sqrt(LC)]$	$\Delta f = R / (2\pi L) = 2\pi\ f/Q$ When $V = .707\ V_{DC}$

Circuit Diagrams

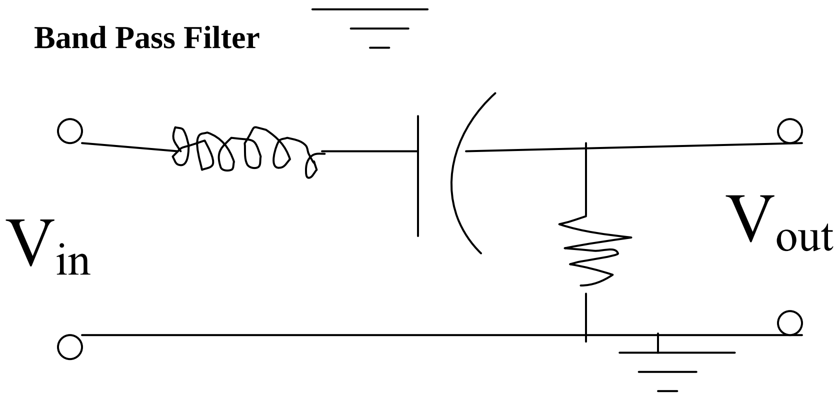
Low Pass Filter



High Pass Filter



Band Pass Filter



Band Stop Filter