Frequency Response Graphs for RL and RC Circuit

Whereas a resistor has a resistive nature that is fixed in all cases no matter what the power source is doing, inductors and capacitors in an AC setting have a resistive nature that is dependent upon the *frequency* of the AC source. That means the amount of current you will see in, say, an RL circuit (a circuit in which there is a resistor and inductor) will depend upon how much *resistance to charge flow* the resistor is presenting AND the amount of *resistance to charge flow* the inductor is presenting *at the frequency being impressed upon the system by the function generator*.

A "frequency-response graph" is a visual representation of how a circuit's current varies as the frequency of the power supply proceeds from low frequency to high. This lab is designed to allow you to determine the frequency response of both an RL and RC circuit.

As this will be a distant learning exercise, you will be expected to watch two videos, "The Frequency Response of an RL Circuit "and "The Frequency Response of an RC Circuit." In each video, you will be asked to take data as is appropriate. Although the video will explain everything, the protocol for the lab set-up follows (you won't need to use the protocol in Part A as that has already been done for you, so you can skip down to Part B if you wish):

Procedure:

Part A (general set-up):

a.) Make a two-column Table with *frequency* in one column and *resistor's peak-to-peak voltage* in the other.

b.) Use the Impedance Bridge to determine the value of the *capacitor* and *resistor* in the circuit. Put the information with your Table.

c.) The general wiring pattern is shown to the right.

d.) In all cases, the oscilloscope's *sweep time* should be set at 2 ms/cm and its vertical scaling at .5 volts/cm (that is, each jump between two hashmarks is worth .1 volts).

e.) The leads out of Channel A of the oscilloscope should be hooked across the output of the Function Generator. This will be kept at 2 volts peak-to-peak throughout the lab. The leads out of Channel B should be hooked across the resistor (this is the channel that will give us insight into what the current is doing).

BIG NOTE: Why will the voltage across Channel B will give us insight into the current? Because the voltage across a resistor, which is what Channel B will give us, is proportional to the current through the resistor . . . which in this case is the current in the circuit. Big output voltage means small net *resistance to charge flow* in the circuit, and big current.

Part B (RL circuit):

f.) You will not need these values for calculations in the write-up, but for reference sake, the ballpark values for the inductor circuit will be R = 100 ohms and L = 12 mH (where the inductor being used is a freestanding, wire wrapped, variable coil).

g.) Set the output signal (as viewed on Channel A) to 2 volts peak-to-peak and tune the frequency to 200 Hz. Measure the p-to-p voltage across the resistor from Channel A. Record this data.

h.) Follow *Procedure g* for frequencies of 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz and 8000 Hz, placing all your data on your Table. (Note that all of this will be done for you on the video.)

Part C (RC circuit):

i.) Make a two-column table (frequency/output-voltage) for your data.

j.) You won't need these values for calculations in the write-up, but for reference sake, the ballpark values for the capacitor circuit will be R = 10 ohms and C = 100 microfarads.

k.) Again with the Channel A input set at 2 volts peak-to-peak, set the frequency of the source to 25 Hz. Measure the output voltage and record.

l.) Follow *Procedure k* for frequencies of 50 Hz, 75 Hz, 100 Hz, 200 Hz, 300 Hz, 500 Hz and 1000 Hz, placing all your data in a Table.

Calculations:

In theory, we should be working with RMS values. It isn't crucial, though, for the spirit of this lab, so we will be working with peak-to-peak values here. :)

Being sure to include a blurb with your respond to each section:

FOR THE RL CIRCUIT:

1. Make a screen shot of the "frequency response graph for an RL circuit" present in the video you watched. On that picture, identify where the inductor's resistance to charge flow is great and where is it not (be careful with this—think about what the current should be doing when the resistance is great).

2. On the video you watched, you were shown the data-taking process, then shown the end-result graph for the frequency response of an RL circuit. We need to draw some conclusion from that graph. Specifically:

i.) From what you are seeing on the graph, what can you say about the resistive nature of inductors in AC circuits? That is, in what general frequency range (high, low, what?) do inductors have low resistance to charge flow and, as a consequence, allow current to "pass," and in what range is their resistance high and, as a consequence, do they pretty much wipe out a signal?

ii.) Given your answer to #2i, consider the following scenario: You have a stereo radio that has two speakers, a woofer designed to deal with low frequency signals and a tweeter designed to deal with high frequency signals. The signal from your system has both high and low frequencies associated with it. Upon leaving the radio, that signal is split so that half the power goes to the woofer and half to the tweeter. You don't really want high frequency messing up the action of the woofer (the speaker that is supposed to be putting out low frequency sound), so what might you do to eliminate the high frequency in the signal coming to the woofer? Explain your thinking . . .

FOR THE RC CIRCUIT:

3. You have data from the video for the frequency response graph for an RC circuit. You can either use an Excel spreadsheet (or whatever you use to create graphs) to have a computer make a frequency response graph for the situation, or you can hand draw it. Somehow, though, create that graph.
4. From what you are seeing on the graph, what can you say about the resistive nature of capacitors in AC circuits. That is, in what general frequency range (high, low, what?) do capacitors have low resistance to charge flow and, as a consequence, allow current to "pass," and in what range is their resistance high and, as a consequence, do they pretty much wipe out a signal?
5. Given your answer to #4, consider the following scenario: You have a stereo radio that has two speakers, a woofer designed to deal with low frequency signals and a tweeter designed to deal with high frequency signals. The signal from your system has both high and low frequencies associated with it. Upon leaving the radio, that signal is split so that half the power goes to the woofer and half to the tweeter. You don't really want low frequency messing up the action of the tweeter (the speaker that is supposed to be putting out high frequency sound), so what might you do to eliminate the low frequency in the signal coming to the tweeter? Explain your thinking.