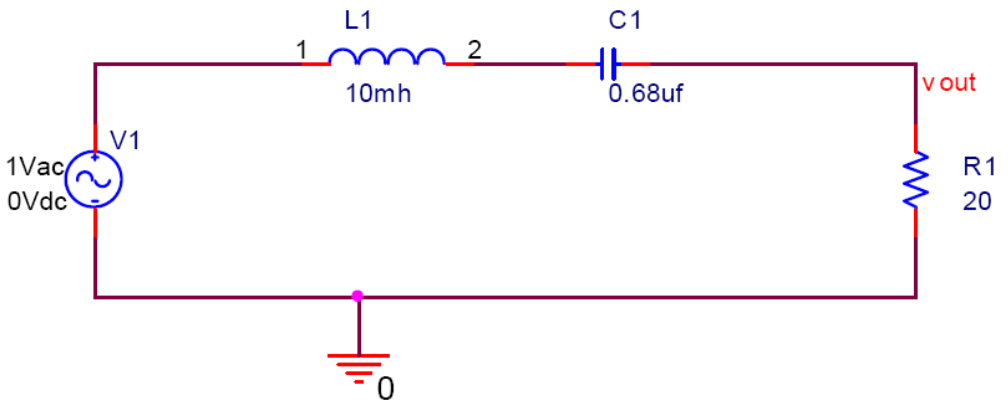
Laboratory 6: RLC Bandpass Filters

Circuits consisting of DC sources and resistors can accomplish important tasks, but many interesting applications make use of capacitors, inductors, time-varying (especially sinusoidal) sources, and a few other components. Using these devices, an engineer can build signal sources, amplifiers with tailor-made frequency responses, filters, and other useful circuits. The key to making these kinds of circuits operate properly is a good understanding of the frequency-dependent behavior of capacitors and inductors. In this lab you will explore some properties of a series combination of a resistor, a capacitor, and an inductor.



Prelab Assignment: (Due from each student at start of lab session for one-third of grade)

Perform an AC analysis of the circuit shown above using PSpice and plot the dB gain at *vout* over two frequency decades, from 100 Hz to 10,000 Hz. Also perform a transient analysis at 900 Hz, 1,930 Hz, and 3,500 Hz. Observe the input voltage and output voltage waveforms and note the amplitudes and phase shifts for each frequency.

Lab Activities:

1. Build the circuit and measure the gain of the circuit at about 20 different sinusoidal frequencies from 100 Hz to 10,000 Hz. Use the function generator and the oscilloscope, and be sure to measure the amplitudes of the input and output signals at each frequency. (Why would the input amplitude change with frequency? What is the Thevenin equivalent of the function generator source?)
   Plot the gain in dB = 20 $\log_{10}$ (vout/vin) versus frequency.
2. We will learn in class that the maximum gain of this circuit should occur at 1/sqrt(L C)/(2π) Hz. How do your PSpice simulation and measured results agree with this value? This is also called the "resonant" frequency of the circuit.
3. The inductor is a coil of wire, so it has a resistance. Measure the DC resistance of the inductor and include it as a series resistor in your PSpice simulation. How does including the resistance of the inductor change the plot of dB gain versus frequency?
4. Add op amp circuits to apply a gain and buffer the input and output of the RLC circuit.
5. Use the Matlab program `freqout.m` to play tones with different frequencies through the PC soundcard and listen to them on a speaker.
6. Change the inductor to larger (100 mH) and smaller (1 or 2 mH) values. How does this affect the resonant frequency and what you hear?
7. Play music through the RLC bandpass filter with different values for L and listen to the effects.