LRC Laboratory

In this laboratory exercise you will measure properties of the LRC circuit and analyze them. The four primary aspects of the lab are:

HARMONIC RESPONSE:	Measure the circuit's response to an harmonic input.
IMPULSE RESPONSE:	Measure the circuit's response to a current impulse.
FOURIER TRANSFORM:	Show how the Fourier transform connects the above responses.
SQUARE WAVE RESPONSE:	Measure the circuit's response to a square wave input.

HARMONIC RESPONSE: Measure the response of the LRC circuit to an harmonic input for a series of frequencies in the vicinity of the resonance frequency. For each input frequency, note the output frequency (period), output time lag (phase shift), and input and output amplitudes. From your data determine the admittance of the LRC circuit, both as an amplitude and phase and as real and imaginary components. Compare it to the theoretical admittance (1/impedance). Estimate the quality factor Q from the admittance data. Rearrange your circuit to measure the voltage across the capacitor and observe the amplification at resonance. Estimate Q from this amplification.

IMPULSE RESPONSE: Measure the response of the LRC circuit to a voltage impulse. The values of the circuit components: L, R, and C, and the details of the input pulse: amplitude V_0 and duration Δt allow you to predict the impulse response. Compare the predictions with the data, in particular, for the frequency ω_1, the damping time τ, the initial current $I(0)$, and the quality factor Q. Compare the peak of the Fast Fourier Transform (FFT) spectrum with the measured frequency of the decaying oscillation, and estimate the quality factor Q from the FFT. Record a trace of the decaying oscillation and save it to disk for later FFT analysis.

FOURIER TRANSFORM: Compare the impulse and harmonic response data by taking the FFT of the recorded impulse response and comparing it to the amplitude of the measured admittance. Make a graph to illustrate the comparison. Estimate the quality factor *Q* from the FFT spectrum.

SQUARE WAVE RESPONSE: Show how the response of the LRC circuit to a square wave input is related to the impulse response. Do this in the Fourier transform space (i.e., frequency space) by using Fast Fourier Transforms. To do this, you will need to record 4 sets of data in the time domain: (i) impulse input, (ii) impulse response, (iii) square wave input, and (iv) square wave response. Choose a square wave frequency below the circuit resonance frequency. The data sets can be analyzed using FFT procedures in any package you wish to use. I recommend using Excel, since it can also be used to plot the results easily. A Maple worksheet (*fft_lrc.mws*) is also available on the course web site. In Excel, the FFT is available under Tools/Data Analysis; you have to load it if it is not there (just ask the Microsoft gnome for help on Fourier and follow the directions).