LCR Circuits

Equipment

- Oscilloscope, function generator and variable resistors
- Various inductors, capacitors and connectors (BNC, banana and alligator)

Objective

Physics Concepts

- Resonance

Experimental analysis

- Graph time varying functions, combine measurements to graph new quantities
- Fit theoretical curves to experimental data
- Recognizing the uncertainty in measurements
- Use an oscilloscope to measure and compare time varying voltage signals

Conceptual (C-Level)

Draw a diagram of a series LCR circuit.

- What is the expected resonant frequency?
- What does resonance mean?
- What effect does different resistor values have on the resonance curve?

EXPLORATIONS:

- Choose an inductor, capacitor and resistor to produce a resonance between 1 and 10 kHz. Connect these components in series to your function generator.
- Using an oscilloscope qualitatively examine the voltage across the resistor (and input voltage) as a function of the frequency. Notice the relative phase of the signals as well as the amplitudes.
- NOTE: You can try these same activities in the PhET AC Circuit Lab simulation. However, this simulation does not allow you to change values so it is harder to see these effects.

Basic Lab (B-Level)

You will be measuring time varying voltage signals. Use an oscilloscope to determine the voltage (and phase shift) across the resistor as a function of the frequency.

- Compare V_R/V_o (normalized voltage drop across the resistor) as a function of ω (or f).
- Plot this function and fit to the theoretical function.
- To compare different LC circuit curves plot versus the normalized frequency ω/ω_o.
- Determine the phase shift as a function of normalized frequency for your LCR circuit.

Advanced/Extended Lab Ideas (A-Level)

- Determine how the shape of the curve changes for different resistances.
- Examine high-pass and low-pass filters (RC and/or RL circuits)
- Determine the operation and limitation of transformers
- Construct and analyze a rectifying circuit (ask for a suitable diode)
- Construct and analyze an amplifying circuit (ask for a suitable transistor)
- Ideas of your choosing.

NOTE: A good combination for the LCR circuit would be C = .2 μF, L = 15 mH and R = 100 Ω to R = 2000 Ω. There are many other good combinations.