# ENSC 220, ELECTRIC CIRCUITS I, Fall 2004 due Nov. 22, 2004
# Lab #4: RLC Circuits v2.0

**OBJECTIVE**:
You will study a series RLC circuit from both a time-domain and frequency-domain perspective in order to investigate topics such as: damping, overshoot, rise time, frequency of oscillation, settling time, resonance, bandwidth and Q.

**PREPARATION**:
Read Lab Handbook

- ``Inductors, Inductive Devices and Cores"
- Appendix II ``Mathematical Formulae"
- Appendix III ``Pulse Parameter Definitions"

**EQUIPMENT**:

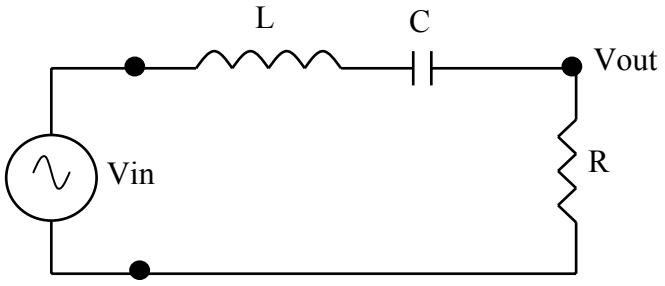
- Oscilloscope, Tektronix 2245, 2235, TAS465, or similar 2 channel scope
- 100 μH inductor (supplied in parts bag previously distributed)
- Your home brew inductor from Lab #3
- 1 capacitor in the range 100pF - 10nF
- Function generator
- Breadboard
- Resistors

**NOTES**:

- Ensure good contact on inductor taps by tinning with solder.
- Calculate values for $R_{under}$ and $R_{over}$ **prior** to the experiment.

**METHOD**:

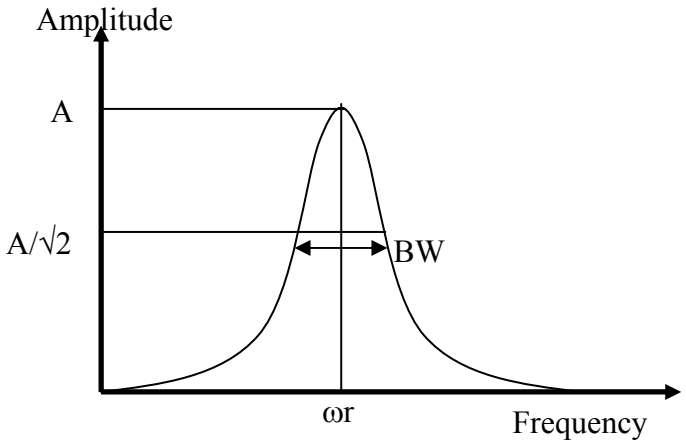
**TIME-DOMAIN RESPONSE**:




LCR test circuit

Use one capacitor (say C = 100pF - 10nF) and two different inductors: the one that you made for Lab #3 and a 100μH inductor that has been supplied to you. While using the home-made

inductor use the full length value (close to 200 μH) so that you can compare the performance between the home-made inductor and the industry made inductor. Note do not use one of the taps as mutual inductance with the rest of the coil creates different results Use two different resistors: one that demonstrates under-damping ($R_{under}$) and one producing an over-damped response ($R_{over}$). Apply appropriate signals and observe the input and output. Sketch the step and natural responses by observing the output voltage, $V_{out}$, across the resistor, R, for each case. Measure (if possible): overshoot, rise time and frequency of oscillation.




Frequency Domain Response

Apply a sinusoidal voltage to the input. Determine the gain (magnitude and phase) of the circuit at various frequencies. This is best done by sweeping the input frequency from a low value (say a few 100 Hz) to a high value: jotting down the gain (magnitude and phase at a reasonable frequency intervals). Using the observed data plot frequency and phase response. Do this for under damped and over damped conditions.

Using the response plots, for both $R_{under}$ and $R_{over}$ cases, determine the following:
**1**. Resonant frequency ( $\omega_r$ )
**2** Bandwidth (BW)
**3**. Quality factor (Q, where Q = ($\omega_r$/BW).

Note that a ``high Q'' circuit has a relatively very narrow bandwidth.

**DISCUSSION**:
For both $R_{under}$ and $R_{over}$ cases, calculate:
**1**. Resonant frequency: $\omega_r = 1/\sqrt{(LC)}$
**2**. Bandwidth: BW = R/L
**3**. Quality factor: Q = [√ (L/C)] / R.
Compare these to the values determined from your graphs.

If a series RC, RL, or RLC circuit was given to you in a black box (with access only to the two terminals) how could you determine the component values?