# IT 327 – Lab #4
## Impedance and Resonance

### Background

Impedance consists of resistance, inductive reactance, and capacitive reactance, added as vectors. To observe the effects of impedance in the lab, you need to have all 3 elements: resistors, inductors, and capacitors. Since all real circuits consists of all 3 of these elements (even if only due to their parasitic presence), this is a study of real circuits.

Resonance is essential for effective tuned circuits, which includes nearly all communication circuits. Resonance occurs when the inductive reactance is equal to the capacitive reactance, causing them to cancel each other out and leaving only the resistance. At this particular frequency, the amplitude of the current is maximum, which can be used to drive a current amplifier and provide a circuit which is tuned to that particular frequency.

### Objective

The objective of this lab is to give the student experience with circuits which contain a resistor, an inductor, and a capacitor. Using this circuit, the effects of impedance and resonance can be observed.

### Equipment Required

Oscilloscope, DMM, LCR meter, function generator, inductor, resistor, capacitor.

### Procedures (335 CTB)

Be sure to take plenty of pictures and include them in your write-up with an appropriate caption.

This lab requires two components: a 1 nF capacitor, and a 27 mH inductor with an internal resistance of about 100 Ω. Together, these components give R, XL, and XC for a circuit.

This lab will allow you to observe their behavior in a frequency-selective circuit exhibiting elements of both impedance and resonance.

1. Measure and record the capacitance of the capacitor and the inductance of the inductor, using the LCR meter. Using these measured values, calculate the resonant frequency (fres). It should be around 30 kHz.
2. Using a spreadsheet, calculate the XL, XC, $Z_{total}$ (both polar and rectangular), and the expected current for a sine wave with amplitude of 10 $V_{rms}$, for the following frequencies:

| | | | |
|---|---|---|---|
| 0.032 $f_{res}$ | 0.88 $f_{res}$ | 1.01 $f_{res}$ | 1.35 $f_{res}$ |
| 0.10 $f_{res}$ | 0.93 $f_{res}$ | 1.02 $f_{res}$ | 1.68 $f_{res}$ |
| 0.32 $f_{res}$ | 0.98 $f_{res}$ | 1.07 $f_{res}$ | 10.0 $f_{res}$ |
| 0.65 $f_{res}$ | 0.99 $f_{res}$ | 1.12 $f_{res}$ | 32.6 $f_{res}$ |
| 0.82 $f_{res}$ | 1.00 $f_{res}$ | 1.18 $f_{res}$ | |

This calculating exercise is the main part of this lab, and can (and should) be done before coming to lab. The purpose is to look at the behavior of this circuit at frequencies both above and below the resonant frequency.

3. Using the function generator and the components measured (the inductor and capacitor), build a series circuit and measure the actual current at each of the above frequencies.
4. Compute the % difference for each measurement.

### Conclusion

What did this exercise show you about frequency-selective circuits? About impedance? About resonance?