**Introduction:**

The objectives of this lab were;

1. To determine the impedance of a circuit based off its frequency, phase angle, voltage, and current.
2. To determine the phase angle shift of the circuit (within the current, voltage, and impedance values) based off of the frequency and thus which branch value is “leading” or “lagging” the other (i.e. the current in respect to the voltage, or the impedance in respect to the current, etc.)

**Procedure/Discussion:**

For the first circuit of the experiment (in steps 1-3), the nominal values of R, Rp, and C, were 511, 240, and 220 nF respectively. Their measured values however, were 511, 239, and 211nF respectively. The Ch1 voltage measured was 1.981 vRMS and the Ch2 voltage measured was 1.133 vRMS at 1009 Hz (1000 Hz nominal). The time-shift between peaks was 148, with Ch2 leading Ch1. The polar form values ended up being 1.981 ∠ 0**°** v for V1, 1.133 ∠ 53.76**°** v for V2, 2.22 ∠ 53.76**°** mA for I, 8.25 ∠ 0**°** mA for Ip, and 0.848 ∠ -53.76**°** for Vc. The impedance (ZRC) ended up being 905.52 ∠ -53.76**°**.

For the second circuit of the experiment (in steps 4-6), the nominal values of r, R, L, and C were 113, 511, 49 mH, and 370 nF respectively. Their measured values however, were 113.7, 511, 49.2 mH, and 365.79 nF respectively. The nominal resonant frequency was 1182 Hz whereas its measured value was 1186.27 Hz. The resonant frequency is when both V1 and V2 are in phase (phase shift angle of 0°). Then, to test the phase shift angle change, two frequencies were to be chosen in order to re-run the calculations against. One had to be below resonance, and the other higher. The values of the chosen frequencies were as follows; f1 = 500 Hz (500 nominally and 508.9 Hz measured. Here, Ch2 leads Ch1.) and f2 = 2000 Hz (2000 Hz nominally and 2008 Hz measured. Here, Ch2 lags Ch1.).

* For f1, the Ch1 voltage measured was 2.37 vRMS and the Ch2 voltage measured was 1.263 vRMS. The time-shift between peaks was 280, with Ch2 leading Ch1. The polar form values ended up being 2.37 ∠ 0**°** v for V1, 1.263 ∠ 51.30**°** v for V2, 2.47 ∠ 51.30**°** mA for I, and 1.107 ∠ -51.30**°** for Vc. The impedance (ZRC) ended up being 1189.54 ∠ -51.30**°**.
* For f2, the Ch1 voltage measured was 2.314 vRMS and the Ch2 voltage measured was 1.579 vRMS. The time-shift between peaks was 55, with Ch1 leading Ch2. The polar form values ended up being 2.314 ∠ 0**°** v for V1, 1.579 ∠ -39.76**°** v for V2, 3.09 ∠ -39.76**°** mA for I, and 0.735 ∠ 39.76**°** for Vc. The impedance (ZRC) ended up being 1044.76 ∠ 39.76**°**.

For the third circuit of the experiment (in step 7), the nominal values of r, R, Rv, L, and C, were 113, 511, 1560, 49 mH, and 220 nF respectively. Their measured values however, were 113.7, 511, 1560, 49.2 mH, and 211 nF respectively. The Ch1 voltage measured was 1.924 vRMS and the Ch2 voltage measured was 1.027 vRMS at 3012 Hz (3000 Hz nominally and 3012 Hz measured). The time-shift between peaks was 29, with Ch2 lagging Ch1. The impedance (ZRC) ended up being 1178.044.52 ∠ 36.46**°**.

**Conclusion:**

For the first circuit, the impedance magnitude and angle error between the measured and nominal values were 2.237% and 1.834% respectively.

For the second circuit, the impedance magnitude and angle error between the measured and nominal values at f1 were 0.1074% and 12.155% respectively. At f2, they were 0.357% and 25% respectively.

For the first circuit, the impedance magnitude and angle error between the measured and nominal values were 21.70% and 13.922% respectively.

I noticed when calculating the error between the nominal and determined values was extremely high because for the measured values, they had been drawn from the actual instruments of calculation (i.e. the oscilloscope) and the “nominal” value were derived (mistakenly) from the complex form of the nominal RLC values from the circuit. When further compared to the measured RLC values in complex form, it actually lowers the error to below 5%. As for the large error on the third circuit’s impedance magnitude, perhaps a calculation error when simplifying the massive values via complex conjugate derivation.