# AC Circuits Lab Instructions

## Goal:

For each of three boxes containing unknown circuit elements, you will determine a simple ideal circuit which accurately models the impedance for frequencies in the range 0-100kHz. Each box can be modelled by a network of one, two, or three components (each component being an R, L, or C).

The results that must be reported in your lab report are:

- An idealized model of each given "black box" circuit element.
- A theoretical function for the impedance of the model.
- An estimate of the expected uncertainty in the model impedance.
- Plots of the impedance versus frequency, including both experimental data and the model, and including error bars.
- Quantitative analysis of how well the model fits.

For more detailed lab report expectations, see the *Lab Report Guidelines* handout.

See the example figure for "Box M", for a demonstration of how these results can be summarized.

## Procedure:

First:

1. See *AC Circuits and Impedance* handout for background and experimental setup.
2. At each data point you will need to measure $f$, $|V_1|$, $|\text{-}V_2|$, $\delta$, $R_t$. Make sure you know how to measure these quantities, and how to extract the complex impedance values $z(f)$.
3. Make preliminary estimate of accuracy/uncertainty associated with scope measurements.
4. See lab manual for other useful info (but, you don't need to follow lab manual instructions).

Then choose 3 of Boxes A-F (at least one resonant). For each box:

1. Set up a computer and directory with a plan to record your measurements.
2. Using the DMM, take a DC measurement of the resistance of the unknown box. This helps eliminate some possible models (i.e. capacitors in series and inductors in parallel).
3. Without recording data, do a preliminary sweep of the entire frequency range to get a qualitative idea of the impedance response. Record observations in notebook, and sketch a preliminary model circuit.
4. Record a dataset over the frequency range. Use a denser spacing of points in regions where impedance is changing rapidly.
5. Using your data, determine a model circuit and obtain an estimate of the parameters. Prepare a preliminary version of your results (impedance and phase graphs with data and model curves).
6. Analyze your preliminary results. Does the model fit well? Do you need to take more data to obtain a better model? Do you need to use a different method of estimating the parameters? Does your data show that the model is accurate? Record notes in notebook.
7. Go back to the beginning and iterate until you have an accurate model which is well-supported by your data.
8. Finalize results, parameters, plots.