ECE 3251 – Electromagnetic Energy Conversion
Lab #1: Single Phase Measurements

Laboratory Goals

- Understand safety hazards and procedures to mitigate risk in the laboratory
- Understand basic operation of lab benches
- Understand basic operation of LabVIEW data collection and measurement system
- Relate basic principles on voltage, current, impedance, power, and power factor learned in class to actual hardware used in lab

Safety Protocols:

- **Before starting, be sure you know where the Emergency Cut-Off button for your bench is located.**
- **ALWAYS turn the variac to zero volts BEFORE switching loads**

Single Phase System

Lab Procedures:

1. Read the safety protocols above!

2. Connect the SINGLE-PHASE POWER SUPPLY to the AC LOAD PANEL as shown in the below schematic. Be sure to connect the DATA ACQUISITION PANEL to measure the current flowing into the AC LOAD PANEL and measure the voltage across it.

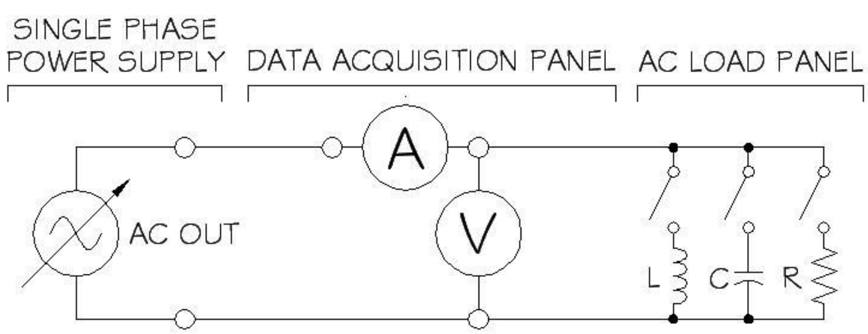

Figure 1. Schematic of Lab Bench Single-Phase Connections

Be sure all switches on the AC LOAD PANEL are turned off except for the switch for the resistor (R). By adjusting the knob on the autotransformer of the SINGLE PHASE POWER SUPPLY, what is the maximum voltage (RMS) across and maximum current (RMS) through the resistor in the AC LOAD PANEL that you can obtain?

3. Turn the voltage down to around 60VAC (RMS) and determine using the voltage and current what the value of the resistor should be.

In steps 4-8, be sure to record for later calculations the RMS voltage, RMS current, average power, and calculated phase angle, as described in step 4. You should have a table or spreadsheet set up to record these values.

4. Turn the variac down to zero. Then, with the resistor still on, turn the capacitor (C) on. Turn the variac back up and determine the phase angle using the cursors in the time domain display. By using this phase angle, along with the RMS voltage and current to calculate real power. How does this number compare with the 'average power' given by LabVIEW? Using RMS voltage, current, and phase angle, what is the equivalent parallel impedance model for the capacitor? What is the value (in µF) of the capacitor?

5. Turn the variac down to zero. Turn off the capacitor and turn on the inductor (L) and repeat this procedure (keep the resistor on.) Using RMS voltage, current, and phase angle, what is the equivalent parallel impedance model for the inductor? What is the value (in mH) of the inductor?

6. Turn the variac down to zero. Turn off the inductor and resistor and turn on ONLY the capacitor (C) and repeat. What do you notice about the measurements that LabVIEW is reading? Using these measurements, calculate the equivalent parallel impedance for the capacitor and its value in µF.

7. Turn the variac down to zero. Turn off the capacitor and turn on ONLY the inductor (L) and repeat. What do you notice about the measurements that LabVIEW is reading? How does the impedance of the inductor compare with the impedance of the resistor and capacitor? Using these measurements, calculate the equivalent parallel impedance of the inductor and its value in mH.

8. Turn the variac down to zero. Now, turn on the capacitor, inductor, and resistor and take repeat the measurements. Again find the equivalent parallel impedance and component values.

9. **Clean up** – Turn off the power to your bench (both circuit breakers) and return all cables to the racks in an orderly fashion.

Some helpful Power Relations:

$\boldsymbol{S} = \boldsymbol{V}\boldsymbol{I}^* \rightarrow \text{Units: VA}$

$S = P + jQ$

$P = VI\cos(\theta) = |S|\cos(\theta) \rightarrow \text{Units: W}$

$Q = VI\sin(\theta) = |S|\sin(\theta) \rightarrow \text{Units: VAR}$

Grading

- Formal report: Organization, neatness, clear writing, proper formatting of graphs, figures, tables, etc. (15 points)
- Lab Participation: Contributions from each lab partner are fairly distributed and

documented (10 points)

- Introduction: What is the purpose of this lab? (5 points)
- Procedures: Brief account of the steps to obtain results (10 points)
- Results: Measurements and calculations for each lab step (40 points)
- Conclusions: Analysis and explanation of data (20 points)