

ECE 370 MACHINES & POWER

EXPERIMENT 1 SINGLE-PHASE AC CIRCUITS

Objective

The objectives of this laboratory experiment are summarized below:

1. Learn to perform power measurements in ac circuits, using the Yokogawa digital meter.
2. Learn to perform differential voltage measurements with the oscilloscope.
3. Learn to perform current measurements and power factor angle calculation, using a current probe and the oscilloscope.
4. Learn to use the CompactFlash Card to store traces from the oscilloscope.
5. Gain an understanding of the effect of various load configurations on the power supply in a single-phase ac circuit by monitoring the real power (P), reactive power (Q), apparent power (S), and power factor angle (θ).

Pre - Lab

Perform the required calculations in your lab notebook prior to attending the laboratory. These calculations will form the analytical (anticipated) results of your work.

In reference to Figures 1 and 2, the following four (4) load configurations are considered:

Case 1:	$R = 600 \Omega$	$L = 0.8 \text{ H}$	$C = \text{O.C. (Open Circuit)}$
Case 2:	$R = 300 \Omega$	$L = \text{O.C.}$	$C = 4 \mu\text{F}$
Case 3:	$R = \text{O.C.}$	$L = 1.6 \text{ H}$	$C = 4 \mu\text{F}$
Case 4:	$R = 150 \Omega$	$L = 0.4 \text{ H}$	$C = 16 \mu\text{F}$

For each of the above load configurations calculate each *load* and *line* I, P, Q, S, and the power factor. Then complete the appropriate portions of Tables 1 and 2. Note that the supply voltage will be maintained fixed at 120 V.

Calculate the value of the capacitor needed in part 6 on page 5.

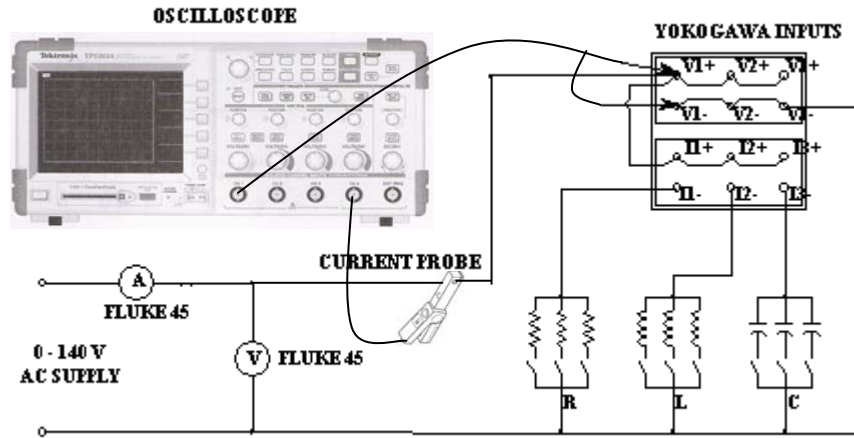


Figure 1. Circuit Connections for Load Quantity Measurements.

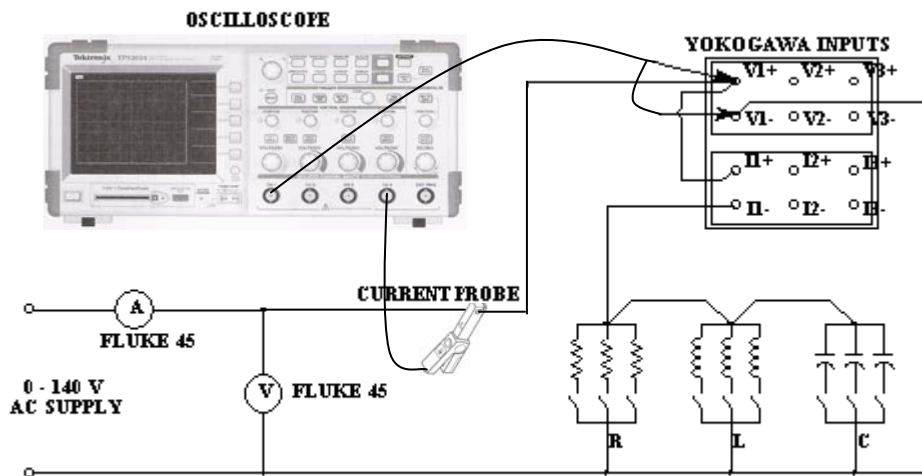


Figure 2. Circuit Connections for Line Quantity Measurements.

Table 1. Summary of Load Variables

CASE	ELEMENT	I (A)		P (W)		Q (VAR)		S (VA)		P.F.	
		Calc.	Meas.	Calc.	Meas.	Calc.	Meas.	Calc.	Meas.	Calc.	Meas.
1	R = 600 Ω										
1	L = 0.8 H										
2	R = 300 Ω										
2	C = 4.0 μ F										
3	L = 1.6 H										
3	C = 4.0 μ F										
4	R = 150 Ω										
4	L = 0.4 H										
4	C = 16 μ F										

Table 2. Summary of Line Variables

CASE	ELEMENT	I (A)		P (W)		Q (VAR)		S (VA)		P.F.	
		Calc.	Meas.	Calc.	Meas.	Calc.	Meas.	Calc.	Meas.	Calc.	Meas.
1	R & L										
2	R & C										
3	L & C										
4	R & L & C										

Procedure

The following is the recommended procedure for performing this experiment.

1. Setting up the oscilloscope:
 - a. You need to set the oscilloscope to match the scale of your voltage probe.
To set the scale, follow these steps:
 1. Connect the voltage probe to **Channels 1, 2, or 3**.
 2. Push the channel **Menu** button.
 3. Push the **Probe** option button.
 4. Push the **Voltage** option button.
 5. Push the **Attenuation** option button and select **20X**.
 - b. Current probe provides a voltage signal proportional to the current. You need to set the oscilloscope to match the scale of your current probe. To set the scale, follow these steps:

1. Connect the current probe to **Channel 4**, and set the range switch on the probe to 100mV/A.
 2. Push Channel 4 **Menu** button.
 3. Push the **Probe** option button.
 4. Push the **Current** option button.
 5. Push the **Scale** option button and select **10X**.
- c. Oscilloscope traces can be stored on the CompactFlash (CF) Card.
To clear the CF card follow these steps:
1. Insert a CF card into the card slot.
 2. Push the **Utility** button.
 3. Push **File Utilities** and select **More** then select **Format**.
 4. Select **Yes** to format the CF card.
- To store a waveform on the CF card and print it follow these steps:
1. Push the **Save/Recall** button.
 2. Push the **Action** button and select **Save Image**.
 3. Push the **File Format** button and select **BMP**.
 4. Push the **Save** Button and wait a few seconds for the red LED to turn on and the waveform is stored.
 5. Remove the CF card from the oscilloscope and insert it into the lab computer.
 6. Select the Drive F to display the stored waveforms.
 7. Push the print button and select the waveform then choose the 4 x 6 size.
2. Setting up the other meters:
- a. The voltmeters and the oscilloscope probes can be overlaid on the circuit. Therefore, it is recommended to construct the entire voltage measuring circuit after the power circuit has been built.

 - b. Set all of the measuring devices (meters) for ac measurements. Choose the Auto Scale measuring mode.
3. Construct the circuits shown in Figures 1 and 2 with a supply voltage of 120 V. This voltage should be maintained fixed throughout the experiment, since it is the control variable.

It is recommended that you first perform the experiment with the connections shown in Figure 1 to record all of the information for each parallel element. Then reconnect the equipment as shown in Figure 2 and record the line data.

4. For each of the four (4) load configurations that you have used for the pre-lab calculations, record the appropriate value of the *load* variables in *Table 1* and the *line* variables in *Table 2*. Note that the Yokogawa digital meter can be used for reading the values. The lagging or leading power factor can be determined from the voltage and current traces that are being displayed on the oscilloscope.

5. Use the CompactFlash Card to store pictures of voltage and current traces of cases 1, 2, and 4 for the circuit of Figure 2.

6. Draw a circuit with the adequate measuring devices and a load resistance of $200\ \Omega$ in parallel with an inductance of $0.267\ \text{H}$. Analytically design a reactive power compensating circuit (shunt capacitor banks) to limit the source power factor to 0.9 lagging. Verify the adequacy of your design experimentally by recording the line values of real power, reactive power, and the power factor. Then perform the necessary percent error calculations.

Documentation

The experiment should be documented in your lab notebook in a lab log format. Your documentation should be complete and clear, so you would be able to write a formal report based on the logged information. The photographs should be neatly pasted in your lab notebook.

The pre-lab calculations for the four (4) load configurations and the design of Part 6 will be the analytical (anticipated) results. The laboratory measurement will establish your experimental results. There will be a discrepancy between your analytical and experimental results. The discrepancies should be described and explained in the conclusion section of your lab notebook.