EXPERIMENT 7
SINGLE-PHASE AC POWER MEASUREMENTS

I) Pre-lab Assignment (Carry out detailed calculations on the pre-lab worksheet at the end)

Consider the following AC circuit operating at 60 Hz with a source voltage of 40 V_rms.

![Circuit A](image)

- a) Compute the load impedance at the operating frequency.
- b) Compute the power factor of the load.
- c) Calculate the load current.
- d) Compute the power dissipated in the 300-Ω resistor.

The power factor of the load in circuit A is to be corrected by installing a shunt capacitor as shown.

![Circuit B](image)

- a) Compute the value of C that sets the power factor to 1.
- b) Compute Z_{Load} with that value of C.
- c) Calculate the current flowing into the entire load.
- d) Calculate current flowing through the resistor.
- e) Compute the power dissipated in the load.
II) Laboratory experiments

This experiment will use modules in the Lab-Volt unit mounted in the rack next to your lab bench. This unit is capable of generating lethal voltages; thus, some safety precautions are essential.

- All connections will be made with the power turned off.
- When changing the wiring, the unit will first be turned off, the changes made, and then the unit can be turned back on.
- Two jumper wires may not be spliced to form a longer one.

For this laboratory, two Fluke 8010 Multimeters will be used to measure ac voltage and current because they measure true \textit{rms} values. There are two at each station. Use the HP multimeter to measure resistances.

\textit{Circuit A}

1) Select a 300-Ω load resistor from the Variable Resistance Module by flipping the appropriate toggle switch up. Measure the value of the resistor by plugging a multimeter into the corresponding terminals of the module. Compute the \% deviation from nominal.

2) Select a 0.8-H inductor from the Variable Inductance Module by flipping the appropriate switch. Measure the dc resistance of the inductor with the multimeter.

3) Wire up the load by connecting the chosen resistor in series with the selected inductance.

4) Use one Fluke multimeter to measure the load current by placing it in series with the load. Make certain that the ac mode has been selected. Use the mA input.

5) Use the other Fluke multimeter to measure the load voltage by connecting it across the load. Make certain that the ac mode has been selected.

6) The source voltage is generated by the variable AC voltage source located in the lower left corner of the rack. The \textbf{voltage source will be taken across terminals 4 and N}. Turn the voltage adjustment knob fully counterclockwise to set zero volts, and connect the source to the load.

7) Double check your wiring and then turn on the circuit breaker on the variable AC supply. Turn the adjustment knob slowly clockwise until 40 V_{rms} is read on the Fluke multimeter.

8) Measure the load current with the other Fluke multimeter that has already been connected in series with the load. (Remember that these readings are \textit{rms}.)

9) Turn the voltage adjustment knob fully counterclockwise to zero, and \textbf{turn off the power} with the circuit breaker.

\textit{Circuit B}

1) With the \textbf{power off} and wire up circuit B using the appropriate capacitor in the Variable Capacitance module. The Fluke multimeter for measuring current should be connected so that it measures the entire load current, including the portion that is flowing through the capacitor. The other Fluke multimeter is connected to monitor the voltage across the load (same as the voltage across the capacitor).

2) After double-checking the wiring, turn on the circuit breaker on the variable AC supply. Turn the voltage adjustment knob slowly clockwise until 40 V_{rms} is read on the Fluke multimeter.
3) Measure the total load current with the other Fluke multimeter.
4) **Turn off the power**, and change the connection of this multimeter so that it measures the current flowing through the resistor and inductor, but not the current through the capacitor.
5) Turn the power back on. After setting the load voltage to 40 V_{rms}, seen on the Fluke multimeter, measure the current in the resistor/inductor leg of the circuit.
6) Turn the voltage adjustment knob fully counterclockwise to zero, and **turn off the power** with the circuit breaker.

III) Lab Report

The lab report should be in standard format and include the following specific items:

1) Purpose
2) Model numbers of all test equipment used
3) Block diagrams of test setups
4) Circuit schematics for both A and B with component values shown.
5) Test procedure
6) Nominal versus measured load resistor value with %deviation.
7) Measured value of the dc resistance of the inductor.

**Circuit A**

8) Measured load voltage and current.
9) Power dissipated in the resistor computed from the measured load current. Use the measured value of the resistance.
10) Computed power dissipated in the dc resistance of the inductor.
11) Computation of the power factor, \( pf \), from the equation \( P = V_L \| I_L \| pf \)
    
    Use the sum of the powers in steps 9) and 10) for \( P \) in this equation. Compare this value of \( pf \) with the one computed in the pre-lab for circuit A.

**Circuit B**

12) Measured load voltage (\( V_L \)), total load current (\( I_L \)), and current through the resistor/inductor leg of the circuit (\( I_R \)).
13) The power dissipated in the resistor computed from \( I_R \). Use the measured value of the resistor in the computation.
14) Computed power dissipated in the dc resistance of the inductor.
15) Total load power as the sum of (13) and (14).
16) Computation of the power factor from the equation \( P = V_L \| I_L \| pf \)
    
    using the total power from step (15) for \( P \) and values from step 12) for \( V_L \) and \( I_L \).
    
    Compare the result with the desired power factor of 1.
17) Redraw circuit B with another resistor in series with the inductor to represent the dc resistance of the inductor. From this revised circuit description, analyze the circuit in order to compute the power factor with the capacitor installed by looking at the calculated phase angle of the load impedance. Compare this theoretical result to the power factor computed in (16) from the measurements.
18) What conclusions can you make about the viability of power factor compensation?
Consider the following AC circuit operating at 60 Hz with a source voltage of $40 \text{ V}_\text{rms}$.

(a) Compute the load impedance at the operating frequency.

(b) Compute the power factor of the load.

(c) Calculate the load current.

(d) Compute the power dissipated in the 300-$\Omega$ resistor.
Experiment 7: Single-phase AC Power measurements

Pre-lab Worksheet

The power factor of the load in circuit A is to be corrected by installing a shunt capacitor as shown.

a) Compute the value of $C$ that sets the power factor to 1.

b) Compute $Z_{Load}$ with that value of $C$.

c) Calculate the current flowing into the entire load.

d) Calculate current flowing through the resistor.

e) Compute the power dissipated in the load.