I. Purpose.
1. Review the computation of the total impedance for AC series/parallel circuits.
2. Review the application of Kirchhoff’s current law and the current divider rule to AC series/parallel circuits.
3. Introduce the determination of real, reactive and apparent power to a load.

II. Equipment.
**Keysight 34450A Digital Multimeter (DMM)**
Oscilloscope
Function Generator
220-Ω resistor, 1-mH inductor, 100-Ω resistor

III. Pre-lab Calculations.

Step One: Real and Reactive Power

□ Compute the total impedance as seen by the ac power source, \( e(t) = 5 \sin\{2 \pi (20\text{kHz})t\} \), of the ac series/parallel circuit in Figure 1. Assume inductor has an internal coil resistance of 13 ohms.

\[
Z_T = ______________
\]
A Practical Exercise
AC Power

Using Ohm’s law and the predicted total impedance \((Z_T)\), calculate the current supplied by the ac power source for \(e(t) = 5 \sin\{2 \pi (20\text{kHz})t\}\).

\[ I_S = _____ \angle _____ \]

Use the current divider rule to calculate each branch current.

\[ I_1 = _____ \angle _____ \]
\[ I_2 = _____ \angle _____ \]

Calculate the real and reactive power of the individual circuit elements in the AC circuit.

\[ P_{R1} = \]  
\[ P_{R2} = \]  
\[ P_L = \]  
\[ Q_L = \]  

**Step Two:** Power Triangle

Determine the total real, reactive, and apparent power delivered to this circuit.

\[ P_T = \]  
\[ Q_T = \]  
\[ S_T = \]  

**Step Three:** Instructor or lab assistant verification that pre-lab calculations are complete.
A Practical Exercise

IV. Lab Procedure. Time Required: 30 minutes. Check-off each step as you complete it.

Step One: Construct an AC series/parallel circuit

☐ Using a DMM, measure the real value of resistance of the inductor. Measure the resistance of the 220 and 100 ohm resistors (R_1 and R_2).

\[ R_L = \text{___________} \]
\[ R_1 = \text{___________} \]
\[ R_2 = \text{___________} \]

☐ On a QUAD board construct the ac series/parallel circuit in Figure 1

☐ Set the function generator to be a sine wave with 10 V_{pp} at 20 kHz.

☐ Connect the oscilloscope so that CH 1 will measure the ac voltage source and CH 2 will measure the ac voltage across the 100-Ω resistor.

☐ Use the MEASURE function if the oscilloscope to determine the RMS voltage of the source (CH 1). Adjust the function generator amplitude until the Oscilloscope displays 3.54 V_{RMS}.

\[ E_S = \text{_______} \angle \text{0°} \]

Note:
The function generator voltage output decreases when it is attached to a circuit. The voltage indication on the function generator will not match the actual voltage output. You must adjust the function generator output based upon an external reading.

Step Two: Measure total current and component voltages.

☐ Use the cursor function on the oscilloscope measure the time difference between \(E_S\) and \(V_{R2}\).

\[ \Delta t = \text{___________} \]

☐ Determine the phase difference between \(E_S\) and \(V_{R2}\) using \(\Delta \theta = (\Delta t \times 360°) / T\).

\[ \Delta \theta = \text{___________} \]

☐ Using the oscilloscope (CH 2), determine the ac voltage across the 100-Ω resistor and
A Practical Exercise

express the answer in phasor form. The phase angle of VR2 is the phase angle measured on the previous page (negative if lagging, positive if leading).

VR2 = ______∠_____

☐ Use the measured value for VR2 and the measured resistance of the 100 ohm resistor to determine IS.

IS = ______∠_____

☐ Use Ohm’s Law and the measured value for E and IS to determine ZT for the circuit.

ZT = ______∠_____

☐ How do these values of IS and ZT compare to the values calculated in the pre-lab section?

Exact __________ Very close __________ Very Different __________

Step Three: Analysis of total Real, Reactive, and Apparent power.

☐ Using the actual magnitudes of AC voltage source, the current, and the impedance phase angle that you determined in Step One and Two, calculate the measured real, reactive and apparent power supplied to the circuit.

\[ S_T = I_S E_S = \]
\[ P_T = S_T \cos \theta = \]
\[ Q_T = S_T \sin \theta = \]

PT = __________

QT = __________

ST = __________

☐ How do these values of P, Q, and S compare to the values calculated in the pre-lab section?

Exact __________ Very close __________ Very Different __________