

A Practical Exercise

Name: _____

Section: _____

I. Purpose.

1. Review the measurement of sinusoids (ac voltages) using the oscilloscope.
2. Review the operation of the function generator.
3. Introduce the graphing of impedances, voltages and current as functions of phase.
4. Introduce the graphing of voltages and current as function of time.
5. Introduce the calculation of the total impedance for AC series circuits.

II. Equipment.

Agilent 34401A Digital Multimeter (DMM)
Oscilloscope
Function Generator
1000- Ω resistor
0.1- μ F capacitor

III. Preparation.

Complete Step One as a Pre-Lab.

IV. Lab Procedure.

You must **read** and complete each step.

Step One: Total impedance

- Compute the total impedance as seen by the AC power source, $e(t) = 10 \sin\{2\pi(500\text{Hz})t\}$, of the AC series circuit in Figure 1.

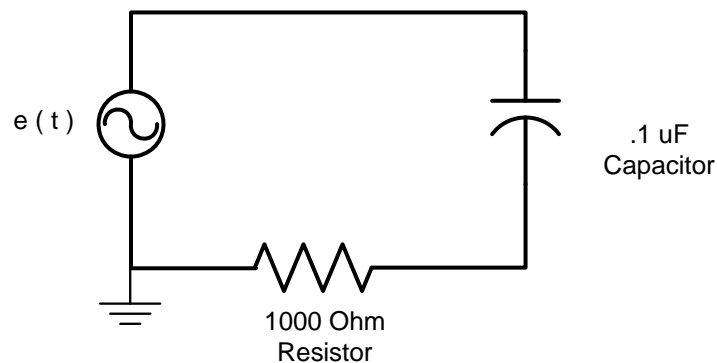
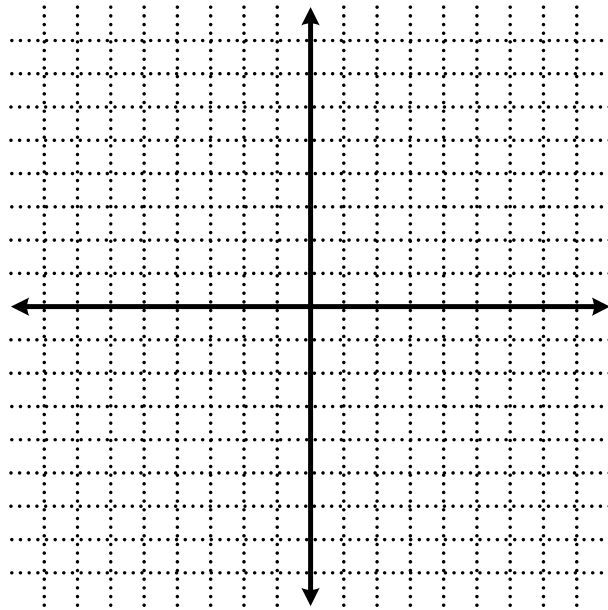


Figure 1

$Z_T =$ _____

PE 15: Impedance

- On Figure 2 sketch the predicted impedances (in polar form) of the resistor (Z_R), the capacitor (Z_C), and the total impedance (Z_T).



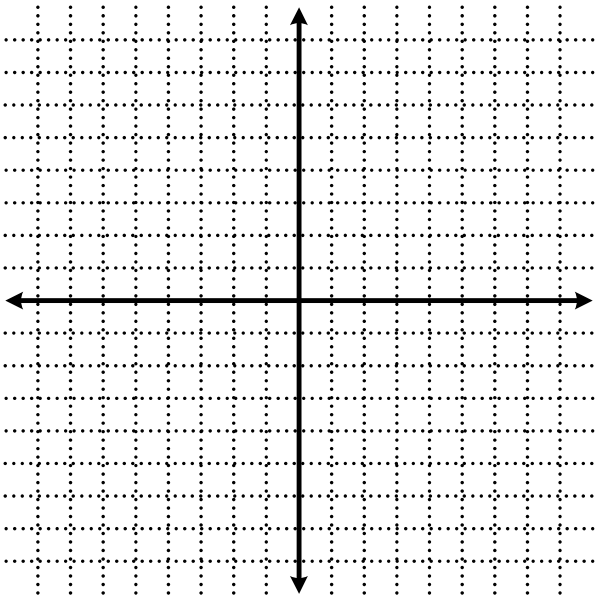
$$Z_R = \underline{\hspace{2cm}}$$

$$Z_C = \underline{\hspace{2cm}}$$

$$Z_T = \underline{\hspace{2cm}}$$

Figure 2

- Sketch the AC power source, $e(t) = 10\sin(2\pi(500\text{Hz})t)$, as a phasor (E_S) in Figure 3.
[Remember that the magnitudes in polar form are *rms* values.]
- Determine I_S , V_C and V_R in this AC series circuit and add them (in polar form) to Figure 3.



$$E_S = \underline{\hspace{2cm}}$$

$$I_S = \underline{\hspace{2cm}}$$

$$V_C = \underline{\hspace{2cm}}$$

$$V_R = \underline{\hspace{2cm}}$$

Figure 3

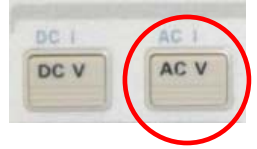
- Write the equation for I_S as a function of time.

$$i_s(t) = \underline{\hspace{10cm}}$$

PE 15: Impedance

Step Two: Construct an AC series circuit

- Using your QUAD board, construct the AC series circuit in Figure 1.
- Set the function generator to output a 20 V_{pp} sinewave at 500 Hz.
- Use a DMM to measure the output of the function generator. Select AC V to allow measurement of AC voltage. The DMM will display RMS values. Adjust the function generator amplitude until the DMM displays 7.07 V_{RMS}.



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 a DMM reading.

- Connect your oscilloscope to your AC series circuit, so that CH 1 will measure the voltage source, and CH 2 will measure the voltage across the resistor (as seen in Figure 4)

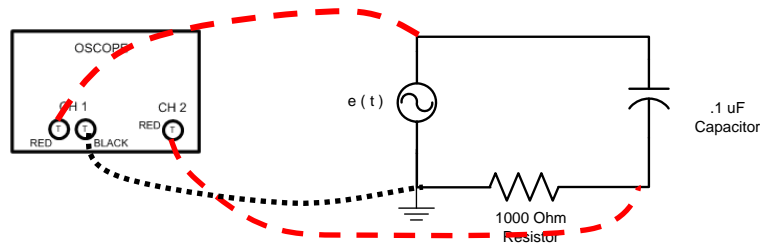


Figure 4

- Adjust your oscilloscope settings until the display shows at least one full cycle of both the CH 1 and CH 2 signals.
- Using Figure 5, sketch the display on the LCD and indicate Volts/Div and Sec/Div.

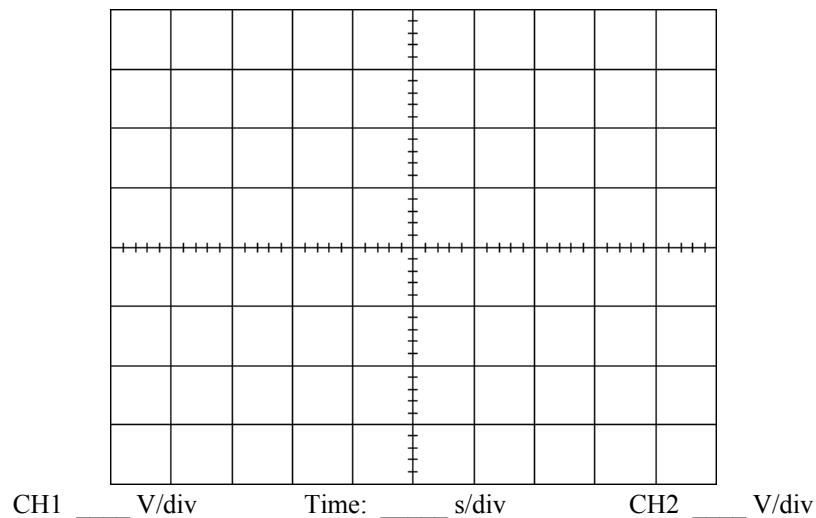


Figure 5

PE 15: Impedance

- Use your oscilloscope, with the voltage source waveform (CH 1) as the reference, to determine if the voltage across the resistor is lagging or leading E_S .

Lagging or Leading

How did you determine the above question with the oscilloscope?

- a) since V_R is to the left of E_S on the display, V_R is leading
- b) since V_R is to the right of E_S on the display, V_R is lagging
- a) since E_S is to the left of V_R on the display, V_R is leading
- b) since E_S is to the right of V_R on the display, V_R is lagging

- Using your oscilloscope, measure the time difference between CH 1 and CH 2.

$$\Delta t = \underline{\hspace{2cm}}$$

Do both CH 1 and CH 2 have the same period?

Yes or No

If CH 1 and CH 2 have the same period, and since one period (T) equals 360° , you can determine the phase difference between CH 1 and CH 2 in degrees.

$$\Delta\theta = (\Delta t \times 360^\circ) / T$$

What is the $\Delta\theta$ between CH 1 and CH 2?

$$\Delta \theta = \underline{\hspace{2cm}}$$

- Using your oscilloscope and the angle above, determine E_S and V_R . (polar form)

$$E_S = \underline{\hspace{2cm}}$$

$$V_R = \underline{\hspace{2cm}}$$

- Using the above values, calculate V_C and I_S . Note that we can use the measured V_R and Ohm's Law to determine the actual current I_S through the series circuit. We can use KVL to calculate V_C from E_S and V_R .

$$I_S = \underline{\hspace{2cm}}$$

$$V_C = \underline{\hspace{2cm}}$$

PE 15: Impedance

Sketch \mathbf{E}_S , \mathbf{V}_R , \mathbf{V}_C and \mathbf{I}_S in Figure 6.

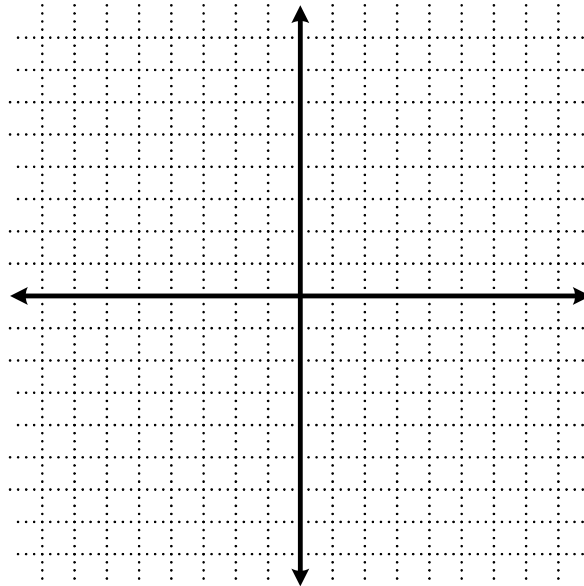


Figure 6

How do these values of \mathbf{V}_R , \mathbf{V}_C and \mathbf{I}_S compare to the values calculated in the pre-lab (Step-One)?

Exact _____ Very close _____ Very Different _____

Step Three: Determine actual impedance and capacitance.

Determine \mathbf{Z}_C and C

Using Ohm's Law, \mathbf{V}_C , and \mathbf{I}_S above, what is the actual impedance \mathbf{Z}_C ?

$\mathbf{Z}_C =$ _____

Determine the actual value of C, based on the equation:

$$Z_c = \frac{1}{2\pi fC} \angle -90^\circ$$

$\mathbf{C} =$ _____

How does this calculated value compare to the actual capacitor value?

Exact _____ Very close _____ Very Different _____

If the signal frequency from the Function Generator were increased, what would happen to the impedance of the capacitor, \mathbf{Z}_C ?

Increase or Decrease