**LabVolt Phasor Lab (50 Points + 2 extra credit)**

(jas, LabVolt Phasor Lab.docx, 8/30/2025)

**Note: When working with dangerous high voltages and rotating machinery, work in groups of two or three for safety. Groups larger than three result in some simply observing rather than contributing. Submit an electronic version of a lab report to receive credit for doing this lab.** The goal of your **lab report is to provide sufficient documentation so that the lab can be repeated if necessary**. Therefore, simply add to this document to arrive at your lab report, as all the explanatory text, procedures, and Discussion and Conclusion questions contained in this document are required for a complete lab report. So for your lab report, **add a cover page that includes name or names, class and name of the lab. Also add in your results, and answers to the Discussion and Conclusions questions to the existing lab document**. While you are to share all **Procedure** items with any lab partners, your **Discussion and Conclusions** section is to be uniquely yours. See the grading rubric at the end of this document for more details.

**Purpose:** The purpose of this lab is to become familiar with the LabVolt test bench, along with better understanding Phasors. The LabVolt main power switch is locked in the off position by a combination lock, with combination 3 1 1, that will need to be removed and then replaced when you are finished with a lab.

**Equipment:**

The following LabVolt Units will be used for this lab:

# Power Supply Unit

The power supply unit is shown in **Figure 1** and provides electrical power to most of the other LabVolt units. The power supply unit provides high-voltage AC and DC at fixed and variable voltage levels. The power supply unit also provides 24 V DC to power the Data Acquisition and Control Interface Unit (DAC Unit). A brief description of the essential elements of the power supply unit follows:

The main power switch for the Power Supply unit is in the upper left corner of the panel shown in **Figure 1**. This is the switch that turns on and off the high-voltage AC and DC power supplies. (Note: A | indicates the switch on position with a **◯** indicating the switch off position.) The main power switch is locked in the off position by a combination lock, with combination 3 1 1, that will need to be removed and then replaced when you are finished with a lab. **WARNING:** High voltages are present in this laboratory exercise whenever the main power switch is on (upward position) on the Power Supply unit. To minimize the high-voltage hazard, keep the main high-voltage power switch of the Power Supply unit in the off position until you are ready to start an experiment, and then turn off this switch as soon as possible at the conclusion of a given experiment.

The auxiliary low-power supply switch is located at the bottom left of the Power Supply unit illustrated in **Figure 1**, and controls power to the two jacks just to the right of the switch. (Note: A | indicates the switch on position with a **◯** indicating the switch off position.) The auxiliary low-power supply provides power to the Data Acquisition and Control Interface (DACI Unit) by means of a thin power cable connected between the two units. Power must be supplied to the DACI Unit before running the LVDAC-EMS Data Acquisition and Control application on the host computer. Hence, the auxiliary low-power supply is to be turned on at the start of each lab and left on until the lab is completed.

**A picture containing electronics, machine, electronic device, text

Description automatically generated**

**Figure 1**: The LabVolt Power Supply Unit for providing fixed and variable AC and DC voltages.

The LabVolt power supply illustrated in **Figure 1** provides both fixed and adjustable AC and DC output voltages. The left most column of front panel connectors labeled 120/208 V 15 A, provide a fixed 4-wire Wye connected source, with outputs labeled 1, 2, 3 and a neutral N. The middle column of front panel connectors labeled 120/208 V 5 A, provide an adjustable 4-wire Wye connected source, with outputs labeled 4, 5, 6 and a neutral N.

With the main power switch of the Power Supply unit turned on, the voltages at the connectors labeled 1, 2, 3, i.e., V1N, V2N, and V3N, are 120 V rms phase voltages with respect to the Neutral N. The voltages between the connectors labeled 1, 2, 3, i.e., V12, V23, and V31 are fixed line-to-line voltages ideally equal to (120 V rms) = 208 V rms. The voltages at the connectors labeled 4, 5, 6, i.e., V4N, V5N, and V6N are adjustable AC voltages with a maximum value of 120 V rms.

The large dial with an adjustment scale ranging from 0 to 100%, provides the adjustment for the AC and DC adjustable output voltages. The right most column of front panel connectors with the upper two connectors labeled 7 and N is an adjustable DC output voltage, while the lower two DC connectors in the right most DC output column labeled 8 and N provide a fixed DC output voltage as indicated.

The LCD voltmeter illustrated in **Figure 1**, works in conjunction with the selector switch to the right of the LCD display. The selector switch is to be rotated to the desired output voltage for display, with possible options being AC line-to-line voltages V45 or V56, or V64, or AC phase voltages V4N or V5N or V6N, or DC voltages V7N or V8N, with N referring to the Neutral side of the voltages. Note, the Wye connected line-to-line or phase voltages associated with the connectors labeled 1, 2, 3 and N cannot be measured and displayed on the LCD voltmeter associated with the LabVolt Power Supply unit.

Several resettable overcurrent circuit breakers are located at the lower right of the panel. If your lab circuit is not receiving power, first check your connections, and then check for tripped overcurrent breakers, pushing in the button of a tripped breaker to reengage the power to the circuits.

# Data Acquisition and Control Interface (DACI) Unit

The Data Acquisition and Control Interface (DACI) is shown in **Figure 2**. It provides the instrumentation interface between the LabVolt bench and the host computer which runs a virtual instrumentation and control application. The DACI unit has four voltage measurement inputs labeled as E1 through E4, with E corresponding to the measurement of an electromotive force, or emf. The DACI unit also has four current measurement inputs labeled I1 through I4, each offering either a 4 A or 40 A current range. In conjunction with the host software, many various AC or DC measurements can be made by means of the DACI, including voltage, current, power, impedance, phase angle and power factor.

The DACI unit requires a low-voltage power supply for operation. The power input jacks are located at the bottom center of the panel. The jacks are identical and are designed for daisy-chain of multiple units. Make sure that the thin-wire cable is connected between one of these jacks and the similar jacks located on the Power Supply unit. Power must be supplied to the DACI unit before running the Instrumentation and Control application on the lab computer. Turn off the low-voltage power supply switch on the Power Supply unit when a lab is completed.

A picture containing electronics, control panel, machine, amplifier

Description automatically generated

**Figure 2**: The Data Acquisition and Control Interface Unit.

Referring to **Figure 2**, the red and black front panel connectors associated with voltages E1 - E4 are the positive and negative voltmeter connections, respectively. For the current meters I1 – I4 shown in **Figure 2**, the two vertical sets of red front panel input connectors, corresponding to two different range options, 4 A or 40 A, with the default measurement setting in the software being 4 A. Current meters I1 – I4 measure current by means of internal low-resistance sense resistors that convert current to voltage. Blowable fuses in series with low-resistance sense resistors are included to protect against excessive current flow. A blown fuse in a current measurement channel must be replaced to make a given channel functional. 5 A replacement fuses are available and can safely be replaced by making sure that the main power switch for the Power Supply unit is set to the off position (**◯**). The fuses can then be accessed and replaced by sliding the Data Acquisition and Control Interface unit partially out of the LabVolt chassis. Simply choose another current meter channel for measurements if no replacement fuses are available.

# Resistive Load Unit

CAUTION: Make sure that you do not exceed the maximum current rating associated with each resistor, which will be the case if the applied voltage does not exceed 120 V DC or 120 V rms.

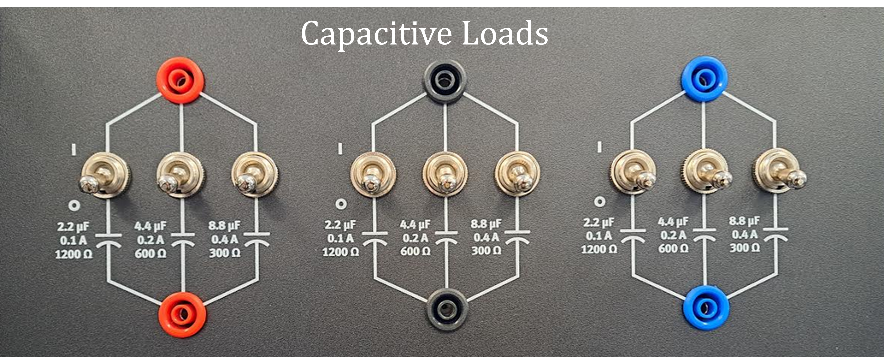
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**Figure 3**: The Resistive Load Unit.

The Resistive Load Unit shown above in **Figure 3**, provides three banks of three parallel resistors that can be used to provide a balanced three-phase load. The three resistor values on each phase are 300 Ω, 600 Ω, and 1200 Ω. Each resistor is individually switched so that you can create various total resistor values. A switch in the up position inserts the associated resistor between the terminal connectors.

# Capacitive Load Unit



**Figure 4**: The Capacitive Load Unit.

The Capacitive Load Unit shown above in **Figure 4**, provides three banks of three parallel capacitors. The three capacitor values are 2.2 µF, 4.4 µF, and 8.8 µF. Each capacitor is individually switched so that you can create various total capacitor values. A switch in the up position inserts the associated capacitor between the terminal connectors.

# Inductive Load Unit

**A close-up of a device

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**Figure 5**: The Inductive Load Unit.

The Inductive Load Unit shown above in **Figure 5**, provides three banks of three parallel inductors. The three inductor values are 3.2 H, 1.6 H, and 0.8 H. Each inductor is individually switched so that you can create various total inductor values. A switch in the up position inserts the associated inductor between the terminal connectors.

**Procedure:**

**WARNING:** High voltages are present in this laboratory exercise. Do not make or modify safety banana jack wiring with the main high-voltage power switch on. Rather keep the main high-voltage power switch of the Power Supply unit in the off position until you are ready to start an experiment and then turn off the switch as soon as possible at the conclusion of a given experiment.

**Part 1 – Basic Phasor Relationships**

A phasor is a complex number that describes the magnitude and phase angle of a sinusoid with respect to a reference sinusoid. In Electromagnetics and Signal Processing the peak value of the sinusoid is used for the phasor magnitude, whereas the rms value of a sinusoid is used for the phasor magnitude in the power industry. For sinusoids, which includes sine and cosine waveforms the relationship between rms and peak values is as follows:

LabVolt AC measurements are in terms of rms. Hence, when comparing calculated and measured phasor quantities in this lab it is necessary to scale measured rms values by to achieve peak values.

1. Make sure that the AC and DC power switches on the **Power Supply Unit** are set to the 0 (off) position.
2. Connect the power input of the **Data Acquisition and Control Interface Unit** to the 24 V power supply on the **Power Supply Unit**. Turn the 24 V power supply on. (Note: This 24 V supply does not present hazardous voltages as does the main power switch for the Power Supply unit, and so the 24 V supply does not need to be turned off until the lab is completed.)
3. Connect the USB port of the **Data Acquisition and Control Interface Unit** to a USB port of the host computer.
4. Turn the host computer on and then start the **LVDAC-EMS** software application. In the **LVDACEMS** start-up window, make sure that the **Data Acquisition and Control Interface Unit** is detected. Set the **Local Network Voltage and Frequency** to **120 V and 60 Hz**, corresponding to the voltage and frequency of our AC power network. Next click **OK** to close the **LVDAC EMS** start-up window.
5. In the **LVDAC-EMS** application, select **Instruments** 🡪 **Metering**. A screen shot of the metering window is illustrated below in **Figure 6**. A total of 18 metering windows are available to accommodate the many possible measurements available with the Metering function.

A screenshot of a computer

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**Figure 6**: Screen Shot of the Metering Window in the LVDAC-EMS Application.

Each of the 18 Individual meters illustrated in **Figure 6** can be configured by clicking on the associated meter label, which opens the **Meter Settings** window. For example, clicking on the meter labeled E1 in **Figure 6** results in the **Meter Settings** window illustrated below in **Figure 7.**

**A screenshot of a computer program

Description automatically generated**

**Figure 7**: Meter Settings Window for Voltage Measurements.

The **Type** options illustrated above in **Figure 7** provide many possible measurement types. The **Input/Function** options illustrated above in **Figure 7** correspond to the measurements available on the **DACI** unit, along with various measurement combinations and functions such as averaging. The **Mode** option illustrated above in **Figure 7**, provides AC (rms) or DC measurements, along with CF for Crest Factor. Meters are enabled/disabled by either clicking on the small square meter label, i.e., M1, M2, etc., illustrated in **Figure 6**, or by clicking the **On** check box illustrated above in **Figure 7**. It is recommended that you turn off all meters that are not actively being used for measurements to avoid confusion.

1. In the main **LVDAC-EMS** software window, select Metering, which opens the **Metering** window and the **Data Acquisition and Control** window as shown below in **Figure 8**. In the **Data Acquisition and Control** window, the 4 A or 40 A Rangesetting of current I1 is shown, with the default being 4 A.

A screenshot of a computer

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**Figure 8**: Meter Range Settings in the **Data Acquisition and Control** Window of the **LVDAC-EMS** software.

1. Configure meter M1 to measure the AC voltage E1and meter M2 to measure AC current I1 using the default 4 A input range. Turn off all other meters in the Metering Window.
2. In the **Meter Settings** window, click on **View** 🡪 **Continuous Refresh**(F6) to enable continuous refresh of the values indicated by the various meters.
3. In **LVDAC-EMS**, select **Instruments** 🡪 **Phasor Analyzer**, then make the appropriate settings to observe the phasor voltage corresponding to meters E1 and I1. Select **View** 🡪 **Color Settings**, in the **Phasor Analyzer** window to change the assigned colors to easily distinguish between .
4. Connect the circuit shown below in **Figure 9a** and **b**, with Zload being a 600 Ω resistor from the **Resistive Load Unit**. Make sure that only the 600 Ω resistor is connected in parallel with E1 by means of the toggle switches with the up position (|) being closed and the down position (**◯**) being open. (Note: Jumper wire colors and LabVolt unit locations shown below in **Figure 9(b)** are only examples and not necessarily what you will encounter.)

A diagram of a circuit

AI-generated content may be incorrect.

(a) Schematic Diagram for AC Load Circuit.

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(b) Wiring Diagram for AC Resistive Load Circuit.

**Figure 9**: (a) Schematic Diagram for AC Load Circuit. (b) Wiring Diagram for AC Resistive Load Circuit.

1. Referring to **Figure 9a**,calculate the theoretical impedance Zload @ 60 Hz for the 600 Ω resistor, an 8.8 μF capacitor, and an 0.8 H inductor, with your calculated results recorded in **Table 1** below using 3 significant digits and appropriate units.
2. Referring to **Figure 9a**, **c**alculate the theoretical phasor current for Zload equal to a 600 Ω resistor, then an 8.8 μF capacitor, and then Zload equal to 0.8 H inductor. For your phasor calculations use peak rather than rms values for the phasor magnitude along with the phase angle in degrees, assuming an applied voltage of 170 peak. Assume an ideal ammeter for I1, which implies 0 V dropped across I1, and an ideal voltmeter for E1 which implies 0 A flowing through E1. Record your calculated phasor values in **Table 1** belowusing 3 significant digits and appropriate units.
3. Turn on the main power switch for the Power Supply unit and observe the measured results in the **Metering** and **Phasor Analyzer** windows, both of which display rms magnitudes. (Note: The rms magnitudes and phase angle in degrees are displayed numerically near the bottom of the **Phasor Analyzer** window.
4. When you are satisfied with the results displayed in the **Phasor Analyzer** window, click on the Single Refresh  icon in the upper right-hand corner of the window to freeze the results for recording.
5. Convert the **Phasor Analyzer** magnitude results from rms to peak and then record both in **Table 1** below. After recording your results in **Table 1** be sure to go back to Continuous Refreshin the **Phasor Analyzer** window for future measurements.
6. Turn off the main power switch for the Power Supply Unit when you are satisfied with your recorded measured results in **Table 1**.

**Table 1**: Calculated and Measured Values for Three Different AC Loads at 60 Hz. (18 points.)

|  |  |  |  |
| --- | --- | --- | --- |
| Load Type | Theoretical Impedance |  |  |
| 600 Ω Resistor |  |  |  |
| 8.8 μF Capacitor |  |  |  |
| 0.8 H Inductor |  |  |  |

1. Replace the resistive Zload in your **Figure 9a** circuit with an 8.8 μF capacitor from the **Capacitive Load Unit**. Make sure that only the 8.8 μF capacitor is connected in parallel with E1 by means of the toggle switches with the up position (|) being closed and the down position (**◯**) being open.
2. Repeat steps 13 – 16 above with the 8.8 μF capacitive load. (Note: Phasor current measurements of the 8.8 μF capacitive load are somewhat noisy.)
3. Replace the capacitive Zload in your **Figure 9a** circuit with an 0.8 H inductor from the **Inductive Load Unit**. Make sure that only the 0.8 H inductor is connected in parallel with E1 by means of the toggle switches with the up position (|) being closed and the down position (**◯**) being open.
4. Repeat steps 13 – 16 above with the 0.8 H inductive load.
5. Turn off the main power switch for the Power Supply Unit when you are satisfied with your recorded measured results in **Table 1**.

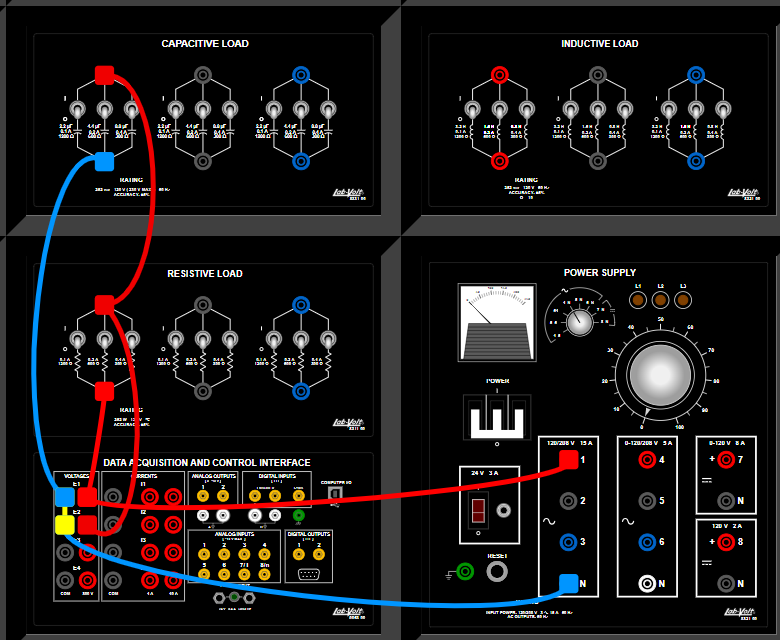
**Part 2 - Series RC Circuit**

1. Connect the circuit shown below in **Figure 10a** and **b**. (Note: Jumper wire colors and LabVolt unit locations shown below in **Figure 10(b)** are only examples and not necessarily what you will encounter.)

A diagram of a circuit

AI-generated content may be incorrect.

(a): Schematic Diagram for Series RC Circuit.



(b): Wiring Diagram for Series RC Circuit.

**Figure 10**: (a) Schematic Diagram for Series RC Circuit. (b) Wiring Diagram for Series RC Circuit.

1. Calculate the theoretical phasor voltage for the **Figure 10** circuit at 60 Hz using peak rather than rms values for the phasor magnitude with the phase angle in degrees. Include your calculated results included in **Table 2** belowusing 3 significant digits and including units. For your calculations assume an applied voltage of 170 peak, along with ideal voltmeters for measuring E1 and E2.
2. Configure meter M1 to measure the AC voltage E1and meter M2 to measure AC voltage E2.
3. In the **LVDAC-EMS** application, choose **Instruments** 🡪 **Oscilloscope**, then make the appropriate settings to observe the voltage waveforms measured by meters E1 and E2 with E1 set as the trigger. Set the Time Base parameter in the **Oscilloscope** window to 2 ms/div. Select the Continuous Refresh icon in the upper right-hand corner of the window. (Note: For the LVDAC-EMS oscilloscope, LA stands for Last Acquisition.)
4. Turn on the main power switch for the Power Supply unit and observe measured results in the **Metering** and **Oscilloscope** windows.
5. When you are satisfied with the results displayed in the **Oscilloscope** window, click on the Single Refresh icon in the upper right-hand corner of the window to freeze the oscilloscope waveforms for easier measurement recording. After recording your measurements be sure to go back to Continuous Refreshfor future measurements.
6. In the **Oscilloscope** Window select **Tools** 🡪 **Horizontal Cursors**. Drag Cursor 1 to the 0 V grid line and the Cursor 2 to the approximate peak voltage of each waveform, for a peak voltage measurement.
7. Record the peak amplitude of E2 as the magnitude of the measured phasor load voltage in **Table 2** below, using 3 significant digits and including units.
8. Using vertical cursors in the **Oscilloscope** window, position Cursor 1 on a zero crossing of the E1 voltage (Reference) waveform and Cursor 2 on a zero crossing of the E2 voltage waveform. Record the time difference between the E1 voltage waveform and the E2 voltage waveform at zero crossings in **Table 2** below,including the sign.
9. The ΔT = Cursor 1 – Cursor 2 difference is numerically displayed at the bottom of the **Oscilloscope** window with a positive number corresponding to Cursor 1 leading Cursor 2 in time and vice versa for a negative number. Yet the sign of ΔT becomes confusing when calculating phase angle because the sign of is opposite the sign of the corresponding phase angle. Hence, the magnitude of ΔT is used in the following calculations, followed by remembering that a positive phase angle corresponds to a phase lead, whereas a negative phase angle corresponds to a phase lag.

The magnitude of the phase angle in degrees between the two waveforms can be estimated as follows, where ∆T is the magnitude of time difference between cursors, T is the period of the waveform, and is the magnitude of the phase angle in degrees between the waveform of interest and the reference waveform.

1. Based on your measured time differences between waveforms, calculate the phase angle of the measured E2 voltage waveform in degrees, entering your results in **Table 2** as ΔT˚using 3 significant digits and including units. (Note: Verify that your calculated and measured phasor current are in reasonable agreement with the **Phasor Analyzer** before proceeding.)

**Table 2**: Calculated and Measured Phasor Voltage for the Series RC Circuit of **Figure 10**. (10 points.)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Theoretical Series RC Impedance |  | ∣ΔT∣ | ΔT˚ including sign |  |
|  |  |  |  |  |

**Part 3 - Series RL Circuit**

1. Connect the circuit shown below in **Figure 11a** and **b**. (Note: Jumper wire colors and LabVolt unit locations shown below in **Figure 11(b)** are only examples and not necessarily what you will encounter.)

A diagram of a circuit

AI-generated content may be incorrect.

(a): Schematic Diagram for Series RC Circuit.

A black panel with many switches and knobs

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(b): Wiring Diagram for Series RC Circuit.

**Figure 11**: (a) Schematic Diagram for Series RC Circuit. (b) Wiring Diagram for Series RC Circuit.

1. Calculate the theoretical phasor voltage for the **Figure 11** circuit at 60 Hz using peak rather than rms values for the phasor magnitude with the phase angle in degrees. Include your calculated results included in **Table 3** belowusing 3 significant digits and including units. For your calculations assume an applied voltage of 170 peak, along with ideal voltmeters for measuring E1 and E2.
2. Verify that meter M1 is configured to measure the AC voltage E1and meter M2 to measure AC voltage E2.
3. In the **LVDAC-EMS** application, choose **Instruments** 🡪 **Oscilloscope**, then make the appropriate settings to observe the voltage waveforms measured by meters E1 and E2 with E1 set as the trigger. Set the Time Base parameter in the **Oscilloscope** window to 2 ms/div. Select the Continuous Refresh icon in the upper right-hand corner of the window. (Note: For the LVDAC-EMS oscilloscope, LA stands for Last Acquisition.)
4. Turn on the main power switch for the Power Supply unit and observe measured results in the **Oscilloscope** window.
5. When you are satisfied with the results displayed in the **Oscilloscope** window, click on the Single Refresh icon in the upper right-hand corner of the window to freeze the oscilloscope waveforms for easier measurement recording. After recording your cursor measurements be sure to go back to Continuous Refreshfor future measurements.
6. Using horizontal cursors in the **Oscilloscope** window, record the peak amplitude of E2 as the magnitude of the measured phasor load voltage in **Table 3** below, using 3 significant digits and including units.
7. Using vertical cursors in the **Oscilloscope** window, with Cursor 1 on the E1 voltage (Reference) waveform, record the time difference between the E1 voltage waveform and the E2 voltage waveform at zero crossings in **Table 3** below,including the sign.
8. Based on your measured magnitude of the time difference between waveform zero crossings, calculate the phase angle of the measured E2 voltage waveform in degrees, entering your results in **Table 3** as ΔT˚using 3 significant digits and including units. (Note: Verify that your calculated and measured phasor current are in reasonable agreement with the **Phasor Analyzer** before proceeding.)

**Table 3**: Calculated and Measured Phasor Voltage for the Series RC Circuit of **Figure 11**. (10 points.)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Theoretical Series RL Impedance |  | ∣ΔT∣ | ΔT˚ including sign |  |
|  |  |  |  |  |

**Discussion and Conclusions Questions:** (Note: For the following questions use your own words along with complete sentences. Points are to be deducted for AI generated answers.)

1. Describe what the phasor output voltage represents in a series RC circuit of **Figure 10** or the series RL circuit of **Figure 11**. (2 points.)
2. Is the circuit of **Figure 10** a lowpass or highpass filter, and why? (2 points.)
3. A diagram of a circuit

   AI-generated content may be incorrect. Given that VC(t) = Vmcos(2πft) along with , show that the current leads the voltage by 90˚ in the adjacent circuit by determining in terms of a cosine term, using the identity: .

(3 points.)

**Figure 12**: Circuit Illustrating Phasor Voltage and Current for a Capacitor.

1. **Extra Credit Problem**: What causes your **Table 1** phasor current phase angle measurement for the 0.8 H inductor to be somewhat less than the theoretical value? (2 points.)

**LabVolt Phasor Lab Grading Rubric:** **You can work in groups of up to three if desired for this hardware lab. Teams that have four or more persons make working with the equipment difficult. Submit an electronic version of a lab report to receive credit for doing this lab.** The goal of your **lab report is to provide sufficient documentation so that the lab can be repeated if necessary**. Therefore, simply add to this document to arrive at your lab report, as all the explanatory text, procedures, and Discussion and Conclusion questions contained in this document are required for a complete lab report. So for your lab report, **add a cover page that includes the name or names, class and name of the lab. Also add in your results, and answers to the Discussion and Conclusions questions to the existing lab document**. While you are to share all **Procedure** items with any lab partners, your **Discussion and Conclusions** section is to be uniquely yours.

|  |  |
| --- | --- |
| **Lab Report Item** | **Points** |
| Cover Page | 2 |
| **Part 1** – **Basic Phasor Relationships**  **Table 1**: (18 points total. 2 points for each reasonable calculated and measured value.) | 18 |
| **Part 2 - Series RC Circuit**  **Table 2**: (10 points total. 2 points for each reasonable calculated and measured value. -0.5 for each missing or incorrect unit. -0.5 for each incorrect sign.) | 10 |
| **Part 3 - Series RL Circuit**  **Table 3**: (10 points total. 2 points for each reasonable calculated and measured value. -0.5 for each missing or incorrect unit. -0.5 for each incorrect sign.) | 10 |
| Discussion and Conclusions | 7 |
| Grammar and Professionalism | 3 |
|  |  |
| **Total** | 50 |

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