LAB MANUAL

Note:

- The Two Port Network lab should be completed using the available ULABS works software available for download. Please read the instruction notepad file attached with the software in zip folder and the software instruction after installation is complete.
- The Alternative Current Circuit Lab should be completed using the online Utech Virtual lab by clicking on the Alternative Current Circuit Lab portal.

University of Technology, Jamaica
School of Engineering
Electrical Networks 2

Alternating Current Circuits Fundamentals

Objectives: At the end of this laboratory exercise students should be able to

1. Use appropriate laboratory techniques and equipment to determine the voltage and phase relationships between series circuit elements
2. Determine the active power dissipated in an electric circuit by current measurement
3. Derive the apparent and reactive power within a circuit based on the measured values

Introduction

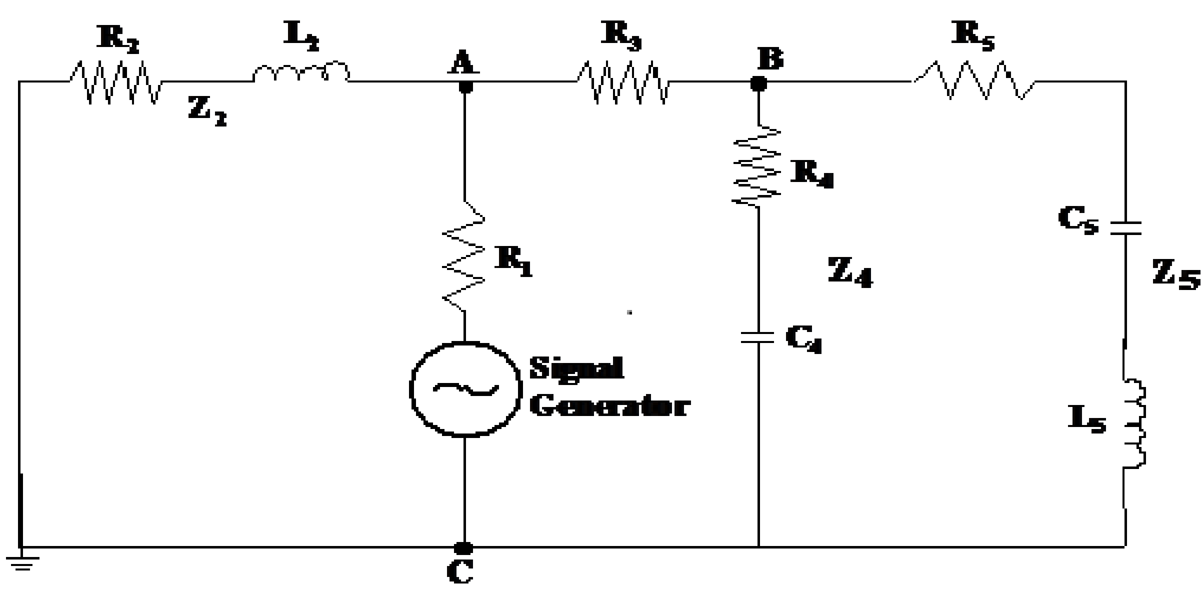
In order to fully describe the operation of alternating current circuits, it is necessary to know the magnitude as well as the phase relationships between the currents and voltages that are present. The standard methods of using analogue or digital multimeters for measurements must therefore be supplemented by the use of oscilloscopes or any other instrument deemed necessary.

In this laboratory exercise, students will be required to pull on their experience from Electrical Networks 1 to carry out voltage, current and phase measurements.

In contrast to the standard approach to laboratory exercises, students will be required to succinctly outline the methods by which each activity is carried out.

Getting started

All activities will be based on the electrical network shown below.



Apparatus

Signal Generator, Digital Multi-meter, Oscilloscope,
Impedances –

- Z_2 - (L_2 = 10 mH; R_2 = 40Ω)
- Z_4 – (C_4 = 3µF; R_4 = 80Ω)
- Z_5 – (L_5 = 30 mH, C_5 = 2µF, R_5 = 60Ω)
- R_3 = 150Ω
- R_1 = 100Ω

Instructions

1. Set and verify the frequency of the signal generator to 250 Hz.

2. Adjust its output until the voltage drop across points “AB” is 20V.

3. Measure the relevant branch voltages and currents:

    a. determine the phase relationships in the branches containing reactive elements;
    b. hence determine the active power dissipated
        i. based on the measured values
        ii. based on the nominal values
    c. use graphical sketches to show the phase relationships for impedances 2, 4 and 5

4. Determine the phase relationship between the supply current and voltage; hence determine the apparent power supplied to the circuit

5. Determine the current through each reactive element and use it to verify the reactive power derived from the measurements in steps 3 and 4

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School of Engineering
Electrical Networks 2

Two-Port Networks

Objectives: At the end of this laboratory exercise students should be able to

1. Use appropriate laboratory techniques and equipment to determine the impedance and the admittance parameters of resistive two-port networks
2. Determine network parameters of interconnected networks
3. Use the derived parameters to determine the power dissipated in connected loads

Introduction

Network parameters are used to determine the relationship between the input and output voltages and currents. These relationships can be expressed as linear equations and hence facilitate the use of the superposition theorem to determine their individual values.

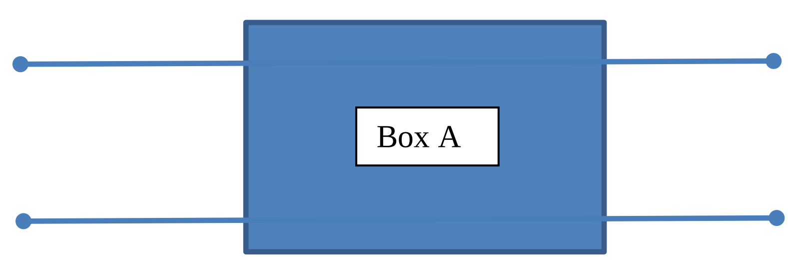
For given sets of network parameters conversion to other parameters can be determined by using standard transformation matrices.

In this laboratory exercise, students will be required to pull on their experience from Electrical Networks 1 to carry out voltage and current measurements using them to determine the parameter being considered.

In completing the laboratory exercise students will be required to succinctly and clearly outline the methods by which each activity is carried out.

Getting started

All exercises will be based on the two “black boxes” supplied to each group.



Apparatus

Voltage Supplies
Voltmeters
Ammeters
Ohmmeter
(Multimeters)
2 Black Boxes

Instructions

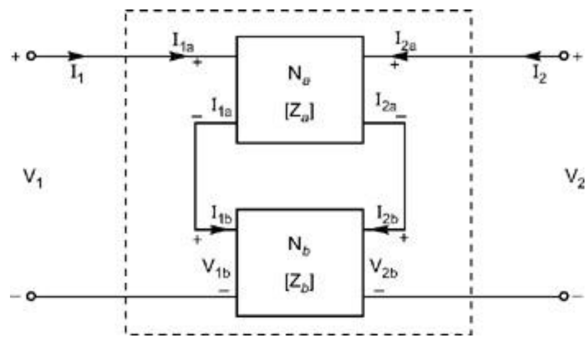
1. Label each black box as “A” and “B” and ensure that this nomenclature is maintained throughout the experiment.

2. Carryout appropriate measurements to determine the open circuit and short measurements on each black box and use your results to determine which of the black boxes are symmetrical or asymmetrical

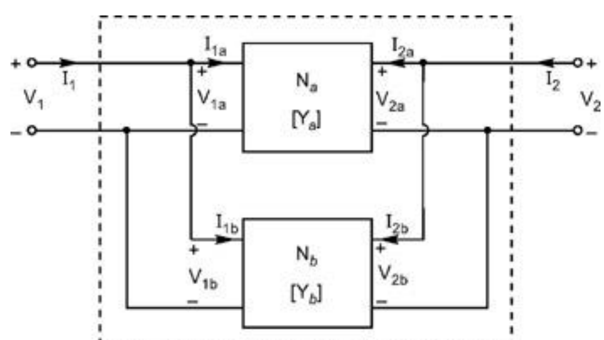
3. Determine, using appropriate measurements the admittance parameters of box “A” and the impedance parameters of Box “B”

4. Using the appropriate conversion matrix, determine the corresponding impedance and admittance parameters for boxes “B” and “A” respectively.

5. Connect box “A” in series with box “B” as shown below, and determine the impedance parameters of the combined network. What is the relationship between the impedance parameters of each network and that of the combined network?



6. Connect box “A” in parallel with box “B” as shown below, and determine the admittance parameters of the combined network. What is the relationship between the admittance parameters of each network and that of the combined network?



7. Connect box “A” in cascade with box “B” by connecting the output of network “A” to the input of network “B”, and determine the transmission parameters of the combined network. What is the relationship between the transmission parameters of each network and that of the combined network?

8. Based on the impedance values determined for box “A” request a set of three resistors with values that are comparable to the input impedance parameter. Also request a load resistor of value approximately twice as large as the output impedance determined. Use your three resistors to form

   a. A “pi” network
   b. A “T” network

   Connect the voltage supply and set its value to 10V for each input network and determine the corresponding power dissipated in the load.

   Use appropriate calculations to verify the values measured for each connection above.

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Electrical Networks 1

4. Network Theorems

Introduction

Three network theorems are investigated: Superposition theorem, Thevenin's theorem, and the Maximum Power Transfer Theorem. In each case, resistances and power supplies are connected into the appropriate configurations. The voltage and current levels throughout each circuit are carefully measured for comparison to the values calculated.

Equipment

Two DC Power Supplies - (0 to 30 V, 100 mA)
DC Ammeter
DC Voltmeter
Three Decade Resistance Boxes - (0 to 10 kΩ, 20 mA)
Resistors: 330 Ω, 560 Ω, 680 Ω, 820 Ω

Procedure 1: Superposition Theorem

1-1 Identify the three decade resistance boxes as R_1, R_2 and R_3, and set them to the resistance values; 120 Ω, 240 Ω, and 200 Ω respectively.

1-2 Identify the two Power Supplies as E_1 and E_2, adjust the voltages to 6 V and 12 V respectively, and connect up the circuit as shown in Fig.1. Note that the ammeter is connected in series with R_3.

1-3 Check the voltage levels of E_1 and E_2 and adjust if necessary, then carefully observe and record the level of current I_3

1-4 Disconnect voltage E_2 and replace it with a short circuit. Observe and record the level of current I_a.

1-5 Remove the short-circuit, and reconnect the voltage E_2. Disconnect voltage E_1, and replace it with a short-circuit. Observe and record current I_b'

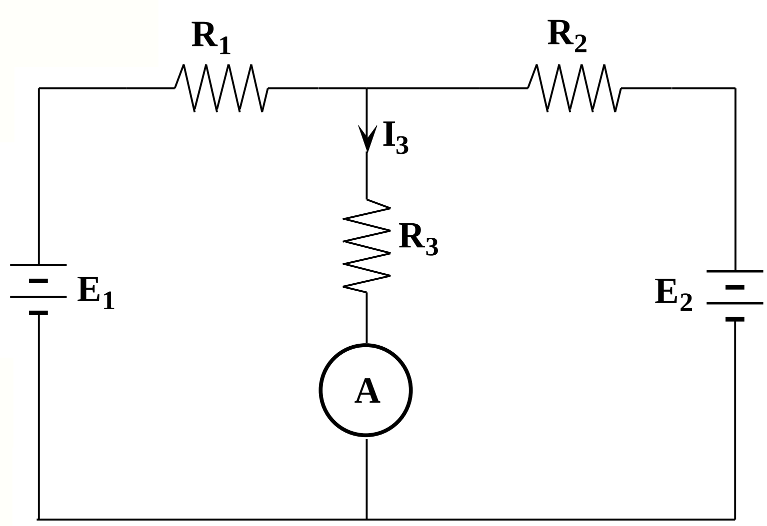

Figure 1

Procedure 2: Thevenin's Theorem

2-1 Reconstruct the circuit of Fig.1 once again.

2-2 Connect a voltmeter and a load resistor $R_L = 330\ \Omega$ across R_3. as in Fig. 2.

2-3 Measure and record the level of the load voltage V_{L1}.

2-4 Remove the 330 Ω load resistor and successively connect $R_{L2} = 560\ \Omega$. $R_{L3} = 680\ \Omega$ and $R_{L4} = 820\ \Omega$. In each case record the levels of V_{L2}. V_{L3}. and V_{L4}.

2-5 Construct the Thevenin equivalent circuit in Fig.3 using a decade resistance box for $R_S = 57.1\ \Omega$. Carefully adjust E_{TH} to 5.71 V.

2-6 Successively connect load resistors $R_{L1} = 330\ \Omega$, $R_{L2} = 560\ \Omega$, $R_{L3} = 680\ \Omega$ and $R_{L4} = 820\ \Omega$. In each case measure and record V_{L1}, V_{L2}, V_{L3} and V_{L4}.

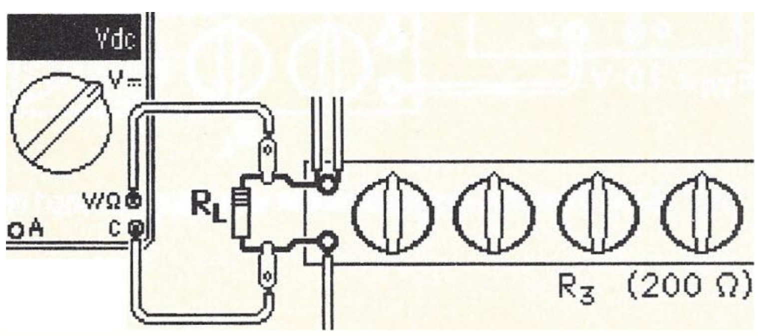

Figure 2

Procedure 3 Maximum Power Transfer Theorem

3-1 Using a dc power supply and two decade resistance boxes, construct a Thevenin equivalent circuit with a variable load, as in Fig. 4. Set the voltage to $E_{TH} = 10$ V, and the source resistance to $R_{TH} = 500\ \Omega$.

3-2 Connect a voltmeter to monitor the load voltage V_L.

3-3 Adjust the load resistor through: 50 Ω, 100 Ω, 250 Ω, 500 Ω,1 k Ω, 2.5 k Ω, and 5 k Ω. For each value of R_L measure and record the level of V_L.

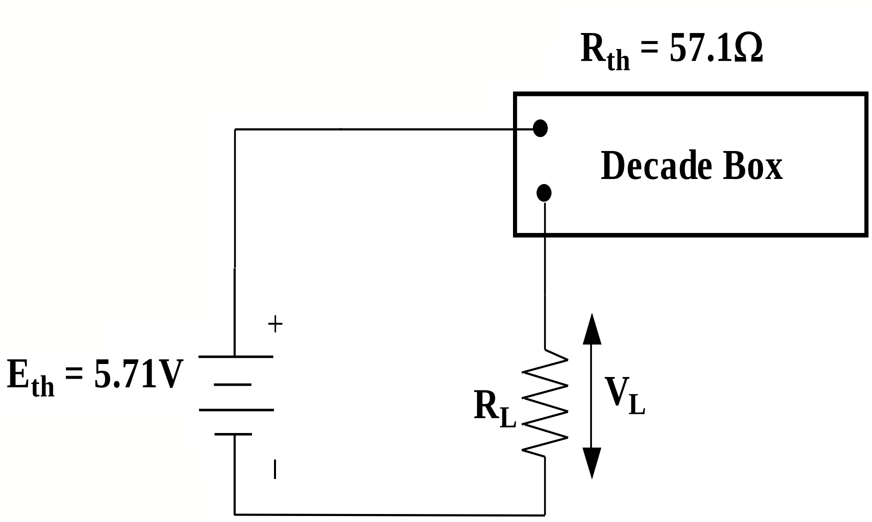

Figure 3

Analysis

1. Compare the levels of I_3, I_a and I_b measured in Procedure 1 to the calculated values.

2. Compare the voltages measured in Procedure 2-3 and 2-4 to the corresponding voltage values measured in Procedure 2-6. Also use V_{L1} to calculate I_L, and compare it to the value of I_L calculated

3. From the results of Procedure 3, calculate the values of I_L and P_L for each load resistance. Plot the graphs of V_L, I_L and P_L approximately to a logarithmic base of R_L.

Procedure 1: Superposition Theorem

I_3	I_a	I_b

Procedure 2: Thevenin's Theorem

R_L	330Ω	560Ω	680Ω	820Ω
V_L				

R_L	330Ω	560Ω	680Ω	820Ω
V_L				

Procedure 3: Maximum Power Transfer Theorem

R_L	50Ω	100Ω	250Ω	500Ω	1 kΩ	2.5 kΩ	5 kΩ
V_L							

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Electric Networks 1
3A. Series Resistive Networks

Introduction

Three measured resistors are connected in series, and their total resistance is measured. The circuit is then connected to a power supply; the voltage drop across each resistor is investigated, and the current flowing is monitored at several points in the circuit. Short-circuits and open-circuits are created to study the effects. A 1.5 V battery is connected alternatively series-aiding and series- opposing with the power supply, to observe its effect upon the circuit current. Finally, a two-resistor voltage divider and a potentiometer are investigated.

Equipment

DC Power Supply - (9 V, 50 mA)
DC Ammeter & Voltmeter
Ohmmeter
Resistors: R1 = 2.2 kΩ, R2 = 1.5 kΩ, R3 = 470 Ω
Potentiometer: 5 kΩ
Voltage cell: 1.5 V

Procedure 1 Resistors in Series

1. Using the Ohmmeter, carefully measure the resistance of the three resistors: R_1, R_2 and R_3. Record the measured value of each component along with the color coded value

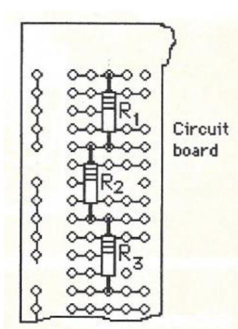

Figure 1

2. Connect the resistors in series as shown in Fig. 5-1 (a) in the text book, (see Fig. 1). Do not connect any battery or power supply

3. Use the Ohmmeter to measure the total resistance. Record the measured total resistance and the total resistance as determined from the colour code.

4. Connect the Power Supply, voltmeter, ammeter and resistors as in Figure 2. **(see below)**
5. Adjust the Power Supply to give E = 9 V.
6. Use the voltmeter to measure V_{R1}, V_{R2} and V_{R3}
7. Successively connect the ammeter directly in series with each resistor in turn. For each ammeter position, carefully observe and record the measured current level.
8. With the ammeter connected to monitor the power supply current, temporarily short-circuit R_3. Observe and record the new level of current indicated on the ammeter.

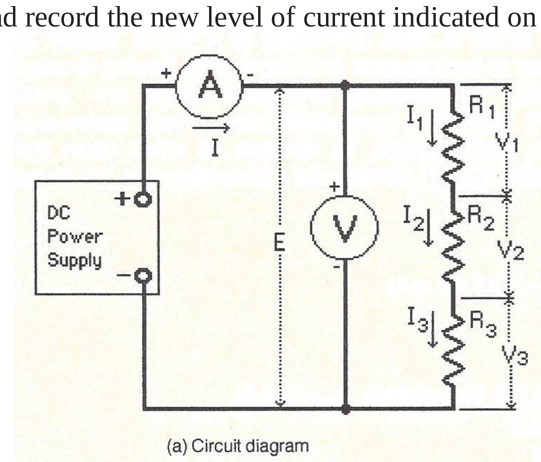

Figure 2

9. Open-circuit the connection between R_2 and R_3, and connect the voltmeter across the open-circuit.

Record the measured voltage level. Also, observe and record the new current level indicated on the ammeter

10. Remove the voltmeter and reconnect the components as shown in Figure 2.
11. Connect a 1.5 V voltage cell in series with the Power Supply and resistors; first in series-aiding, then in series-opposing, (see Figure 3). In each case carefully note the indicated current level

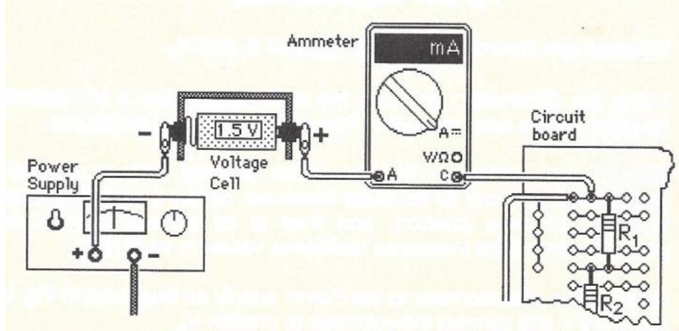

Figure 3

Procedure 2 - Voltage Dividers

1. Connect resistors R1 and R2 as a voltage divider, as shown in Figure 4.
2. Measure and record the levels of voltages V_1 and V_2.
3. Using the Ohmmeter, measure the resistance of the 5 kΩ potentiometer between its two outer terminals. Record the measured resistance

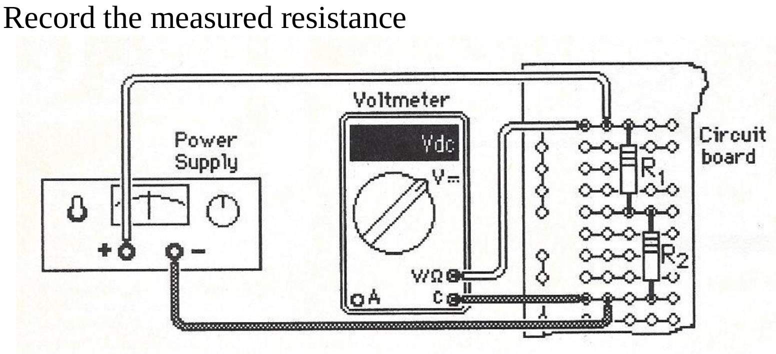

Figure 4

4. Measure the resistance from the center (moving contact) terminal of the potentiometer to one of the outer terminals. Adjust the potentiometer to its extreme clockwise position, and then to its extreme counter-clockwise position. Record the measured resistance values in each case.
5. Connect the potentiometer to the Power supply as illustrated in Figure 5. Set E = 9 V and connect the voltmeter to monitor V_o

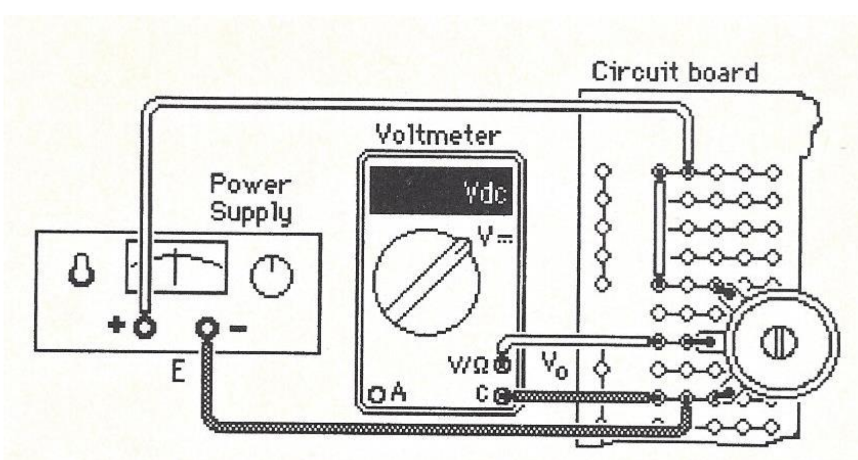

Figure 5

6. Carefully adjust the potentiometer to its extreme clockwise position, then to its extreme counter-clockwise position. Observe and record the maximum and minimum values of V_o
7. Connect the resistor R1 in series with the potentiometer [as in Fig. L3-6(b)], and again apply E = 9 V. Repeat Procedure 2-6

Analysis

1. Analyze the three-resistor series circuit to determine total resistance, circuit current, resistor voltages, power dissipated in each resistor, and total circuit power. Record the calculated quantities together with the measured quantities.
2. Calculate the value of circuit current that flows when resistor R3 is short-circuited. Record this calculated value together with the current level measured in procedure 1-8. Briefly explain.
3. Discuss the voltage and current levels measured for the open-circuit condition in "**Procedure 1-9**"
4. Determine the levels of current that should flow when the 1.5 V cell is connected in series-aiding and series-opposing, as in Procedure 1-11. Also, determine the voltage drop across each resistor for each of the two cases. Relate the voltage drop in each case to Kirchhoff's Voltage Law.
5. Calculate the voltage levels V 1 and V 2 for the voltage divider and potentiometer circuits investigated in Procedure 2. Compare the calculated and measured voltages. Calculate the power dissipated in each component

Series Resistive Circuits

Procedure

1-1 Resistor Values

	Colors	Color-coded resistance	Measured resistance
R_1			
R_2			
R_3			

1-3 Total Resistance

	Measured resistance	Calculated resistance
$R_1 + R_2 + R_3$		

1-6 Voltages

	E	V_1	V_2	V_3
Measured Voltage	9 V			
Calculated Voltage	9 V			

1-7 Current Levels

I_1	I_2	I_3

1-8 R_3 short-circuited

I = ________

1-9 R_2 R_3 open-circuited

Open-circuit voltage	I

1-11 Voltage cell connected

	series-aiding	series-opposing
I		

2-2 Voltage Divider

V_1	V_2

2-3 & 2-4 Potentiometer

Total Resistance	Resistance range

2-6 & 2-7 Potentiometer voltage

	$V_{(min)}$	$V_{(max)}$
Without R_1		
With R_1		

3B. Parallel Resistive Networks

Introduction

Four measured resistors are connected in parallel, and the parallel circuit resistance is measured. The four (parallel-connected) resistors are then connected to the terminals of a power supply. The terminal voltage of each resistor, the supply current, and the current flowing in each resistor are all measured. An open-circuit is created to observe its effect upon the supply current. Finally a two-resistor current divider circuit is investigated.

Equipment

DC Power Supply - (0 to 24 V, 50 mA)
DC Ammeter & Voltmeter
Ohmmeter
Resistors - $R_1 = 2.2\ k\Omega$, $R_2 = 5.6\ k\Omega$, $R_3 = 3.3\ k\Omega$, $R_4 = 4.7\ k\Omega$

Procedure 1 Resistors in Parallel

1. Use the Ohmmeter to measure the resistance value of each resistor. Record the measured value along with the color coded values of each component.
2. Connect R_1, R_2, R_3 and R_4 in parallel as shown in Figure 1.

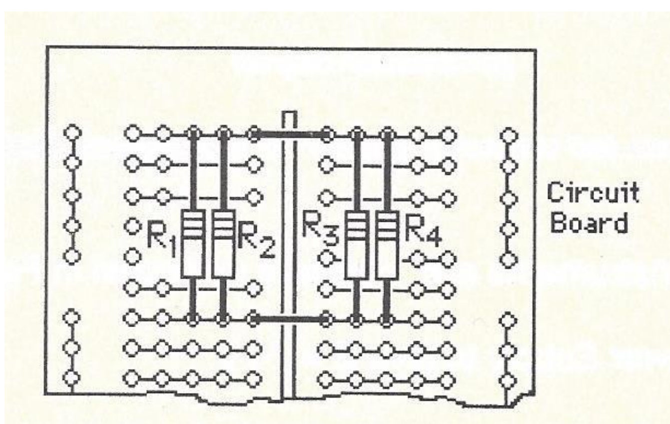

Figure 1

3. Use the Ohmmeter to measure the resistance of the four resistors in parallel. Record the measured resistance, and calculate the parallel equivalent resistance using the color-coded values.
4. Connect the instruments and resistors as shown in Figure 2 and adjust the Power Supply to give E = 24 V.

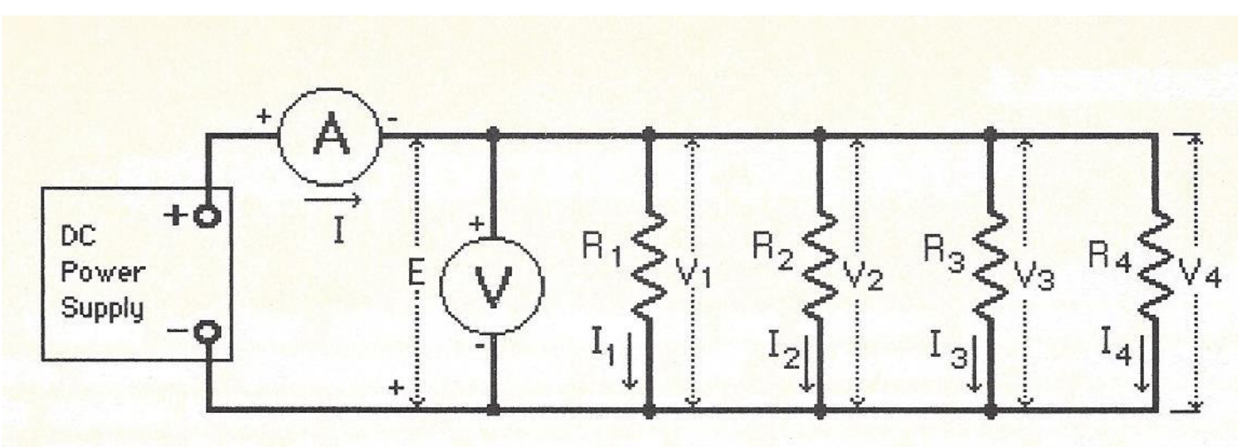

Figure 2

5. Use the voltmeter to measure the terminal voltage of each resistor. Record each measured voltage.
6. Record the level of supply current indicated by the ammeter, then successively connect the ammeter in series with each resistor in turn to measure I_1, I_2, I_3 and I_4. Record all current levels.
7. Reconnect the ammeter to measure the supply current once again. Open- circuit resistor R_1. Carefully observe and record the new level of supply current

Procedure 2 Current Dividers

1. Connect the resistors R_1 and R_2 in parallel as shown in Figure 3 and adjust the power supply to give E = 9 V.
2. Successively connect the Ammeter to measure I, I_{R1} and I_{R2} in turn. Record each current level.

Analysis

1. Analyze the four-resistor circuit to determine the parallel equivalent resistance, each resistor current, the power dissipation in each resistor, and the total circuit power. Record the measured and calculated quantities. Relate the measured current levels to Kirchhoff's Current Law.
2. Convert each resistor to a conductance, and then repeat the analysis of the four-resistor circuit to determine all current levels.
3. Calculate the level of supply current that flows when R1 is open-circuited. Record the measured and calculated current levels.
4. Analyze the two-resistor parallel circuit to determine the total supply current, then use the current divider equation to calculate each resistor current.
Tabulate the calculated and measured current levels

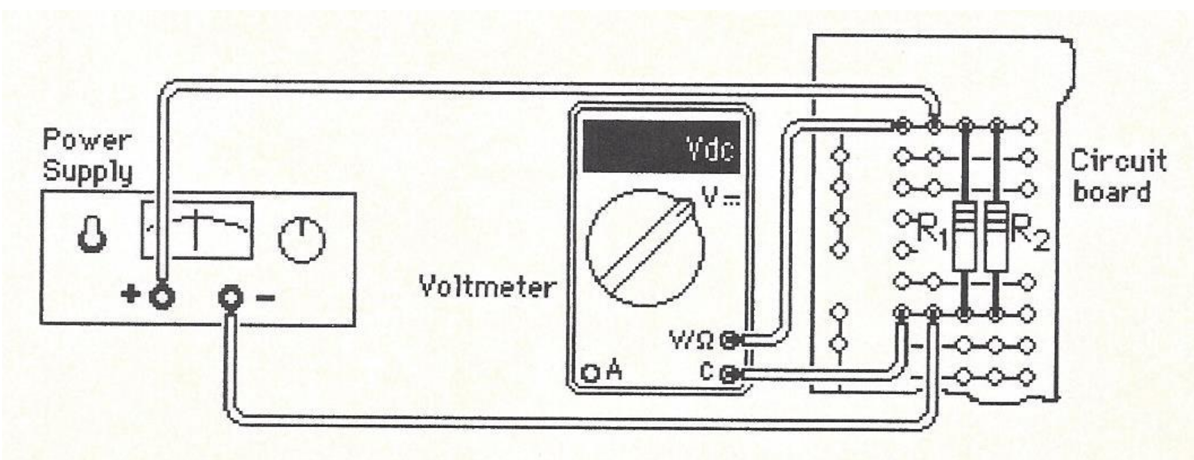

Figure 3

Parallel Resistive Circuits

Procedure

1-1 Resistor values

	Colors	Color- coded resistance	Measured resistance
R_1			
R_2			
R_3			
R_4			

1-3 Total Parallel resistance

	Measured resistance	Calculated resistance
$R_1 \| R_2 \| R_3 \| R_4$		

1-6 Measured voltages

E	V_1	V_2	V_3	V_4
24 V				

1-7 Measured currents

I	I_1	I_2	I_3	I_4

1-8 R_1 open-circuited

Supply current I = ____________

2-2 Current Divider

I	I_1	I_2

3C. Series - Parallel Resistive Networks

Introduction

Five resistors are measured and then connected to form the series-parallel circuit shown in Figure 7-14 in the text book. Each resistor terminal voltage and current level is carefully measured. The supply current is monitored, and the effect of open-circuiting and short-circuiting one resistor is investigated.

Equipment

DC Power Supply - (15 V, 50 mA)
DC Ammeter & Voltmeter
Ohmmeter
Resistors: $R_1 = 4.7\ k\Omega$, $R_2 = 39\ k\Omega$, $R_3 = 27\ k\Omega$, $R_4 = 5.6\ k\Omega$, $R_5 = 22\ k\Omega$

Procedure

1. Use the ohmmeter to measure the resistance value of each resistor. Record the measured and color-coded resistances.
2. Connect the components as shown in Figure 1. *Do not connect any battery or power supply at this time*

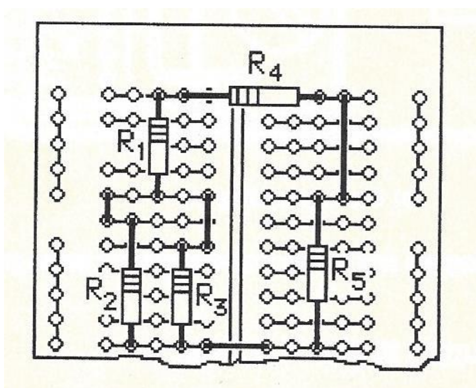

Figure 1

3. Use the ohmmeter to measure the total circuit resistance. Record the measured value.
4. Connect a power supply, voltmeter, and ammeter to the circuit, as in Figure 2

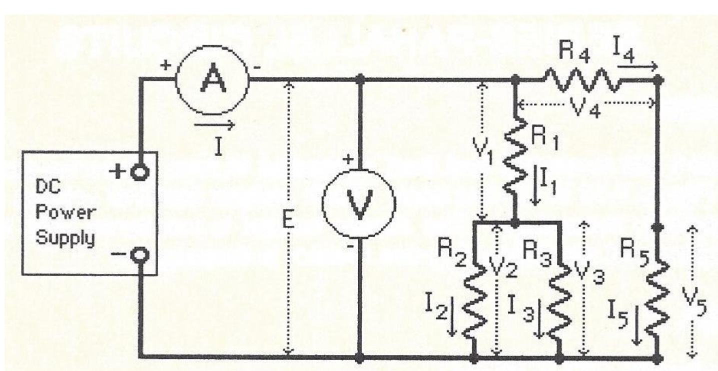

Figure 2

5. Adjust the power supply to give E = 15 V.
6. Measure and record the terminal voltage of each resistor.
7. Record the level of the current drawn from the power supply, then successively connect the ammeter in series with each resistor to determine the currents I_1, I_2, I_3, I_4 and I_5 Record all measured current levels.
8. Once again connect the Ammeter to monitor the supply current. Open-circuit resistor R3 and note the effect on the supply current. Short-circuit R3 and again note the effect on the supply current.

Analysis

1. Compare the measured values of current, voltage and total circuit resistance to those calculated
2. Calculate the level of Power Supply current that flows when R3 is open- circuited, and when R3 is short-circuited. Compare the calculated values to the measured current levels.

Series-Parallel Circuit

Procedure

1. Resistor values

	Colors	Color- coded resistance	Measured resistance
R_1			
R_2			
R_3			
R_4			
R_5			

3. Series-parallel resistance

	Measured resistance	Calculated resistance
R		

6. Measured voltages

E	V_1	V_2	V_3	V_4	V_5
15 V					

7. Measured currents

I	I_1	I_2	I_3	I_4	I_5

8. Open-circuit and short-circuit

	R_3 open	R_3 shorted
supply current		

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Electric Networks 1
6. Series AC Circuits and Resonance

Introduction A

A sinusoidal signal is applied to series resistive-inductive and resistive-capacitive circuits, and the voltages developed across the resistor and inductor and resistor and capacitor are investigated for amplitude and phase relationship to the input. A square wave input is next applied, and the voltages are again investigated.

Equipment

Dual-trace Oscilloscope
Low Frequency Signal Generator - (Sine and Square Waves)
8-15 H Inductor - (winding resistance less than 500 Ω)
0.1 pF capacitor
4.7 kΩ Resistor - (*114* W or larger)

Procedure 1

1. Connect the 4H inductor and 4.7 kΩ resistor to the signal generator as illustrated in Fig.1.

2. Connect the oscilloscope to monitor the input voltage *(E)* and the inductor voltage (V_L). **The two ground terminals of the oscilloscope inputs should be connected to lower terminal of the inductor**.

3. Switch *on* the signal generator and set it to give a sine wave output with a frequency of 250 Hz. Adjust the signal amplitude to give waveforms which approximately fill half the oscilloscope screen.

4. Set the oscilloscope to trigger positively on the input waveform, and adjust the time base to display approximately one cycle of each waveform.

5. Measure the waveform amplitudes and phase. Enter the measured quantities on the record sheet.

6. Reconnect the oscilloscope to monitor E and V_R'. **This time connect the two ground terminals of the oscilloscope to the top of R**.

7. Repeat Procedure 5.

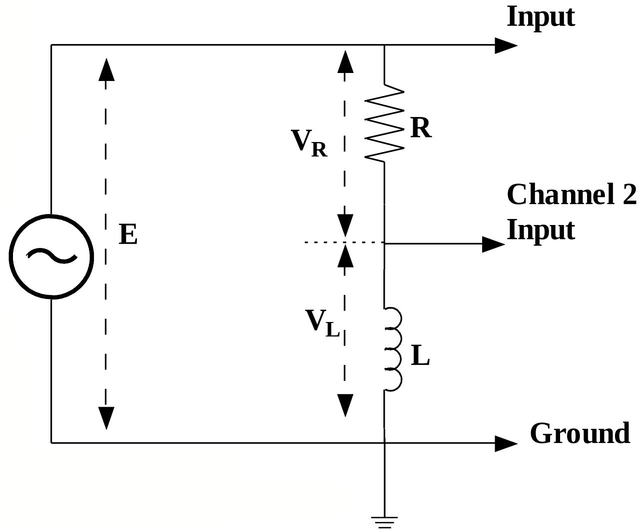

Figure 1

8. Switch the signal generator output to square wave.

9. Observe the waveforms of E and V_R on the oscilloscope. Carefully measure the waveform amplitudes and note their phase relations. Record the measured quantities and sketch the waveforms on the record sheet.

10. Reconnect the oscilloscope to monitor E and V_L once more. Again connect the grounded input terminals to the lower terminal of L in the circuit diagram.

11. Sketch the waveforms, and carefully measure and record the amplitude and phase relationships of E and V_L.

Analysis

1. Use the waveform amplitudes and phase relationships experimentally determined during Procedures 1 through 7 to sketch the waveforms of I, V_R, V_L and E.

2. Sketch a phasor diagram for the LR circuit, using the measured values of V_L, E, V_R and φ.

3. Briefly explain the waveforms obtained in Procedures 9 and 11

Procedure 2

1. Connect the 0.1 pF capacitor and 4.7 kΩ resistor to the signal generator as illustrated in Fig.2.

2. Connect the oscilloscope to monitor the input voltage *(E)* and capacitor voltage *(Vc)*. The two ground terminals of the oscilloscope input should be connected to the lower terminal of the capacitor in the circuit diagram; that is, to the capacitor terminal connected to the signal generator.

3. Switch *on* the signal generator and set it to give a sine wave output with a frequency of 250 Hz. Adjust the signal amplitude to give waveforms which each approximately fill half of the oscilloscope screen.

4. Set the oscilloscope to trigger positively on the input waveform, and adjust the time base to display one cycle of each waveform.

5. Measure the waveform amplitudes and phase. Enter the measured quantities on the record sheet.

6. Reconnect the oscilloscope to measure E and V_R. This time connect the two ground terminals of the oscilloscope to the top of R in the circuit diagram.

7. Repeat Procedure 5.

8. Switch the signal generator output to square wave.

9. Observe the waveforms of *E* and *VR* on the Oscilloscope. Carefully measure the waveform amplitudes and note their phase relationships. Record the measured quantities and sketch the waveforms on the record sheet.

10. Reconnect the oscilloscope to monitor *E* and *Vc* once again. Again connect the grounded inputs to the lower terminal of C in the circuit diagram.

11. Carefully measure the amplitudes and phase relationships of *E* and *V* c. and sketch the waveforms.

Analysis

1. Use the waveform amplitudes and phase relationships experimentally determined during procedures 1 through 7 to sketch the waveforms of I, V_R, Vc.

2. Sketch a phasor diagram for the CR circuit using the measured values of V_C E, V_R and φ.

3. Briefly explain the waveforms obtained in Procedures 9 and 11.

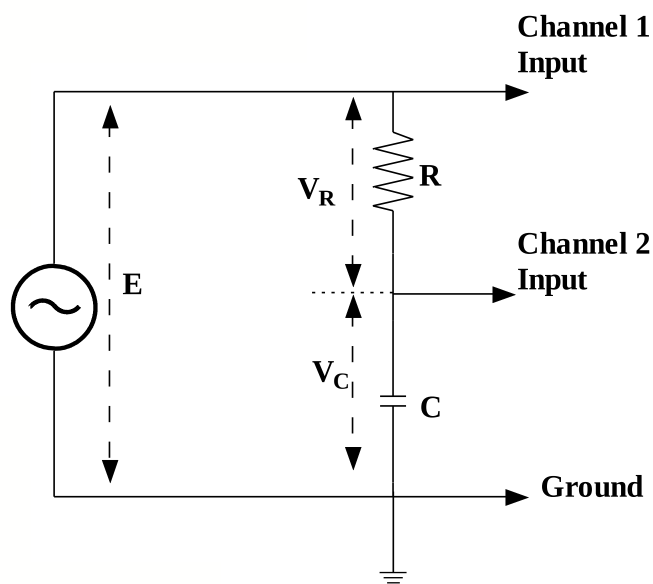

Figure 2

Introduction B

A series impedance circuit is constructed and supplied from a signal generator. An oscilloscope is used to measure the voltage at various points in the circuit, and to determine the phase angle of each voltage with respect to the supply. A parallel impedance circuit is also constructed and supplied from a signal generator. The oscilloscope is used to monitor the voltage drop across the resistive component of each impedance, and to measure the phase angle of each voltage with respect to the supply

Experiment

Dual-trace Oscilloscope
Low Frequency Signal Generator - (Sine Wave)
Resistors - R_1 = 1 kΩ, RΩ = 820 Ω *(1/4* W or larger)
Inductor - L_1 = 0.1 H
Capacitor - C_2 = 0.2 µF

Procedure 1B - Voltage Divider

1.1 Using an Ohmmeter, measure the winding resistance of inductor L_1. Enter the measured value on the record sheet
1.2 Connect the signal generator and components as illustrated in Fig. 3.
1.3 Connect the oscilloscope to monitor the input voltage (V_i) and the voltage across resistor R_2 (V_{R2} at terminals A and D), as illustrated.

1.4 Adjust the signal generator to give $V_i = 10$ V peak-to-peak and f = 500 Hz
1.5 Carefully measure and record the peak-to-peak value of V_{R2} and its phase angle (φ_2) with respect to V_i
1.6 Reconnect the CHANNEL 2 input of the oscilloscope to terminal C. Measure and record V_2 and its phase angle (φ_1) with respect to V_i

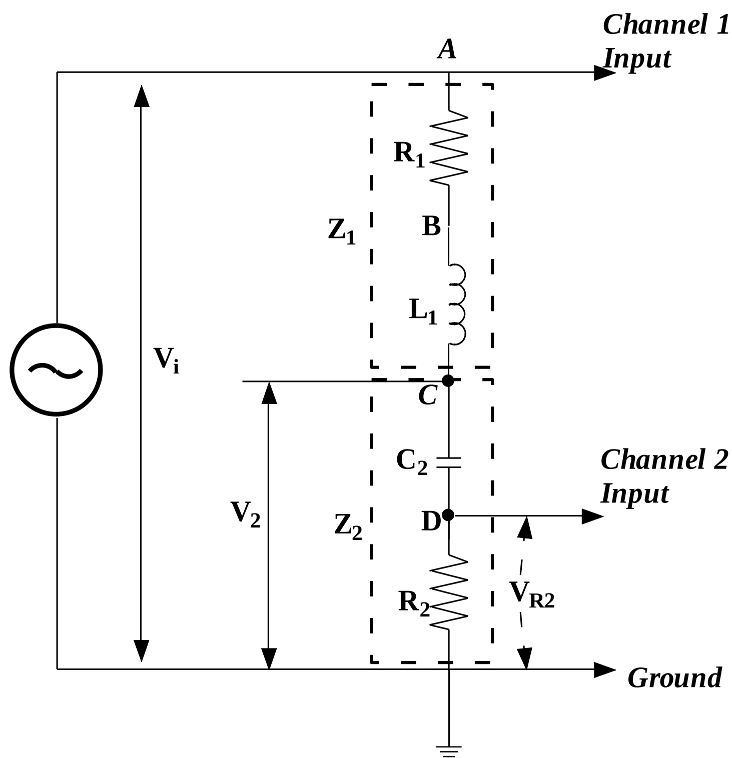

Figure 3

1.7 Reconnect the CHANNEL 1, CHANNEL 2, and the ground connections of the oscilloscope to terminals A, C, and E as illustrated in Fig 4. Measure and record the peak-to-peak value of V_3 and its angle (φ_3) with respect to V_i.
1.8 Reconnect the oscilloscope CHANNEL 1 input to terminal B. Measure and record the peak-to-peak value of V_{R1} and its phase angle (φ_4) with respect to V_i

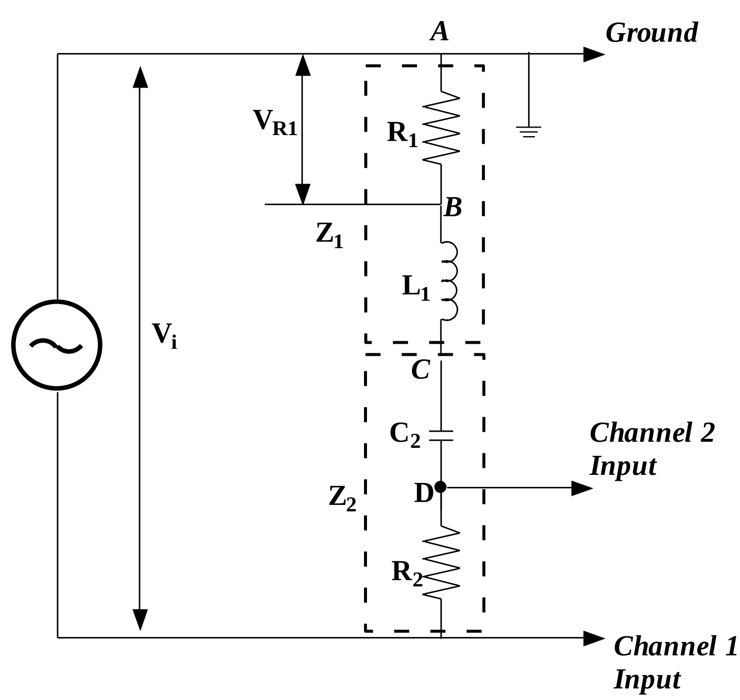

Figure 4

Procedure 2B - Current Divider

2.1 Reconnect R_1, L_1, R_2, C_2 and the signal generator as in Fig. 4

2.2 Connect CHANNEL 1 of the oscilloscope to monitor supply voltage V_i, using terminal A as ground, (that is, ground the common point of R_1 and R_2)'

2.3 Adjust the signal generator to give V_i = 10 V peak-to-peak and f = 500 Hz.

2.4 Using CHANNEL 2 of the oscilloscope, measure and record the peak-to-peak values of V_{R1} and V_{R2}. Also measure and record the phase angles of V_{R1} and V_{R2} with respect to V_i·

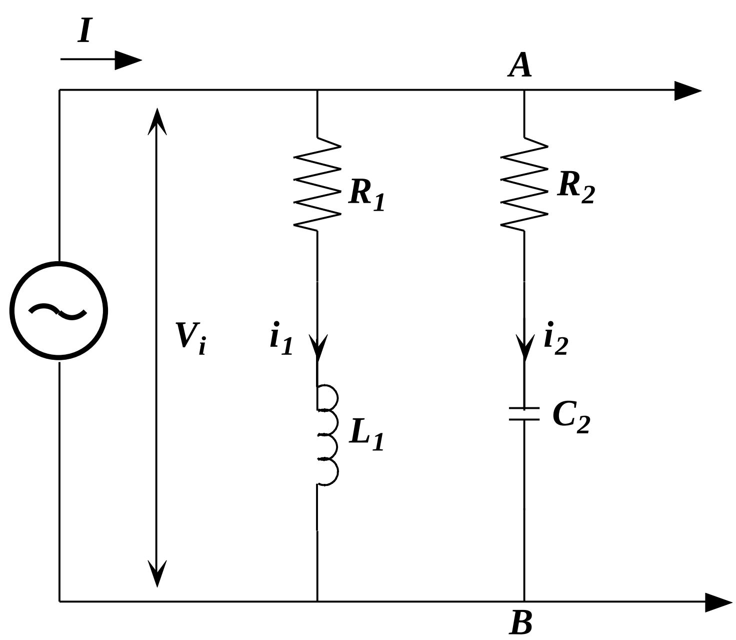

Figure 5

Analysis

1 . For the AC voltage divider investigated in Procedure 1, calculate the current level from the measurement of V_{R2}. Draw a phasor diagram for the circuit showing V_i, I, V_1, V_2 and the phase angles between them.

2. For the AC current divider investigated in Procedure 2, calculate the values of i_1 and i_2· Draw a phasor diagram for the circuit showing V_i' i_1, i_2 and the phase angles between them.

3. Mathematically analyze each circuit and compare to the experimentally determined results. Note that the resistance of L_1 should be added to R_1 to give the total value of resistance in series with inductor L_1.