

ELEC1120 ELECTRICAL FUNDAMENTALS I PRELAB
EXPERIMENT #3 CO _____
SERIES DC CIRCUITS PP _____
NP _____

NAME _____ SECTION _____

PURPOSE

To experimentally demonstrate the characteristics and laws associated with direct current series circuits.

EQUIPMENT

LAB SUPPLIED PARTS

DC power supply
DMM

SERIAL NUMBERS

PARTS KIT PARTS

Resistors a 3.3 KΩ, a 4.7 KΩ and two 1KΩ ¼ watt
Set of meter leads
Set of clip to clip jumper leads

INTRODUCTION

1) The equivalent resistance of resistors connected in series is the sum of the individual resistances.

$$R_T = R_1 + R_2 + R_3 + \dots + R_N$$

2) The equivalent resistance of a resistive network is the supply voltage divided by the supply current.

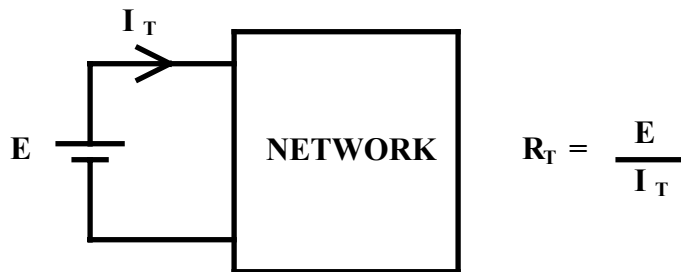


FIGURE #1

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- 3) Since there is only one path for current flow in a series circuit, the current at any point in a series circuit must be the same.

$$I = I_1 = I_2 = I_3 = \dots = I_N$$

- 4) Kirchhoff's Voltage Law states that the sum of the voltages around any closed loop must be zero. Applying this to a simple series circuit yields an equation that demonstrates that the applied voltage is equal to the sum of the voltage drops.

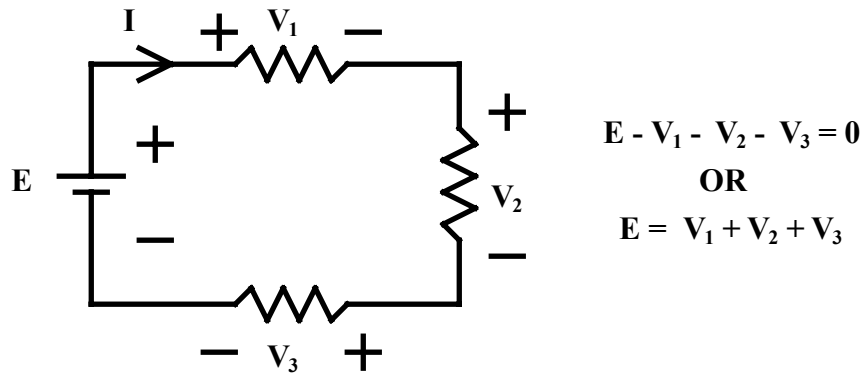


FIGURE #2

- 5) Many circuits have a ground for safety or reference purposes. Voltages are always measured between two points, in many cases the ground is used as one of the points. The voltage at a circuit point relative to ground is the algebraic sum of the voltages from ground to the circuit point. In the circuit shown in figure #3 there are two paths from ground to circuit point B. Each path yields an equation for the voltage V_B (the voltage at point B relative to ground).

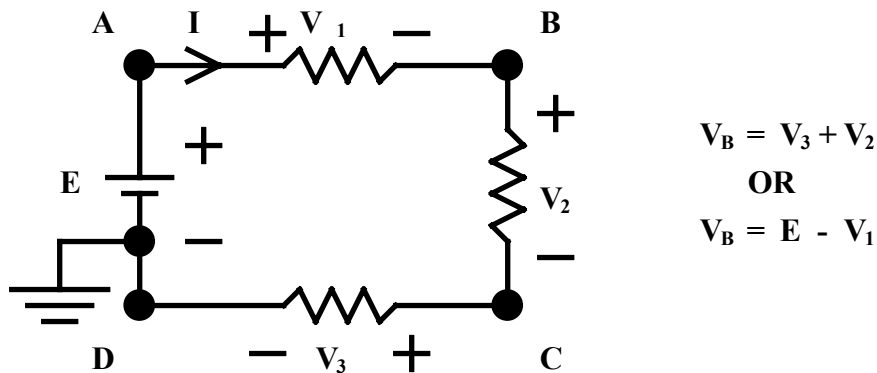


FIGURE #3

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- 6) If a component in a series circuit is bypassed with a short circuit all the current flows through the short circuit. The circuit behaves as if the shorted component were removed.

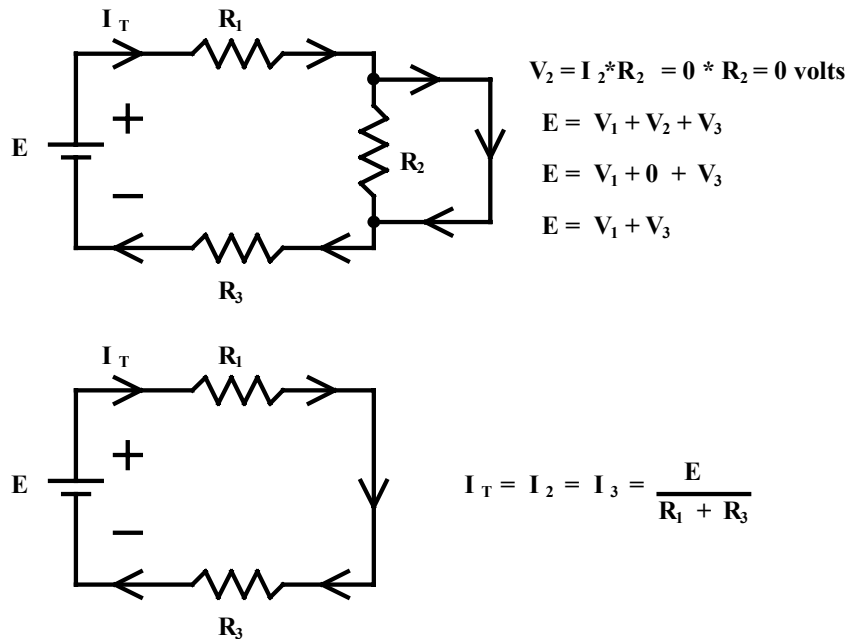


FIGURE #4

- 7) If an open circuit is inserted into a series circuit current stops flowing. This means all the component voltage drops become zero volts. Since the sum of the voltages around the loop must still be zero; the open circuit voltage is equal to the supply voltage.

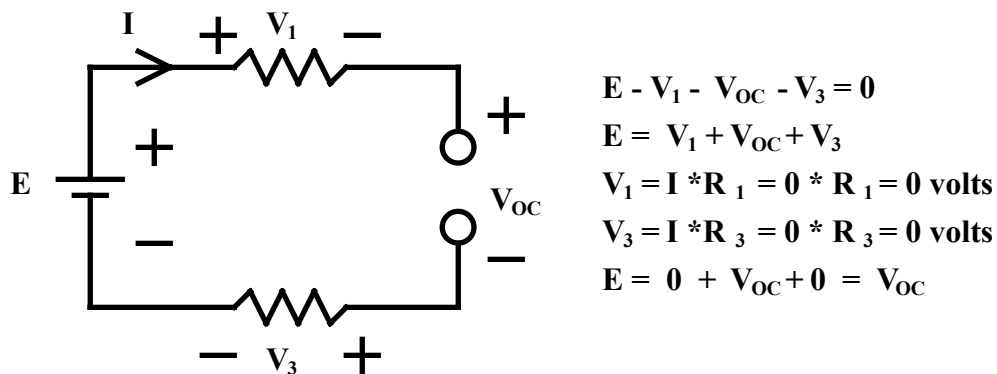


FIGURE #5

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PROCEDURE

- 1) Use the nominal values of the resistors shown in figure #6 to calculate and record the theoretical circuit resistance and the circuit current. Also calculate and record each resistor voltage in table #1. Don't forget to show sample calculations below table #1 and to use the proper units.

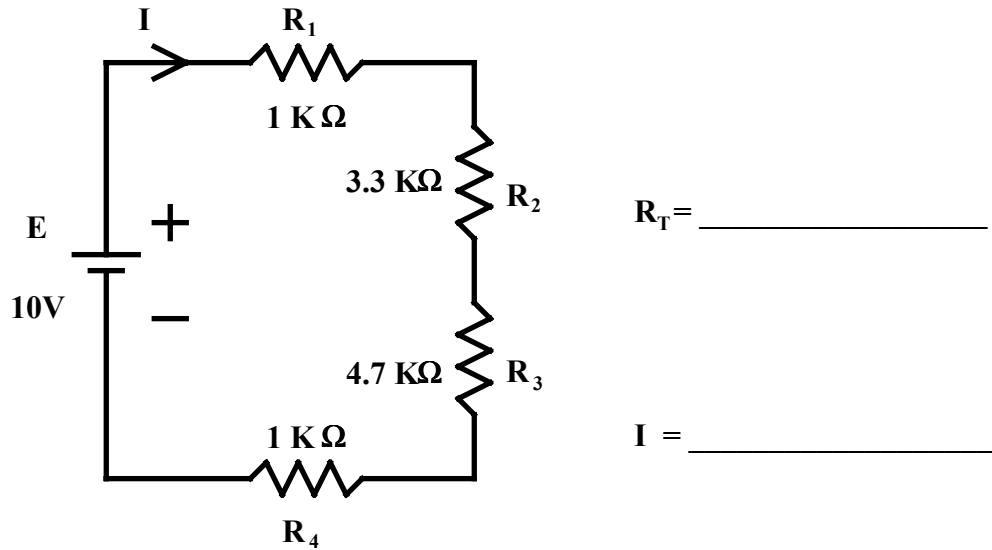


FIGURE #6

TABLE #1 CALCULATED VOLTAGES USING NOMINAL VALUES

RESISTOR	VOLTAGE
R_1	$V_1 =$
R_2	$V_2 =$
R_3	$V_3 =$
R_4	$V_4 =$

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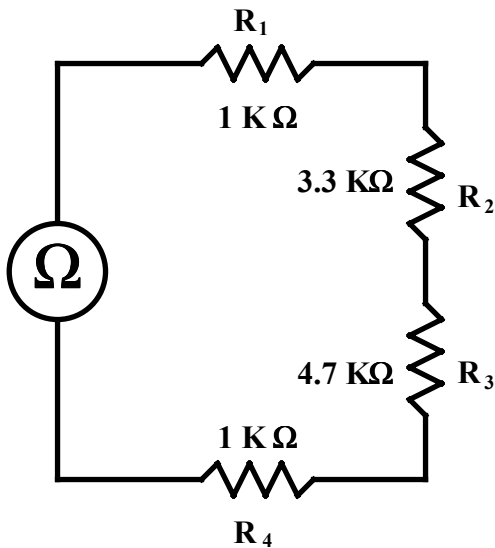
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- 2) Use a piece of masking tape to mark either resistor R_1 or resistor R_4 so the two $1\text{k}\Omega$ resistors can be distinguished. Use the DMM as an ohmmeter to measure and record each of the resistor resistance in table #2. Calculate and record the total resistance R_T using these measured values.

TABLE #2 MEASURED RESISTANCE VALUES

RESISTOR	RESISTANCE
R_1	
R_2	
R_3	
R_4	
R_T	



$R_T =$ _____

FIGURE #7

- 3) Use the DMM to measure the total resistance as shown in figure #7 above. Compare the result with the theoretical value calculated for figure #6. Calculate the percent variation between the theoretical and measured values on the top of page 6. The difference between the two values should be no greater than the tolerance of the resistors.

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$$\text{PERCENT VARIATION} = \left| \frac{\text{MEASURED VALUE} - \text{THEORETICAL VALUE}}{\text{THEORETICAL VALUE}} \right| \times 100 \%$$

- 4) Also calculate the percent variation between the measured resistance and the R_T value calculated in table #2. The difference between these two values should not exceed the maximum meter error $\pm (0.2\% + 1 \text{ digit})$.
- 5) Use the DMM as voltmeter to set the supply voltage to 10 volts as shown in the circuit on the left of figure #8. Once the voltage has been set do not change the power supply controls. Set the DMM to measure current and reconnect it as shown in the circuit on the right of figure #8. Use the supply voltage and current to calculate and record the network's equivalent resistance below.

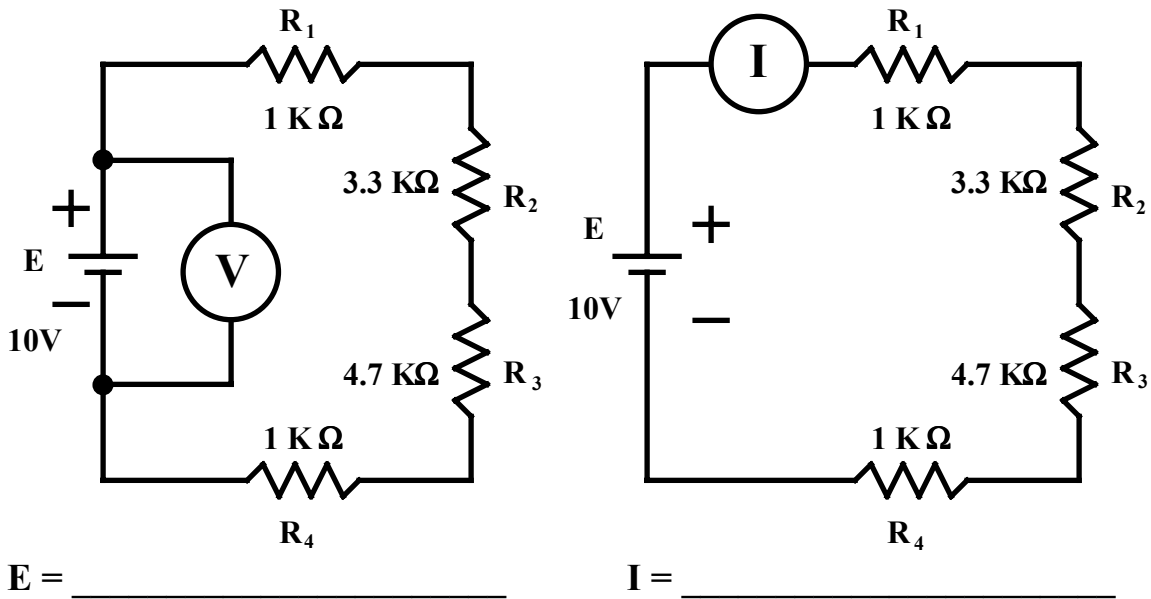


FIGURE #8

$R_T =$ _____

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- 6) Reconnect the DMM to measure the circuit currents at points B, C, D and E of figure #9. The current at point A is the current measured for figure #8. Record all the currents in table #3. The ground shown in the circuit is made by connecting the negative terminal and ground terminal of the power supply together. Grounding the circuit has no effect on the component voltages or currents.

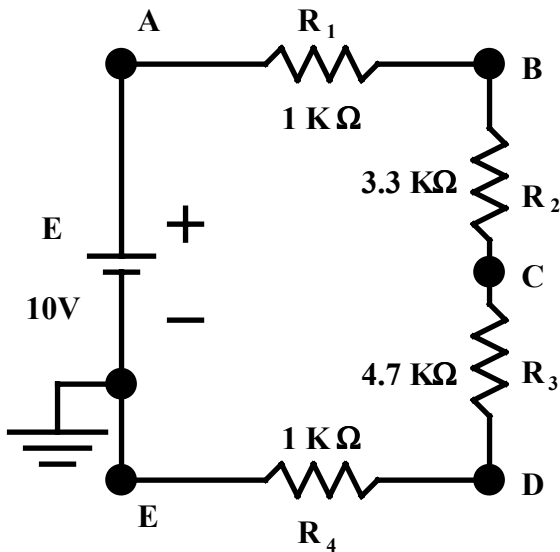


FIGURE #9

TABLE #3 CURRENT

POINT	CURRENT
A	
B	
C	
D	
E	

- 7) Load circuit LAB3C1 into Electronics Workbench from your circuits floppy disk and activate the circuit. Note that this circuit is same as figure #9. Use the workbench DMM to measure each of the resistor voltages. Remember the positive terminal of the DMM should connect to the side of the resistor that current enters. For the resistor R₁ the positive terminal of the DMM should connect to point A and the negative terminal should connect to point B. Record the voltages in table #4. Hint, when connecting the DMM to the circuit start the wires at the DMM terminals and connect them to the labeled connection points. To disconnect the DMM simply drag the wires off the DMM and they will automatically disappear. Before measuring a resistor voltage drag the DMM beside the resistor before connecting the wires. Note the DMM will be in the correct position to measure the resistor voltage V₁ when the circuit is loaded.

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8) Use the DMM as voltmeter to measure each of the actual resistor voltages in figure #9. Record these values in table #4. Calculate the supply voltage using these measured individual resistor voltages. Show the calculation below table #4. How does this compare with the actual supply voltage set in procedure #5? Calculate the percent variation between the two values below table #4.

TABLE #4 CIRCUIT VOLTAGES

RESISTOR	WORKBENCH VOLTAGE	MEASURED VOLTAGE
R ₁	V ₁ =	V ₁ =
R ₂	V ₂ =	V ₂ =
R ₃	V ₃ =	V ₃ =
R ₄	V ₄ =	V ₄ =

9) Use the DMM to measure and record the voltage V_C in figure #9 (the voltage at point C with respect to ground). This voltage is the same as V_{CE}. The voltage V_C can also be calculated using some of the measured individual resistor voltages from table #4. Calculate the V_C below and compare it to the measured value. Also calculate the percent variation between the two values below.

V_C (measured) _____

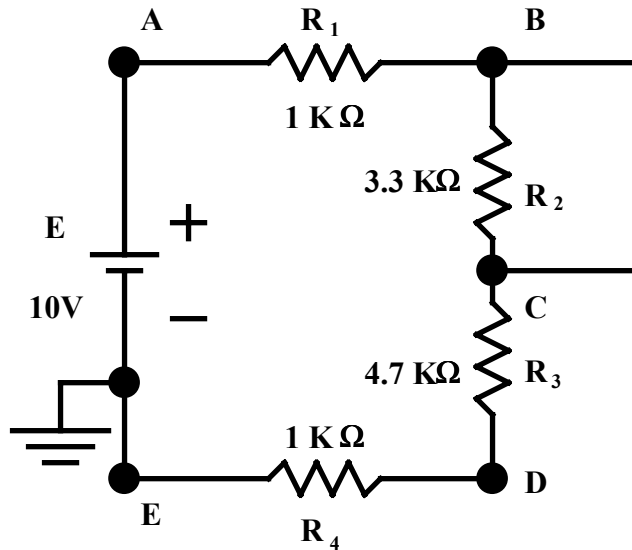
V_C (calculated) _____

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- 10) Short circuit the resistor R_2 by connecting a conductor between points B and C as shown in figure #10. Measure and record each of the resistor voltages in table #5. The sum of the voltages across the unshorted resistors should equal the supply voltage. Calculate the supply voltage using the measure individual resistor voltages and compare the result to supply voltage set in procedure #5.



**TABLE #5
VOLTAGES**

VOLTAGE
$V_1 =$
$V_2 =$
$V_3 =$
$V_4 =$

FIGURE #10

- 11) Use the DMM to measure the supply current in Figure #10. The supply current should be equal to the supply voltage divided by the sum of the unshorted resistances. Use the measured resistance values from table #2 to calculate the supply current and compare it to the measured current. Calculate the percent variation between the two values.

I_T (measured) _____

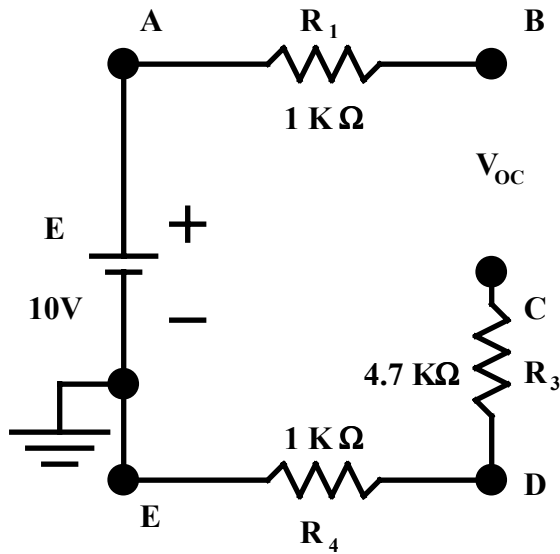
I_T (calculated) _____

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12) Remove the short circuit and resistor R_2 from the circuit to create an open circuit as shown in figure #11. Measure and record each of the resistor voltages and the open circuit voltage (the voltage between points B and C) in table #6. Compare the open circuit voltage to the supply voltage set in procedure #5. Calculate the percent variation between the two values.



**TABLE #6
VOLTAGES**

VOLTAGE
$V_1 =$
$V_{OC} =$
$V_3 =$
$V_4 =$

FIGURE #11

E (measured) _____

V_{OC} (measured) _____