ECE 281

Electrical Circuits and Instrumentation + Laboratory

Fall 2016/2017

LAB # 3

17.10.2016

Objective:

To learn about series circuit and Kirchhoff's Voltage Law

1. **Plot a graph between voltage and current and find the resistance from the graph**
2. **To verify $R_T=R_1+R_2+\ldots+R_n$ in series circuit**
3. **To verify Kirchhoff's Voltage Law**
4. **Learn the use of potentiometer**

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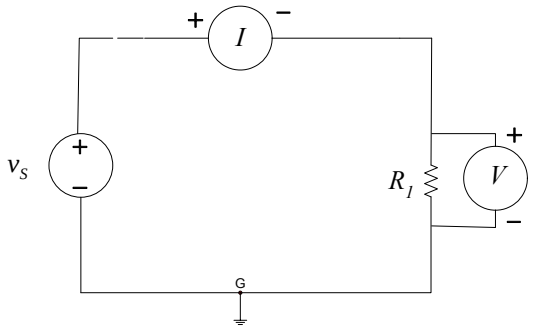
1. Plot a graph between voltage and current and find the resistance from the graph: (25 Points)

Procedure:

1. Construct the circuit given in Figure-1 on the breadboard. This circuit is used to find the **linear relation** between the voltage and current for a resistive circuit. In this circuit, the one digital multimeter is connected as a voltmeter and the other digital multimeter is connected as an ampermeter. The voltage supplied by the DC power source for the first measurement set the voltage to 10V.

Figure 1: Circuit for current and voltage measurements



2. The voltage supplied by the DC power source for the first measurement set the voltage to 10V and measure the current. Fill row 1 of Table 1

3. Increase voltage to 11V, 12V, 13V,…,up to 20V and for each case read the corresponding current and fill the row that corresponds to the set values of voltages.

4. Draw the graph of current in (mA) versus volts (V) to the supplied graphic area.

Table 1: Voltage and current measurements.

Measurement number	Voltage (Volt)	Current (mA)
1.	10	
2.	11	
3.	12	
4.	13	
5.	14	
6.	15	
7.	16	
8.	17	
9.	18	
10.	19	
11.	20	

Figure 2: Voltage versus current graph.

Questions:

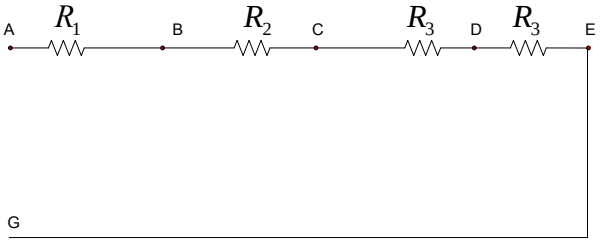
- What kind of a relationship exists between current and voltage in the circuit?

2. To verify $R_T=R_1+R_2+….+R_n$ in series circuit: (25 Points)

Procedure:

1. Construct the circuit given in Figure-3 on the breadboard **without power**.

Figure 3: Circuit for resistance measurements.



R_1=1kΩ, R_2=100Ω, R_3=2.2kΩ, R_4=1.8kΩ,

2. Use digital multi meter for resistors.
3. Find resistive values between A-B, B-C, C-D, D-E, and A-E. Fill Table 2 with these values.
4. Calculate total resistance by using $R_T=R_1+R_2+ R_3+R_4$ and compare it with the resistance between A-E.

Table 2: Resistance measurements

Measurement no:	Between nodes	Resistance value
1.	A and B	
2.	B and C	
3.	C and D	
4.	D and E	
5.	A and E	

Questions:

- Is total resistance measured and calculated equal each other?

3. To verify Kirchhoff's Voltage Law: (25 Points)

Procedure:

1. Use the previous circuit, just add a voltage source as shown in Figure 4. (V_S=10 Volt.)
2. Use digital multimeter as voltmeter and make voltage measurements for the circuit according to the probe connections shown in Table 3 and fill up the table.
3. Find the total algebraic voltage drop over the closed circuit.

$$V_{total\_drop} = V_{AB} + V_{BC} + V_{CD} + V_{DE} + V_{EA}$$

$$V_{total\_drop} = V_{BA} + V_{CB} + V_{DC} + V_{ED} + V_{AE}$$

4. Verify the results with your measurements.

Figure 4: Circuit for voltage measurements.

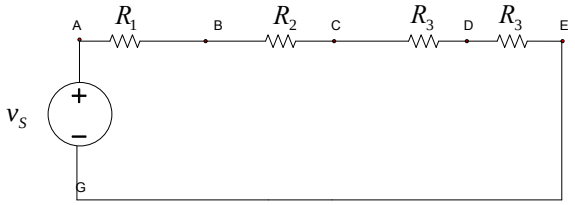


Table 3: Voltage measurements.

Measurement No:	Probe connections		Voltage	Probe connections		Voltage
	Red probe	Black probe		Black probe	Red probe	
1	A	B	V_{AB}=	A	B	V_{BA}=
2	B	C	V_{BC}=	B	C	V_{CB}=
3	C	D	V_{CD}=	C	D	V_{DC}=
4	D	E	V_{DE}=	D	E	V_{ED}=
5	E	A	V_{EA}=	E	A	V_{AE}=

Questions:

- Write down the Kirchhoff's voltage law in words.
- Why the sum of voltages is zero in both cases.

4. Learn the use of potentiometer (25 Points)

Potentiometer: Potentiometer is a kind of variable resistor. This resistor has 3 terminals. Two of the terminals are constant terminals (terminals numbered as 1 and 2) and one terminal is the adjustable terminal (terminal numbered as 3). Between constant terminals there is always the nominal resistance value of the resistor inside the potentiometer). However, the resistance between terminals 1 and terminal 3 and the resistance between terminal 2 and 3 changes when the shaft of the potentiometer is turned clockwise and counter clockwise. Hence between the terminals 1 and 3 and also between terminals 2 and 3, we might observe different resistance values depending on the position of the shaft of the potentiometer.

Procedure:

1. Use a potentiometer whose nominal resistance value 10 kΩ.
2. Construct the circuit shown in Figure 5.

Figure 5: Circuit for voltage measurements over potentiometer.

3. Use digital multi meter for voltages.
4. Measure voltage drop between 3-2 with rotating shaft clockwise to the end (left), than rotate it to counter clockwise (right) about to the middle and up to the end until you see "0V". Fill table 4 with these values.

Table 4: Voltage measurements for different potentiometer settings.

Potentiometer shaft position	V_{23}
Clockwise (left end)	
Counter-clockwise (right end)	
Mid-point	

5. Remove the power from the circuit.
6. Use digital multi meter for resistors.
7. Measure resistors between 1-2, 1-3 and 2-3 counter with rotating shaft clockwise to the end (left), than rotate it to counter clockwise (right) about to the middle and up to the end Fill table 5 with these values.

Table 5: Resistance measurements for different potentiometer settings

Potentiometer shaft position	R_{12}	R_{13}	R_{23}
Clockwise (left end)			
Counter-clockwise			
Mid-point (right end)			

Questions:

- How does the voltage vary when the potentiometer shaft is turned clockwise?
- How does the voltage vary when the potentiometer shaft is turned anti-clockwise?
- How does the resistance vary when the potentiometer shaft is turned clockwise?
- How does the resistance vary when the potentiometer shaft is turned anti-clockwise?