EXPERIMENT 2

VOLTAGE AND CURRENT MEASUREMENT

2.1 Objectives

In this experiment, you will learn:

1. what the resistance concept is and what the related constant and variable resistors are
2. how to measure DC currents and voltages with a digital multi-meter in a resistive circuit
3. how the voltage and current dividers operate for resistive loads
4. measure circuit parameters to determine proportionality constants.
5. superposition theorem.

2.2 Equipment List for Homework

1. DC Power Supply, Digital multi-meter
2. Breadboard
3. Carbon resistors: 1.5 kΩ, 4.7 kΩ , 5.6 kΩ, 6.8 kΩ,18 kΩ,
4. Potentiometers: 1 kΩ POT

2.3 Preliminary Work

1. Find the voltage, current and power values for the circuit given in Figure 2.2 theoretically and record that values into Table 2.2 (Calculated Values (theoretical)) (Hint : Use Ohm's and Kirchhoff's Laws)

2. Find the current values (*i*) for the circuit given in Figure 2.4 when *v'* is tuned as 0, 2, 4, 6, 8, and 10 volts theoretically and record that values into Table 2.5 (*i (mA) (calculated)*) (Hint : Use Ohm's Law)

3. Find the voltage across the 6.8 k Ω resistor for the circuit given in Figure 2.5, Figure 2.6a and Figure 2.6b by using superposition theorem. Record calculated values in Table 2.5.

2.4 Experimental Work

1. In this part of experiment, we will be investigating the properties of the potentiometers (POT). The potentiometer is a variable resistor. Inner structure of potentiometers can be seen in Figure 2.1. By rotating the shaft (slider), you can change the resistor values in between the terminals 1 and 2, and terminals 2 and 3 separately.

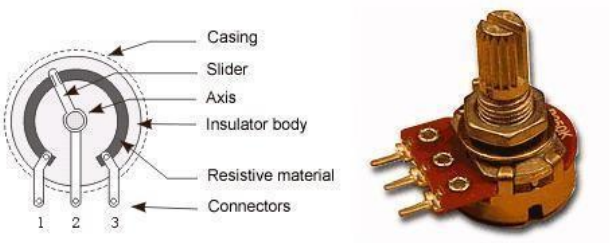


Figure 2.1 Inner structure of a Potentiometer and a typical Potentiometer.

a) Rotate the shaft (slider) of potentiometers anywhere randomly and measure the resistance values by using the digital multi-meter and record them in Table 2.1. Can you describe $R_{1\text{-}3}$ in terms of $R_{1\text{-}2}$ and $R_{2\text{-}3}$? Write the relationship.

	$R_{1\text{-}2}$	$R_{2\text{-}3}$	$R_{1\text{-}3}$
1 kΩ POT			

Table 2.1

2. Adjust the DC power supply to output 12V and set up the circuit in Figure 2.2. Measure and record all the currents and the voltages regarding to each resistor by using the digital multi-meter to the Table 2.2. Calculate the power dissipated in each resistor by P = i.v. Are the measured and calculated values found in preliminary work in agreement? If there are small differences, explain its reasons.

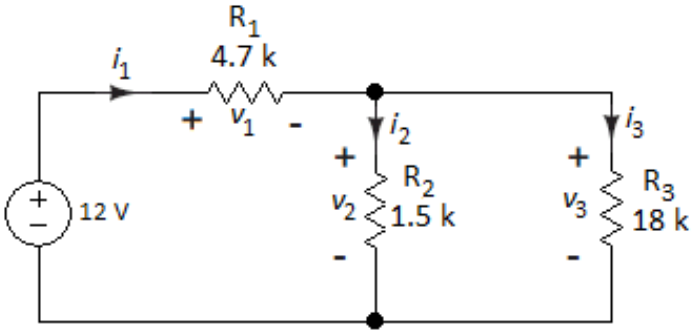


Figure 2.2

	i_1	i_2	i_3	v_1	v_2	v_3	$P_1=i_1.v_1$	$P_2=i_2.v_2$	$P_3=i_3.v_3$
Calculated Values **(experimental)**									
Measued Values **(theoretical)**									

Table 2.2

3. At 3 different voltages of V_{in} between 0 and 12V, measure the V_3 as output voltage for the given circuit in Figure 2.2. Calculate the proportionality constant that relates the output voltage to the input voltage. Record your data in Table 2.3. Is there any linear relationship between V_{in} and V_{out}?

Input Voltage Vin (V)	***Output Voltage Vout (V)***	***Proportionality Constant K=Vout / Vin***

Table 2.3

4. Adjust the DC power supply to output 12V and setup the circuit in Figure 2.4. Use 1 kΩ POT as R_1 and 4.7 kΩ resistor as R_2. Then vary the position of the potentiometer so that *v'* is 0, 2, 4, 6, 8, and 10 volts. For each case measure current *i* and record it in Table 2.4.

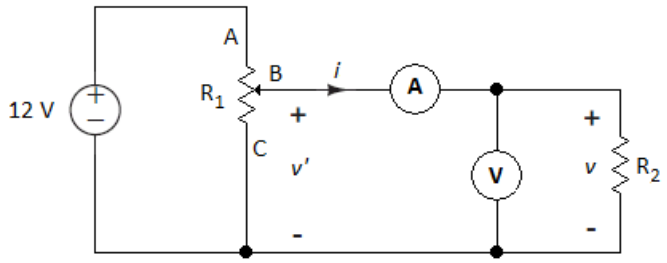


Figure 2.4

	V'=0 V	*v'* =2 V	*v'*=4 V	*v'*=6 V	*v'*=8 V	*v'*=10 V
i (mA) ***(calculated)***						
i (mA) ***(measured)***						

Table 2.4

a) Plot *i* vs. *v* graph and determine the resistance of R_2 by using *i* vs. *v* graph. ("*i*" must be placed in y-axis and "*v*" must be placed in x-axis) (Hint: What is the slope of *i* vs. *v* curve?)

b) Disconnect R_2 in the circuit and measure the resistance of R_2 by using the digital multi-meter.

c) Compare the results obtained in Parts 4.a and 4.b. Do they match? If there is a small difference, explain its reasons.

5. We will now verify the superposition circuit. Since we will be constructing three circuits.

a) Construct the circuit shown in Figure 2.5 and measure V_{out}. Record your V_{out} in Table 2.5.

b) Now remove the 15V source by replacing it with a short circuit. Measure the voltage V_1 across the 6.8 kΩ resistor. Record your V_1 in Table 2.5. This circuit is shown in Figure 2.6a.

c) Reconnect the 15V source and replace the 5V source with a short circuit and measure the voltage V_2 across the 6.8 kΩ resistor. Record your V_2 in Table 5.7. This circuit is shown in Figure 2.6b.

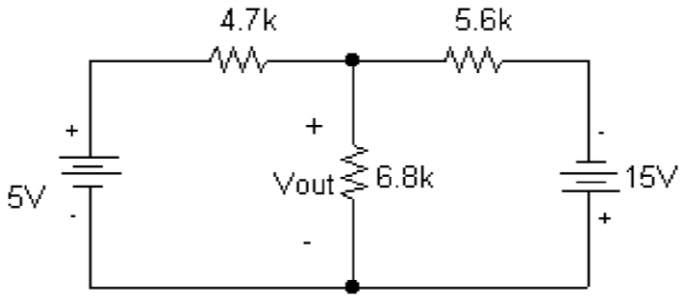
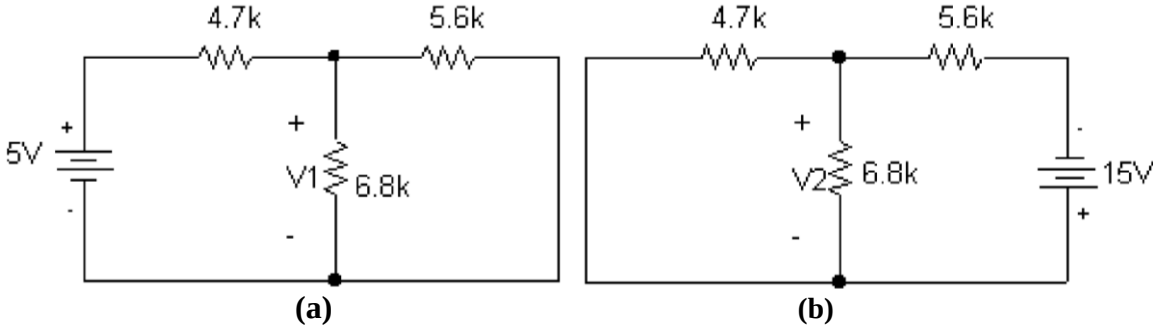


Figure 2.5 Circuit to Verify Superposition



(a) **(b)**

Figure 2.6 Superposition Circuit with **(a)** 15V Source Removed **(b)** 5V Source Removed

Quantity	***Calculated Voltage (V)***	***Measured Voltage (V)***
Vout		
V1		
V2		

Table 2.5 Data for verifying Superposition Theorem