

## EXPERIMENT 3:

### Proportionality and Superposition

#### Objective:

Verify the proportionality and superposition theorems.

#### Equipment:

- NI – ELVIS
- Assorted Resistors(1 K $\Omega$ , 3.3 K $\Omega$ , 5.6 K $\Omega$ )

#### Theory:

In this exercise proportionality and superposition theorems are examined by applying them to the circuits given below.

1. **Proportionality Theorem** states that the response in a circuit is proportional to the source acting in the circuit. This is also known as Linearity.

The proportionality constant  $K$  relates the input voltage to the output voltage as:

$$V_{out} = K V_{in} \quad (1)$$

For the circuit of figure 1, the source voltage is  $V_{in}$ . The response  $V_{out}$  is across the 3.3 K $\Omega$  resistor. The most important consequence of linearity is superposition.

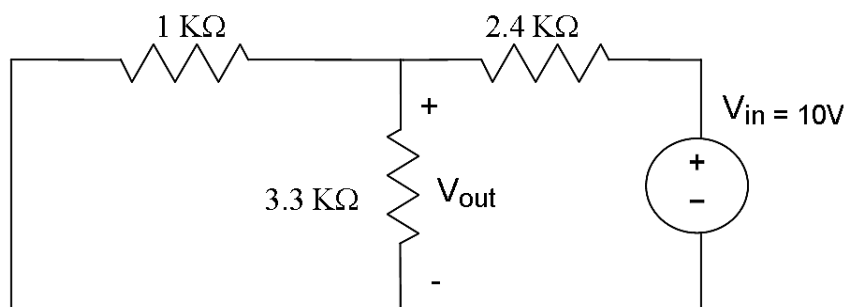


Figure 1

2. **Superposition Theorem** states that the response in a linear circuit with multiple sources can be obtained by adding the individual responses caused by the separate independent sources acting alone.

For an independent source acting alone, all other independent voltage sources are replaced by short circuits and all other independent current sources are replaced by open circuits.

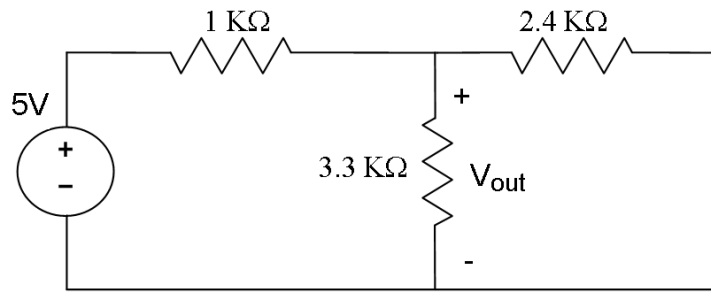


Figure 2.

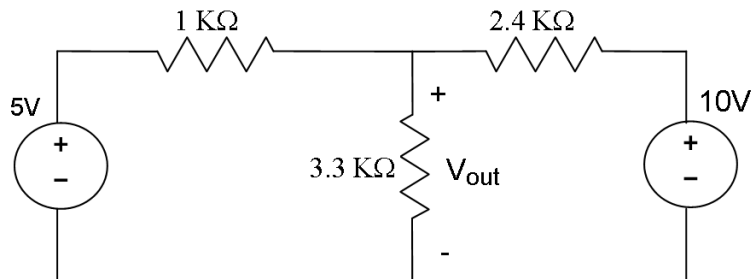


Figure 3.

### Procedure:

1. Verifying the proportionality theorem:
  - a) Construct the circuit of **Figure 1** (see breadboard configuration in Fig. 4. of **Appendix**). Accurately measure  $V_{out}$  for the four input voltages as shown in the table below.

S.No	$V_{in}$ (volts)	$V_{out}$ (volts)	K (no units)
1	2 V		
2	4 V		
3	8 V		
4	10 V		

Table 1

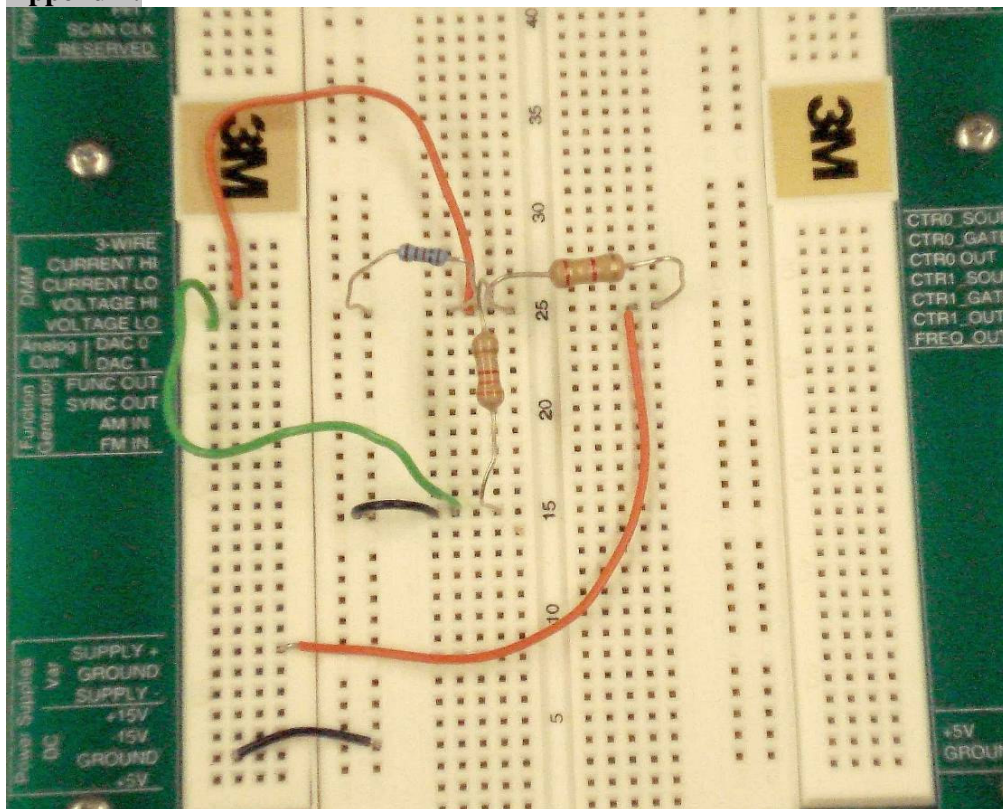
- b) Calculate the value of  $K$  in each case using equation 1.
- c) Plot a graph with  $V_{in}$  on x-axis and  $V_{out}$  on y-axis.

2. Verifying the **Superposition** theorem:
  - a) Construct the circuit of **Figure 2** (see **breadboard configuration in Fig. 5. of Appendix**). Measure and record the voltage across the  $3.3\text{ K}\Omega$  resistor.
  - b) Construct the circuit of **Figure 3** (see **breadboard configuration in Fig. 6. of Appendix**). Measure and record the voltage across the  $3.3\text{ K}\Omega$  resistor.
  - c) Calculate the total response " $V_{\text{out}}$ " for circuit of Figure 3 by adding the responses from steps 1a and 2a.

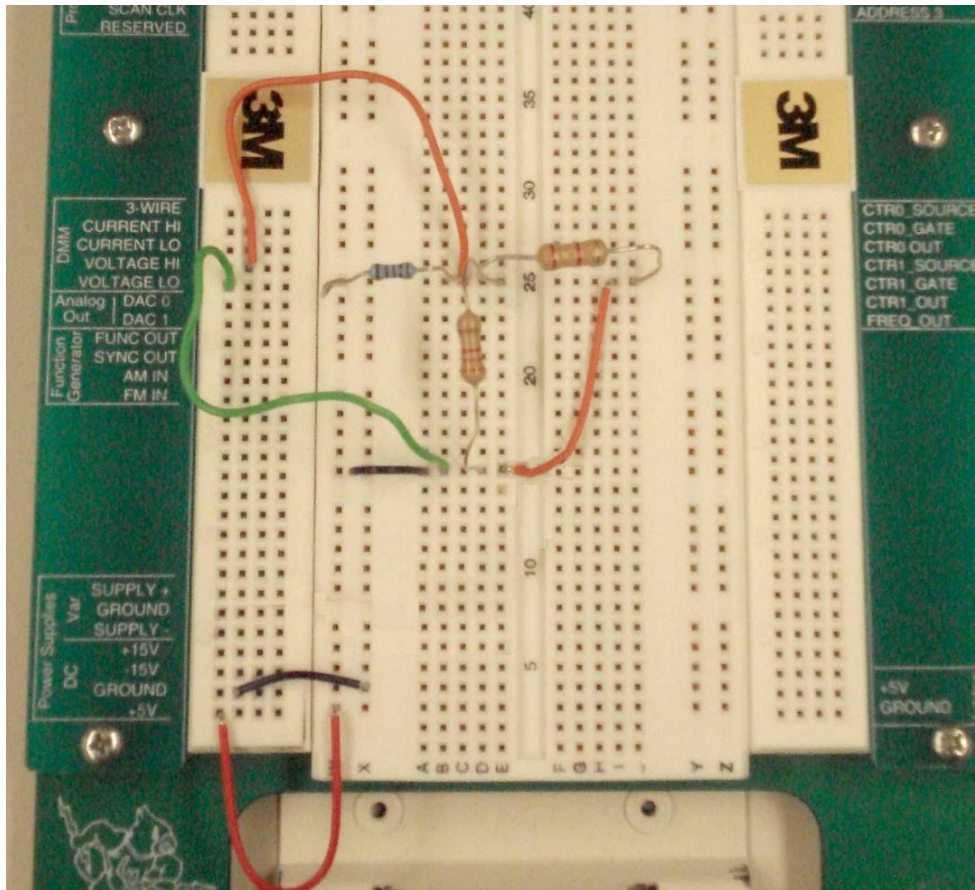
#### Questions for Lab Report:

1. Is the graph obtained a straight line? Compute the slope of the graph at any point and compare it to the value of  $K$  obtained from the measurements. Explain any differences.
2. For each of the three circuits you built for the superposition experiment, how well did the calculated and measured outputs compare? Explain any differences.

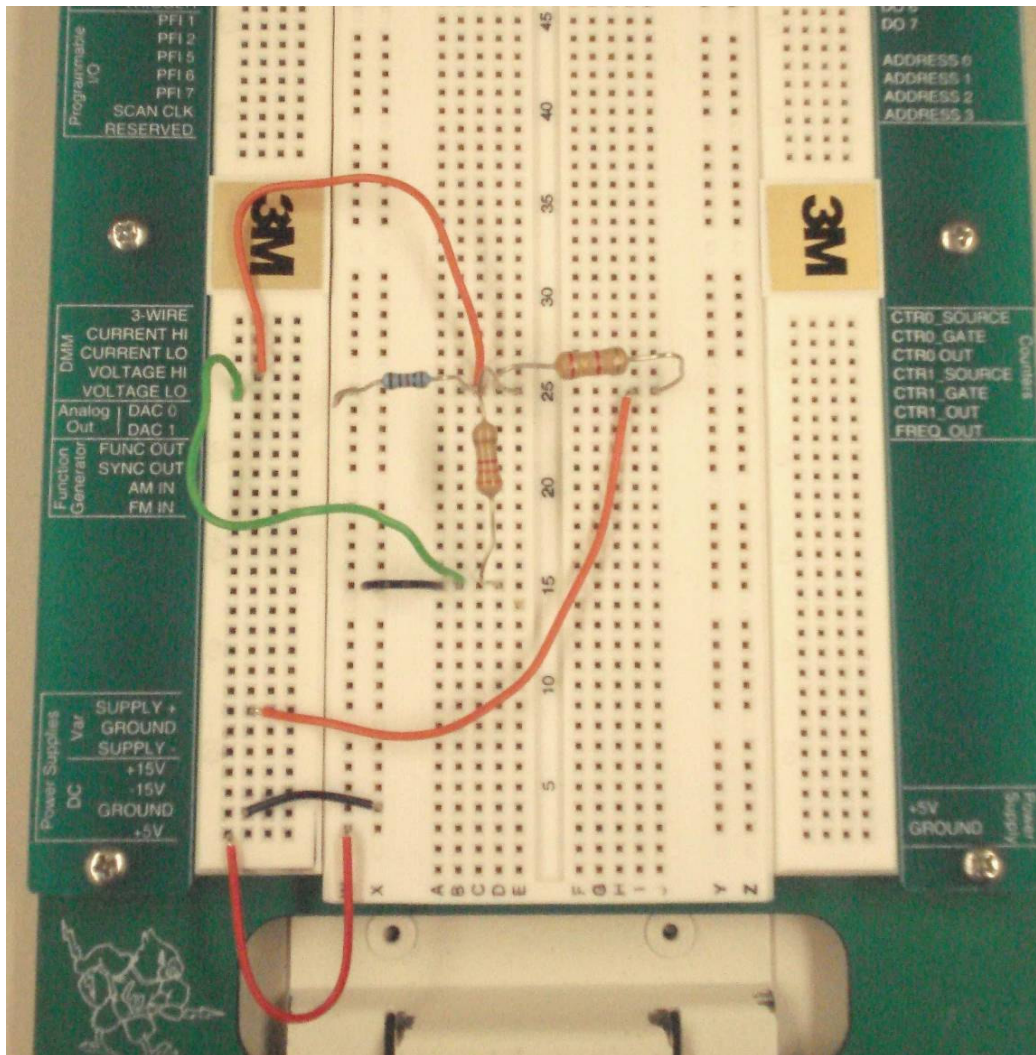
#### Appendix:



**Figure 4.** Only 10V source (variable power supply) is active.



**Figure 5.** Only 5V source is active.



**Figure 6.** Both sources (10V source and 5V source) are active.