

EE1002 Lab2: Principle of Superposition

Safety Precautions

1. Always turn off power when you reconnect the circuit.
2. Double check your circuit and voltage source setting before reapplying power.

I. OBJECTIVES

1. To build DC circuits.
1. To measure the DC circuits using multimeters.
2. To understand and verify the principle of superposition.
3. To understand the limitation of superposition.

II. EQUIPMENT AND MATERIALS REQUIRED

1. Variable DC power supply
2. Multimeter
3. Solderless breadboard
4. Resistors ($510\ \Omega$, $1\ \text{k}\Omega$ and $2\ \text{k}\Omega$).

III. THEORY

The superposition principle states that the overall voltage and current responses of a linear circuit with multiple sources are equal to the sum of the individual voltage and current responses due to the individual sources.

IV. PROCEDURES

(A) Single DC Source (superposition of voltages)

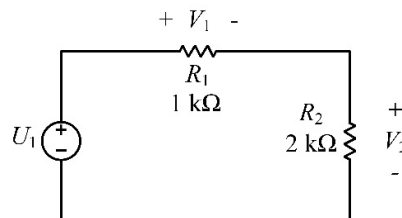


Figure 1. Circuit configuration with voltage source of $U_1 = 6.0\ \text{V}$.

1. Build the circuit of Figure 1.
2. Set the voltage of the DC source to $U_1 = 6.0\ \text{V}$. Measure and calculate the voltages of V_1 and V_2 across the resistors and record the voltages in Table I (Column " $U_1 = 6.0\ \text{V}$ ").

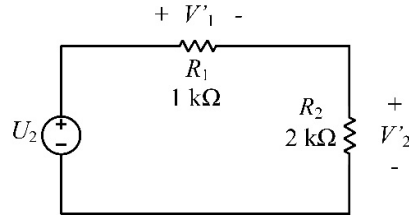


Figure 2. Circuit configuration with voltage source of $U_2 = 2.0$ V

3. Change the DC voltage source to $U_2 = 2.0$ V. Measure and calculate the voltages of V_1' and V_2' (see Figure 2) and record the voltages in Table I (“Column $U_2 = 2.0$ V”).

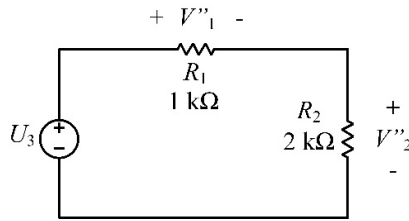


Figure 3. Circuit configuration with voltage source of $U_3 = 4.0$ V.

4. Change the DC voltage source to $U_3 = 4.0$ V. Measure and calculate the voltages of V_1'' and V_2'' (see Figure 3) and record the voltages in Table I (Column “ $U_3 = 4.0$ V”).

Table I
The Measured Voltages in Part A

DC Sources	$U_1 = 6.0$ V	$U_2 = 2.0$ V	$U_3 = 4.0$ V	Superposition	Errors
Voltage (V)	V_1	V_1'	V_1''	$V_1' + V_1''$	$(V_1' + V_1'') - V_1$
Measurement					
Calculation					
Voltage (V)	V_2	V_2'	V_2''	$V_2' + V_2''$	$(V_2' + V_2'') - V_2$
Measurement					
Calculation					

(B) Single DC Source (superposition of currents)

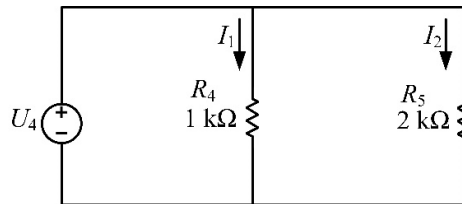


Figure 4. Circuit configuration with voltage source of $U_4 = 4.5$ V.

1. Build the circuit of Figure 4.
2. Set the DC voltage source to $U_4 = 4.5$ V. Measure and calculate the currents of I_1 , I_2 and record

the values in Table II (Column “ $U_4 = 4.5 \text{ V}$ ”).

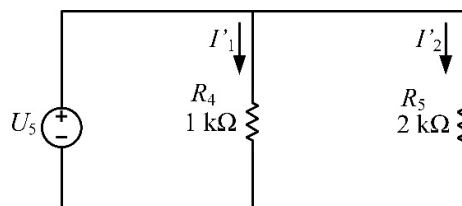


Figure 5. Circuit configuration with voltage source of $U_5 = 1.5 \text{ V}$

3. Change the DC voltage source to $U_5 = 1.5 \text{ V}$. Measure and calculate the currents of I_1' , I_2' (see Figure 5) and record the values in Table II (“Column $U_5 = 1.5 \text{ V}$ ”).

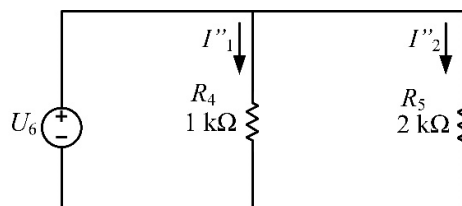


Figure 6. Circuit configuration with voltage source of $U_6 = 3.0 \text{ V}$.

4. Change the DC voltage source to $U_6 = 3.0 \text{ V}$. Measure and calculate the currents of I_1'' , I_2'' (see Figure 6) and record the voltages in Table II (Column “ $U_6 = 3.0 \text{ V}$ ”).

Table II
The Measured Currents in Part B

DC Sources	$U_4 = 4.5 \text{ V}$	$U_5 = 1.5 \text{ V}$	$U_6 = 3.0 \text{ V}$	Superposition	Errors
Current (mA)	I_1	I_1'	I_1''	$I_1' + I_1''$	$(I_1' + I_1'') - I_1$
Measurement					
Calculation					
Current (mA)	I_2	I_2'	I_2''	$I_2' + I_2''$	$(I_2' + I_2'') - I_2$
Measurement					
Calculation					

(C) Dual DC Sources

1. Build the circuit of Figure 7.

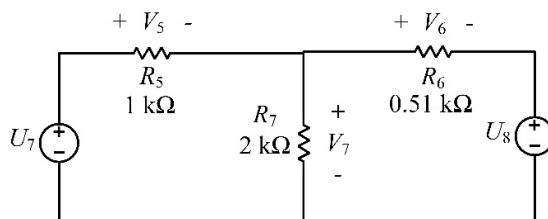


Figure 7. Circuit configuration with voltage sources of $U_7 = 6.4 \text{ V}$ and $U_8 = 3.5 \text{ V}$.

2. Measure and calculate the voltages and record the results in Table III (Column “With U_7 & U_8 ”).

3. Replace the voltage source U_8 in Figure 7 with a short circuit to obtain the circuit of Figure 8. Measure and calculate the voltages and record the results in Table III (Column “ U_7 only”).

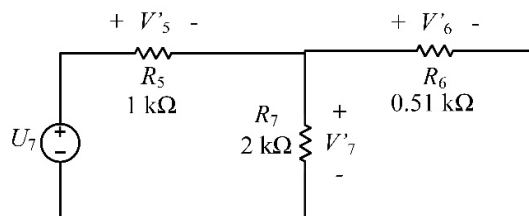


Figure 8. Circuit configuration with voltage source of $U_7 = 6.4$ V only.

4. Replace the voltage source U_7 in Figure 7 with a short circuit to obtain the circuit of Figure 9. Measure and calculate the voltages and record the results in Table III (Column “ U_8 only”).

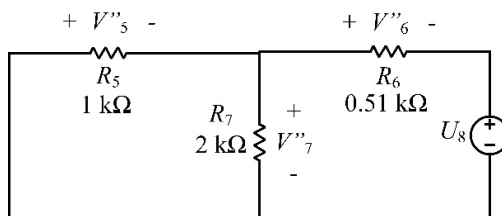


Figure 9. Circuit configuration with voltage source of $U_8 = 3.5$ V only.

Table III

The Measured Voltages for Dual DC Sources

DC Sources	U_7 only	U_8 only	Superposition	With U_7 & U_8	Errors
Voltages (V)	V_5'	V_5''	$V_5' + V_5''$	V_5	$(V_5' + V_5'') - V_5$
Measurement					
Calculation					
Voltages (V)	V_6'	V_6''	$V_6' + V_6''$	V_6	$(V_6' + V_6'') - V_6$
Measurement					
Calculation					
Voltages (V)	V_7'	V_7''	$V_7' + V_7''$	V_7	$(V_7' + V_7'') - V_7$
Measurement					
Calculation					

V. DISCUSSIONS

1. Explain the discrepancy between the measured and calculated results.
2. Explain the errors of using the superposition.
3. In Part C, calculate the powers delivered to R_5 , R_6 and R_7 for each circuit (Figures 7-8). Check whether the powers satisfy the superposition principle. Explain briefly.
4. In Part C, the voltage sources (U_7 , U_8) have been considered one by one in using the superposition principle, and the source that is not considered has been shorted. What should we do for a current source if it is not considered in using the superposition principle? Explain briefly.
5. A diode is a device with a current-voltage relationship of $I = I_0(e^{av} - 1)$, where I_0 and a are

constants. Can the superposition principle be used if R_5 in Part C is replaced by a diode? Explain briefly.

VI. REFERENCE

“Fundamentals of Electric Circuits” by Charles K Alexander, Matthew Sadiku (Edition:7), McGraw Hill, 2021.