Study and Experimental Verification of Superposition Theorem in DC Circuits

Course Title: Basic Electrical and Electronic Circuit
Course Code: EEE 07131206B

Submitted by:

Rudro Sen
Dept. of CEP, SUST
Regi. No. : 2021332008
Session: 2021-2022

Submitted to:

Name of course Teacher
Associate Professor
Dept. of EEE, SUST
Room No. 421, IICT, SUST

Department of Electrical and Electronic Engineering
Report Submission Date: **December 11, 2025**

Deceleration

I, the undersigned, **Rudro Sen**, hereby declare that the work presented in this report is my own, carried out under the scientific direction of **Name of course Teacher**, in accordance with the principles of honesty, integrity, and responsibility. This report was written entirely by myself and complies with the charter on the fight against scientific plagiarism.

Sylhet, December 11, 2025

Signature

Signature

Contents

List of Figures

Experiment numberm: 07

Name of the experiment: *Study and Experimental Verification of Superposition Theorem in DC Circuits*

Objective

- To understand the principle of the Superposition Theorem and its application in linear DC circuits.
- To experimentally verify that the response in any element is the sum of individual effects of each independent source.
- To learn how to correctly turn off independent voltage and current sources.
- To compare measured and theoretical values to confirm the validity of the theorem.
- To gain practical skills in building DC circuits and using measuring instruments.

Introduction

Superposition Theorem is a fundamental principle in electrical engineering used to analyze linear circuits with multiple independent sources. The theorem states that the response (voltage or current) in any element of a linear circuit is the algebraic sum of the responses caused by each independent source acting alone, while all other independent sources are replaced by their internal resistances. This experiment validates the theorem through practical circuit analysis.

Theory

According to the Superposition Theorem:

> In any linear bilateral network with multiple independent sources, the current through or voltage across any element is equal to the algebraic sum of the currents or voltages produced by each source acting independently.

While considering one voltage source:

- All other voltage sources are replaced by short circuits.
- All other current sources are replaced by open circuits.

This principle is valid only for linear circuits and cannot be directly applied to power calculations.

Circuit Connection

The circuit used in this experiment consists of two independent voltage sources and three resistors.

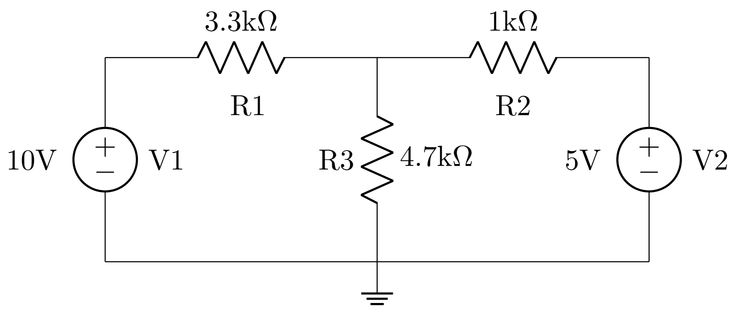

Figure 1: Complete circuit with both voltage sources active

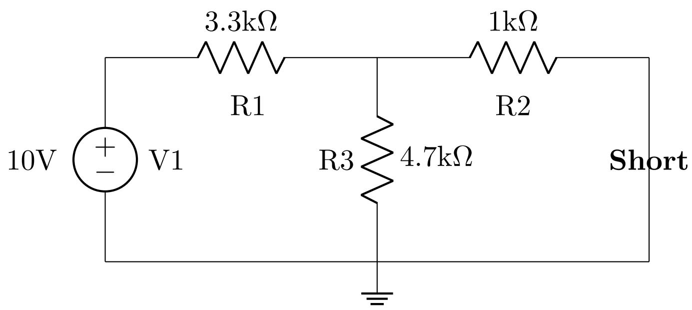

Figure 2: Circuit with V1 active and V2 replaced by short circuit

Circuit 1: Complete Circuit (Both Sources Active)

Circuit 2: V1 Active, V2 Short Circuit

Circuit 3: V2 Active, V1 Short Circuit

Apparatus

- DC Voltage Source (10 V)
- DC Voltage Source (5 V)
- Resistors: 3.3 kΩ, 1 kΩ, 4.7 kΩ
- Digital Multimeter
- Breadboard and connecting wires

Data Collection

Condition	**Current through R_2 (mA)**
V_1 and V_2 active	
Only V_1 active	
Only V_2 active	

Calculations

Given:

$$R_1 = 3.3\,k\Omega, \quad R_2 = 1\,k\Omega, \quad R_3 = 4.7\,k\Omega$$
$$V_1 = 10\,V, \quad V_2 = 5\,V$$

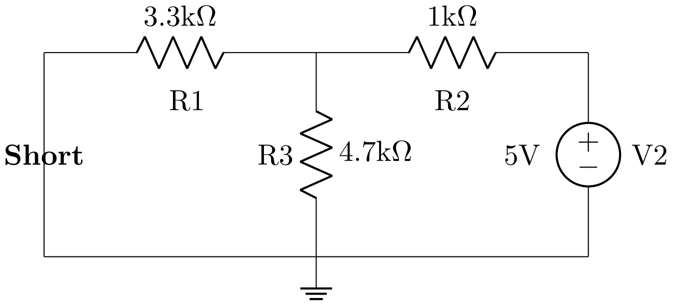

Figure 3: Circuit with V2 active and V1 replaced by short circuit

Case 1: Only V_1 Active

V_2 is replaced by a short circuit. Using nodal analysis, the current through R_2 is calculated as $I_{R_2(V_1)}$.

Case 2: Only V_2 Active

V_1 is replaced by a short circuit. The current through R_2 is calculated as $I_{R_2(V_2)}$.

Case 3: Both Sources Active

The total current through R_2 is:

$$I_{R_2} = I_{R_2(V_1)} + I_{R_2(V_2)}$$

Result Analysis

The experimentally obtained current through resistor R_2 when both sources are active closely matches the algebraic sum of the currents obtained from individual sources. Minor discrepancies may occur due to resistor tolerance and measurement errors.

Discussion and Conclusion

The experiment successfully demonstrated the validity of the superposition theorem for a linear resistive network containing two independent voltage sources. The calculated node voltage using superposition closely matched the value obtained from direct nodal analysis, confirming that the total response in a linear circuit is indeed the sum of the individual responses produced by each independent source acting alone.

The individual contributions from V_1 and V_2 were first determined by turning off one source at a time and observing the effect on the current through R_2. When the contributions were added, the resulting current and node voltage closely matched the values obtained when both sources were active simultaneously. This agreement verifies that linearity holds for the given circuit.

Minor deviations that may occur in practical measurements can be attributed to resistor tolerances, source internal resistance, measurement instrument precision, and wiring losses. Nevertheless, such discrepancies do not significantly affect the overall verification of the theorem.

In conclusion, the experiment confirms that the superposition theorem accurately predicts circuit behavior in linear DC circuits. The results obtained reinforce the theoretical expectation that complex circuits with multiple sources can be analyzed by isolating each source and combining their individual effects.

References

1. Hayt, W. H., Kemmerly, J. E., & Durbin, S. M. (2012). *Engineering Circuit Analysis* (8th ed.). McGraw-Hill. (Chapter 5, pp. 173-182)
2. Alexander, C. K., & Sadiku, M. N. O. (2016). *Fundamentals of Electric Circuits* (6th ed.). McGraw-Hill. (Chapter 4, pp. 126-138)