East West University
Department of Computer Science and Engineering

Course: CSE209 Electrical Circuits
Expt No.: 5
Title: Verification of Superposition Theorem

Objective:

1. To verify the superposition theorem theoretically, experimentally, and using PSpice simulation.

Theory:

Superposition theorem works for linear circuits. The superposition theorem states that if a linear circuit contains more than one source, the voltage across or the current through any element may be determined by algebraically adding the contribution of each source acting alone with other sources remaining inactive. A voltage source is made inactive by setting its voltage value to zero (or by replacing it with a short circuit).

Circuit Diagrams:

$$E_1 = 10\text{V}\ E_2 = 5\text{V}\ E_3 = 5\text{V}$$

$$\text{R}_1 = 33\Omega\ R_2 = 47\Omega\ R_3 = 33\Omega\ R_4 = 47\Omega\ R_5 = 47\Omega\ R_L = 68\Omega$$

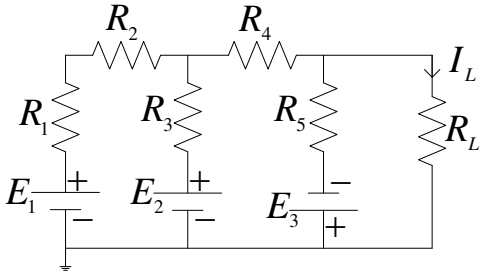

Figure 1. Circuit with all sources active.

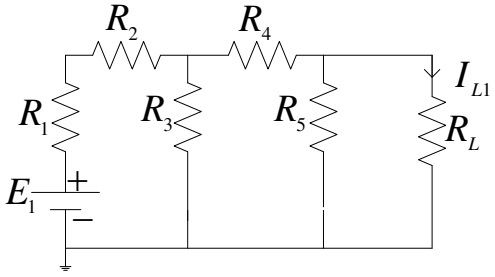

Figure 2. Circuit with E_1 source active.

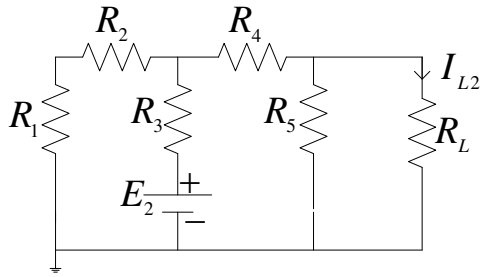

Figure 3. Circuit with E_2 source active.

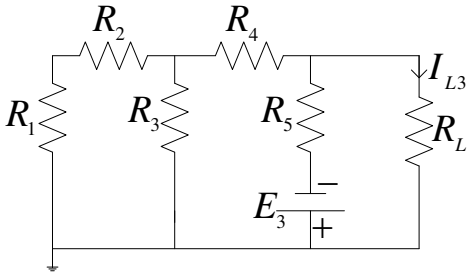

Figure 4. Circuit with E_3 sources active.

Pre-Lab Report Question:

1. Theoretically calculate the values of I_L, I_{L1}, I_{L2}, and I_{L3} of the circuits of Figures 1 through 4. From the calculated values, show that the superposition theorem holds, that is, $I_L = I_{L1} + I_{L2} + I_{L2}$.

Equipments and Components Needed:

1. DC power supply
2. Trainer board
3. DC ammeter
4. Multimeter
5. Resistors 33Ω (two), 47Ω (three), 68Ω (one)
6. Breadboard
7. Connecting wires

Lab Procedure:

1. Measure the resistance values of the given resistors and record them in Table 1.
2. Construct the circuit with all voltage sources active as shown in Figure. 1. For the E_1 = 10V source, use DC power supply. For the E_2 = 5V and E_3 = 5V sources, use the fixed voltage sources of the trainer board (be careful of the polarity of the voltage sources). Measure the values of the voltage sources and record them in Table 1. Measure I_L and record it in Table 1.
3. Construct the circuit with only voltage source E_1 active as shown in Figure 2. This may be done by removing the voltage sources E_2 and E_3 from the circuit and replacing them with short circuits. **Caution: Do not try to replace any voltage source with a short circuit by directly connecting a wire across it. This will burn the trainer board.** Measure the value of I_{L1} and record it in Table 1. This is the current through the R_L = 68Ω resistor when only the E_1 = 10V source is active.
4. Construct the circuit with only voltage source E_2 active as shown in Figure 3. Measure the current I_{L2} and record it in Table 1. This is the current through the R_L = 68Ω resistor when only the E_2 = 5V source is active.
5. Construct the circuit with only voltage source E_3 active as shown in Figure 4. Measure the current I_{L3} and record it in Table 1. This is the current through the R_L = 68Ω resistor when only the E_3 = 5V source is active (be careful of the polarity of this source).
6. From the experimental data, show that the superposition theorem holds, that is, $I_L = I_{L1} + I_{L2} + I_{L2}$.
7. Have the datasheet signed by your instructor.

Table 1. Experimental Datasheet.

Measured Value of E_1 (V)	Measured Value of E_2 (V)	Measured Value of E_3 (V)	Measured value of I_L with all sources active (mA)	Measured value of I_{L1} with only E_1 active (mA)	Measured value of I_{L2} with only E_2 active (mA)	Measured value of I_{L3} with only E_2 active (mA)	Measured values of resistors (Ω)
							R_1 = R_2 = R_3 = R_4 = R_5 = R_L =

Post-Lab Report Questions:

1. Calculate the values of I_L, I_{L1}, I_{L2}, and I_{L3} of the circuits of Figures 1 through 4 using the measured values of E_1, E_2, E_3, R_1, R_2, R_3, R_4, R_5, and R_L. From the calculated values show that the superposition theorem holds. Compare these calculated values of currents with the experimental values and comment on any discrepancy observed.
2. Solve the circuits of Figures 1 through 4 using PSpice. Include the PSpice circuits with only currents shown. From the PSpice solution show that the superposition theorem holds. Compare the PSpice solutions with the theoretical solutions and comment on any discrepancy found.