

- Aim: Verification of superposition theorem for electric circuit.
- Apparatus: DC power supply, Ammeter (0-1A), Voltmeter (0-150V), Rheostat, Multimeter.
- Theory: If network contains two or more than two sources, then principle of superposition theorem is used to simplify network calculations. It may be stated as follows -  
 "In a bilateral network if two or more than two energy sources are present, then the correct flow at any pt. is the algebraic sum of all currents which would ~~not~~ flow at that pt. if each source was considered separately and all other sources replaced at the time by impedance equal to their internal impedances.

If,  $I_3$  = current through  $R_3$  when both sources are connected.

$I_3'$  = current flowing through  $R_3$  when only  $V_{dc}$  is connected.

$I_3''$  = current flowing through  $R_3$  when only  $V_{ac}$  is connected.

$$\therefore I_3 = I_3' + I_3''$$



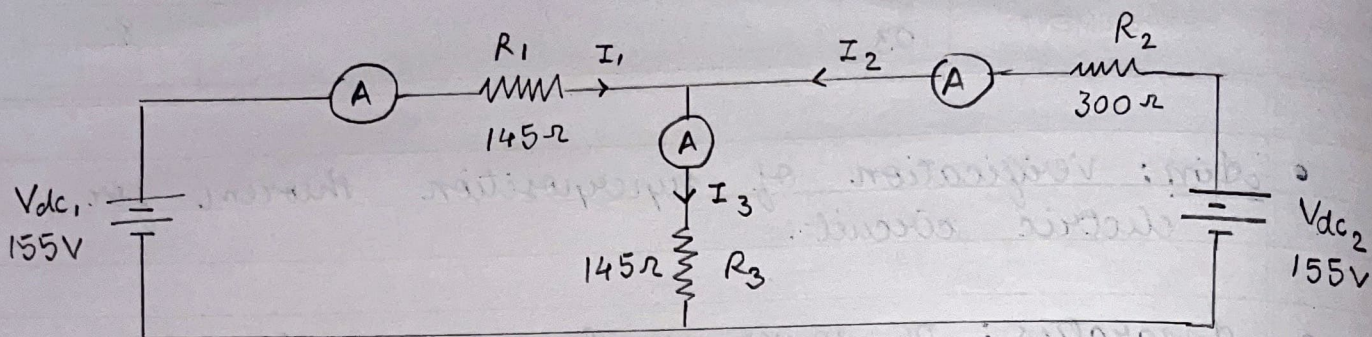


Fig 1

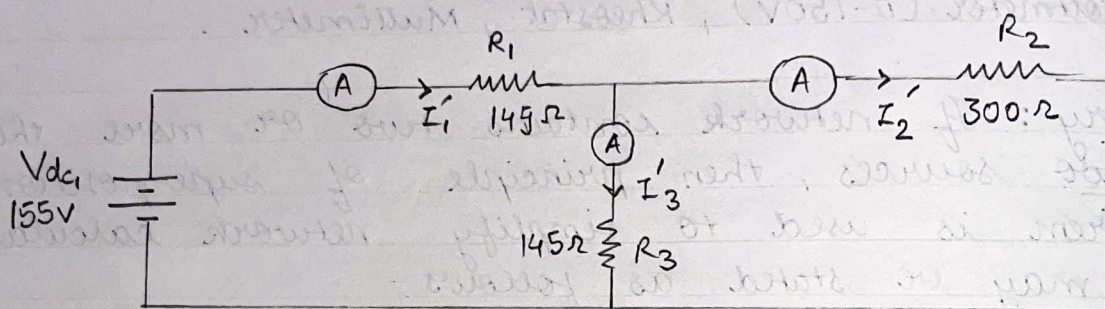


Fig 2

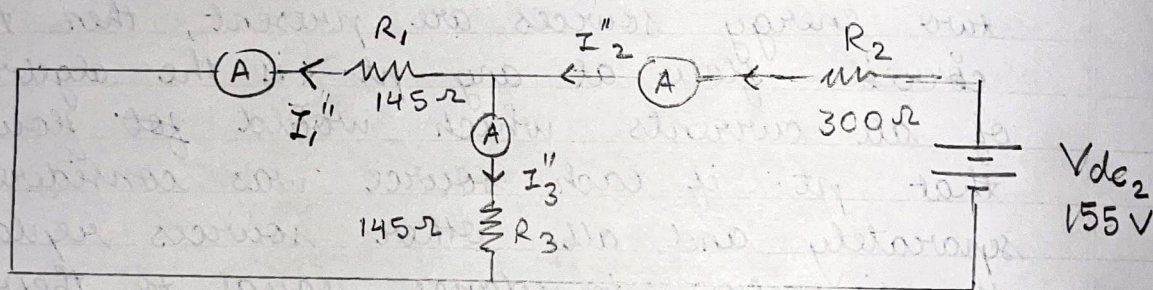


Fig 3

### Calculations -

For Fig 1

Apply KVL:

$$155 - 145I_1 - 145I_3 = 0$$

$$\Rightarrow 155 - 290I_1 - 145I_2 = 0$$

$$155 - 145I_1 + 300I_2 - 155 = 0$$

$$29I_1 = 60I_2$$

$$\therefore I_1 = 0.43 \text{ A}$$

$$I_2 = 0.21 \text{ A}$$

$$I_3 = 0.64 \text{ A}$$

For Fig 2

$$R_{eq} = \frac{145 \times 300}{445}$$

$$R_{eq} = 242.75$$

$$\therefore I_1' = \frac{155}{242.75} = 0.64 \text{ A}$$

$$\therefore I_2' = 0.21 \text{ A}$$

$$\therefore I_3' = 0.43 \text{ A}$$

$$I_1' = 0.64 \text{ A}$$

For Fig 3

$$R_{eq} = \frac{145 + 300}{2}$$

$$I_2'' = \frac{155}{372.5} = 0.42 \text{ A}$$

$$\therefore I_1'' = 0.21 \text{ A}$$

$$I_3'' = 0.21 \text{ A}$$

$$I_2'' = 0.42 \text{ A}$$



### • Procedure :

1. Set up circuit as shown in Fig.1
2. Apply 155V as ~~at~~  $V_{dc_1}$  & 155V as ~~at~~  $V_{dc_2}$
3. Measure the current  $I_1$ ,  $I_2$ ,  $I_3$  using ammeters connected in the circuit & note it in table.
4. Now, start circuit the terminal where  $V_{dc_2}$  is connected as shown in Fig.2.
5. Measure the current  $I_1'$ ,  $I_2'$ ,  $I_3'$  using ~~at~~ ammeters connected in the circuit and note it in table.
6. Now short circuit the terminal where  $V_{dc_1}$  is connected and apply 155V at  $V_{dc_2}$  terminal as shown in Fig.3.
7. Measure the current  $I_1''$ ,  $I_2''$ ,  $I_3''$  using ammeters connected in the circuit and note it in table.
8. Verify if  $I_3 = I_3' + I_3''$ , which will be true.

### • Questions :

1. What are the limitations of superposition theorem?
- A.1.
- It cannot be used to measure power.
  - It is valid only for linear & bilateral network.
  - It can only be used for circuits having two or more than two energy sources.



# Observations :

## EXPERIMENTAL

Current through Resistors

$V_{dc1} = 155V$ $V_{dc2} = 155V$	$V_{dc1} = 155V$ $V_{dc2} = 0V$	$V_{dc1} = 0V$ $V_{dc2} = 155V$
$I_1 = 0.5A$ $I_2 = 0.23A$ $I_3 = 0.7A$	$I_1' = 0.7A$ $I_2' = 0.23A$ $I_3 = 0.5A$	$I_1'' = 0.2A$ $I_2'' = 0.45A$ $I_3'' = 0.2A$

## CALCULATIONS

Current through Resistors

$V_{dc1} = 155V$ $V_{dc2} = 155V$	$V_{dc1} = 155V$ $V_{dc2} = 0V$	$V_{dc1} = 0V$ $V_{dc2} = 155V$
$I_1 = 0.43A$ $I_2 = 0.21A$ $I_3 = 0.64A$	$I_1' = 0.64A$ $I_2' = 0.21A$ $I_3' = 0.43A$	$I_1'' = 0.21A$ $I_2'' = 0.42A$ $I_3'' = 0.21A$

Using Superposition —

CALCULATED

$$I_1 = I_1' - I_1''$$

$$LHS = 0.43A$$

$$RHS = 0.64 - 0.21 = \underline{0.43A}$$

$$I_2 = I_2'' - I_2'$$

$$LHS = 0.21A$$

$$RHS = 0.42 - 0.21 = \underline{0.21A}$$

$$I_3 = I_3' + I_3''$$

$$LHS = 0.64A$$

$$RHS = \underline{0.64A}$$



- This theorem is not applicable to unbalanced circuits

- Results :

- For Fig 1

The current through resistor  $R_1$ ,  $I_1 = 0.5A$

The current through resistor  $R_2$ ,  $I_2 = 0.23A$

The current through resistor  $R_3$ ,  $I_3 = 0.7A$

- For Fig 2

The current through resistor  $R_1$ ,  $I'_1 = 0.7A$

The current through resistor  $R_2$ ,  $I'_2 = 0.23A$

The current through resistor  $R_3$ ,  $I'_3 = 0.5A$

- For Fig 3

The current through resistor  $R_1$ ,  $I''_1 = 0.2A$

The current through resistor  $R_2$ ,  $I''_2 = 0.45A$

The current through resistor  $R_3$ ,  $I''_3 = 0.8A$

- Conclusion :

In this experiment we are able to verify superposition Theorem.

We also see some limitations of superposition theorem.