VERIFICATION OF SUPERPOSITION THEOREM

INTRODUCTION

Superposition theorem is a fundamental principle in electrical engineering that states that the response (current or voltage) of a linear circuit to multiple input sources can be determined by adding up the individual responses to each source acting alone. This means that the total response is equal to the sum of the responses due to each individual source, while all other sources are turned off. The theorem is based on the principle of linearity, which holds that the behaviour of a circuit is proportional to the applied input. The superposition theorem is a powerful tool for analyzing complex circuits, as it simplifies the analysis by breaking down a complex circuit into smaller, more manageable parts.

OBJECTIVE

To verify Superposition Theorem

APPARATUS REQUIRED

SL.NO	EQUIPMENTS	RANGE	QUANTITY
1	Resistor		4
2	DC Power Supply	(0-30) V	
3	Voltmeter	(0-600) V	1
4	Ammeter	(0-10A)	1

PRE-LAB

Read the lab over and answer the following questions.

1. The output of the circuits in Figures 1.1, 2.1 and 3.1 is predicted in equations 1.1, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 3.2, 3.3 respectively.
   - Calculate the value of current through R_4 in Figure 1.1 in the same format or students can use any circuit analysis method.
   - Calculate the value of current through R_4 in Figure 2.1 in the same format or students can use any circuit analysis method.
   - Calculate the value of current through R_4 in Figure 3.1 in the same format or students can use any circuit analysis method.

THEORY

Superposition Theorem:

According to superposition theorem, in any linear bilateral multisource network, the current or voltages across any branch can be determined by taking algebric sum of values calculated by selecting one source at a time and replacing other active sources by their internal resistances.

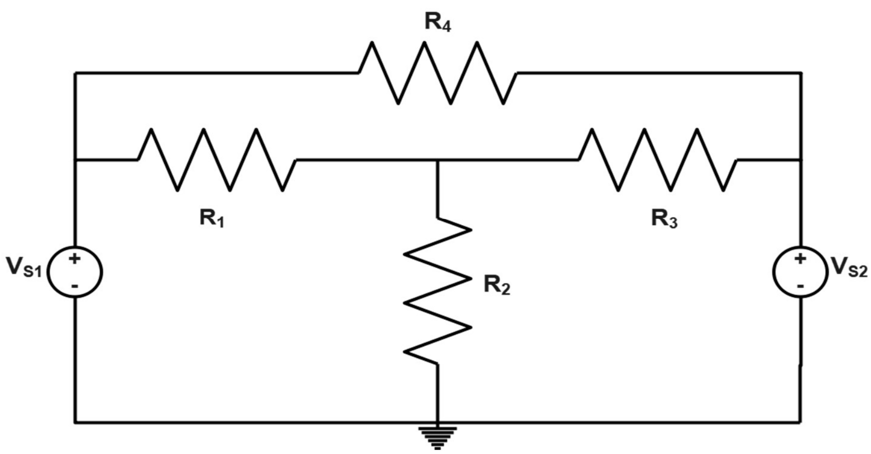
Steps to solve

1. Identify the branch and quantity to be calculated along with the presence of more than one active source.
2. Consider any one active source and replace the other sources by their internal resistances. Calculate the required electrical quantity for that particular source.
3. Repeat the last two steps for all active source.
4. The required electrical quantity for all the sources functioning together will equal the algebraic sum of all these individual values.

TEST SYSTEM -1

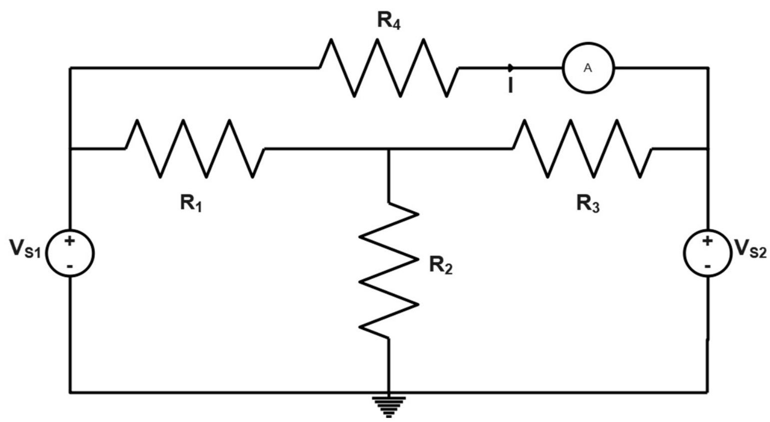
Superposition Theorem with two independent voltage source.

Computing current through R_4, denoted by I.



[Fig.1.1: Main circuit Diagram]

Step 1: compute I from main circuit by any circuit analysis method.

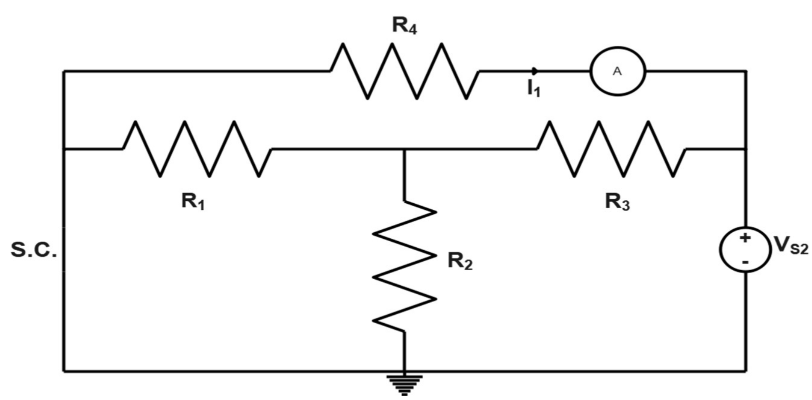


[Fig.1.2: circuit dig. With ammeter]

$$I = \frac{V_{S1} - V_{S2}}{R_4} \tag{1.1}$$

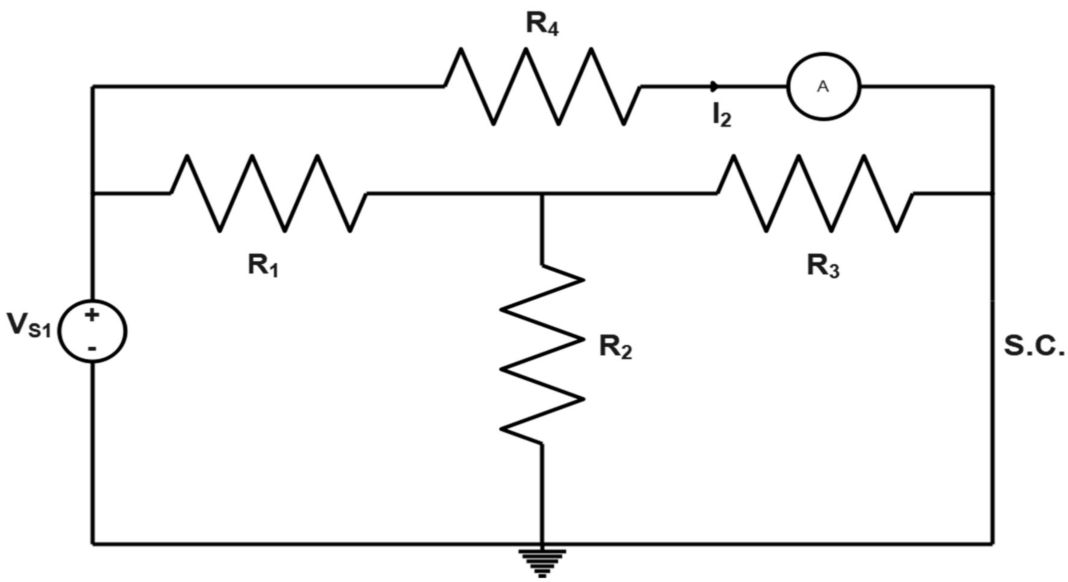
Step 2: compute I_1, when V_{s1} is short circuited and V_{s2} is acting alone.

$$I_1 = \frac{0 - V_{S2}}{R_4} = \frac{-V_{S2}}{R_4} \tag{1.2}$$



[Fig.1.3: Circuit diagram with V_{s1} short circuited]

Step 3: Compute I_2, when V_{s2} is short circuited and V_{s1} is acting alone.



[Fig.1.4: Circuit diagram with V_{s2} is short circuited]

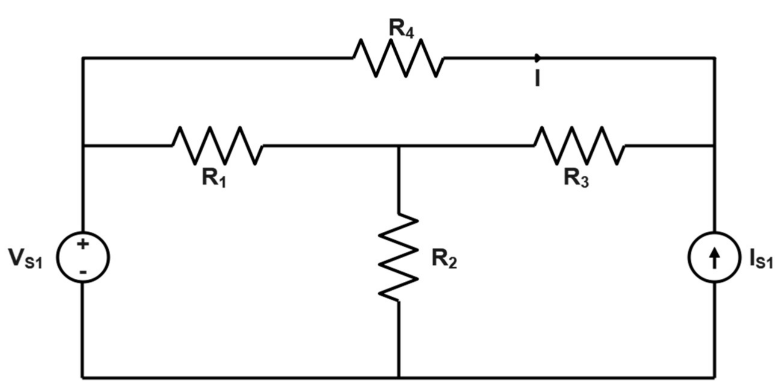
$$I_2 = \frac{V_{s1} - 0}{R_4} = \frac{V_{s1}}{R_4} \quad (1.3)$$

Step 4: As per superposition theorem,

I= $I_1 + I_2$

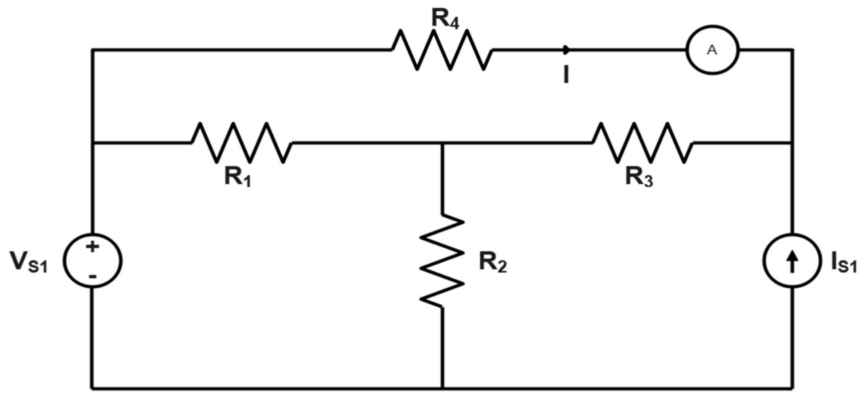
<u>TEST SYSTEM -2</u>

<u>Superposition Theorem with independent voltage source and independent current source</u>



[Fig. 2.1: Main Circuit]

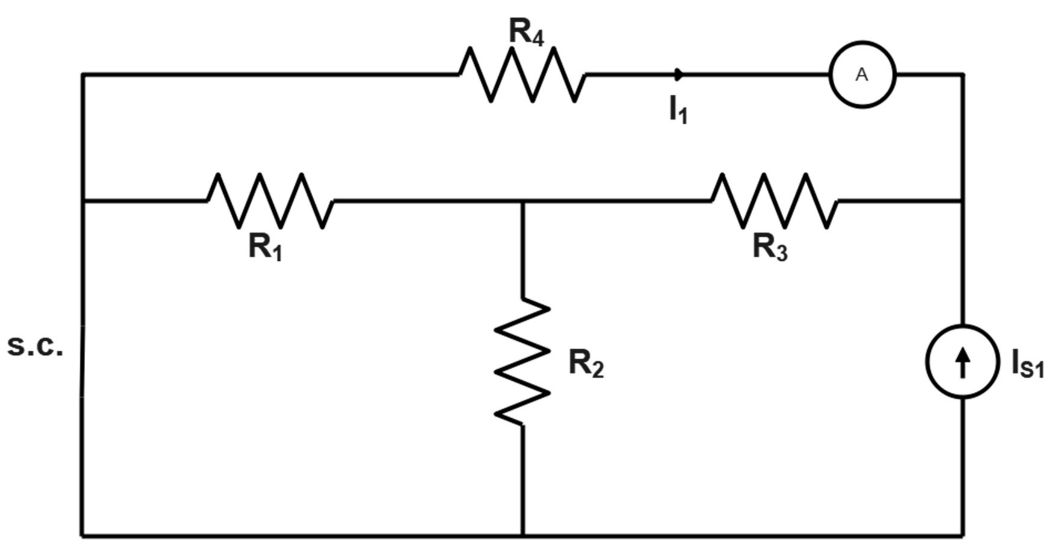
Step 1: Compute I from main circuit, by any circuit analysis method.



[Fig.2.2: circuit diagram with ammeter

$$I = \frac{(V_{S1} - I_{S1}R_2)R_1 - (R_1 + R_2)(I_{S2}R_3)}{(R_1 + R_2)(R_1 + R_3 + R_4) - {R_1}^2} \tag{2.1}$$

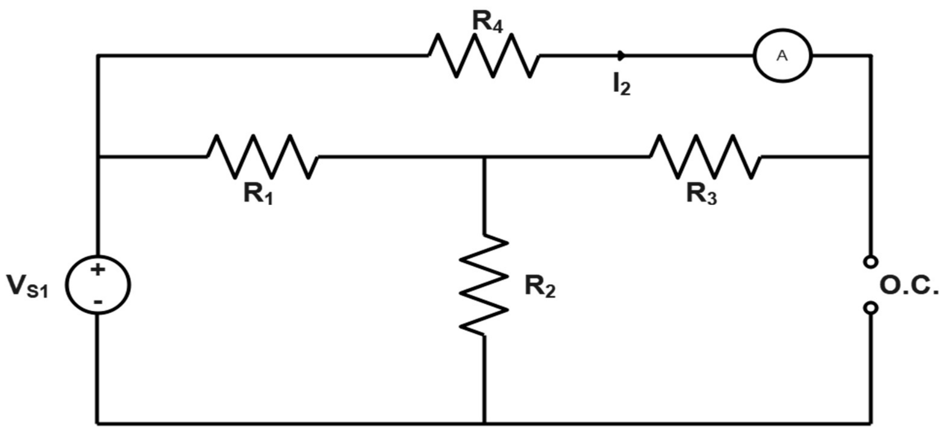
Step 2: Compute I_1, when V_{s1} is short circuited and I_{s1} is acting alone.



[Fig.2.3: circuit diagram with V_{s1} short circuited]

$$I_1 = \frac{-I_{S1}R_1R_2 - (R_1 + R_2)(I_{S2}R_3)}{(R_1 + R_2)(R_1 + R_3 + R_4) - {R_1}^2} \tag{2.2}$$

Step 3: Compute I_2, when I_{s1} is open circuited and V_{s1} is acting alone.



[Fig.2.4: circuit diagram with I_{s1} open circuited]

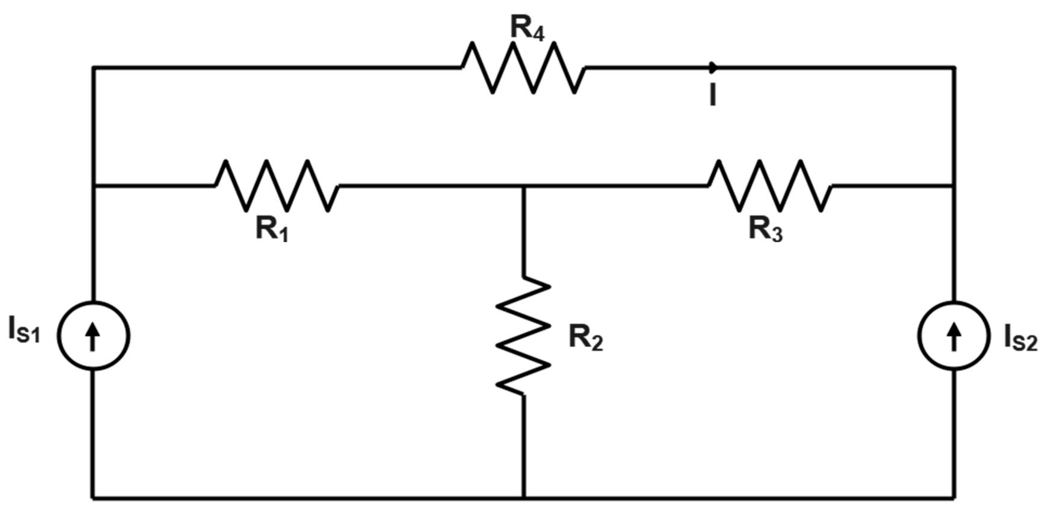
$I_2 = \frac{V_{S1}R_1}{(R_1+R_2)(R_1+R_3+R_4)-R_1{}^2}$ (2.3)

Step 4: As per superposition theorem,

I= I_1+I_2

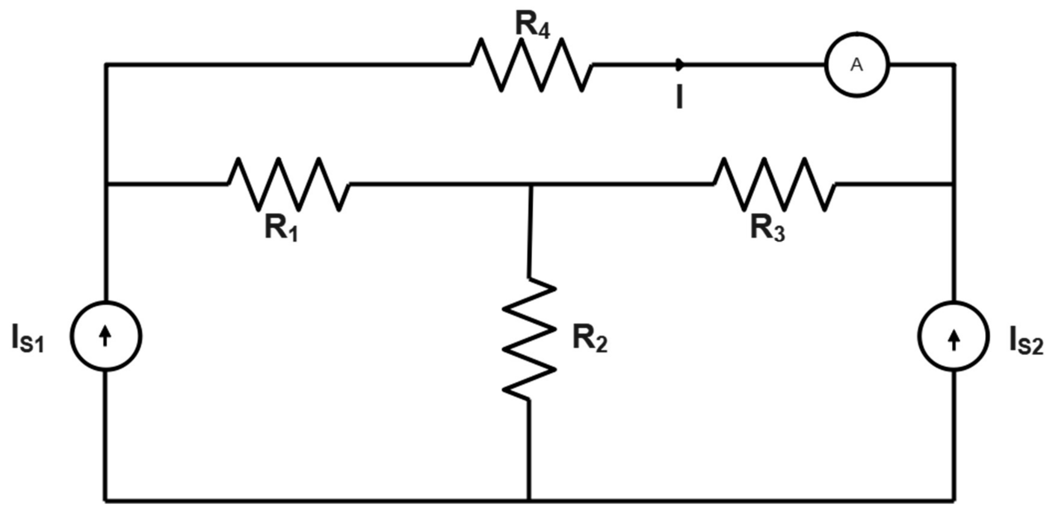
TEST SYSTEM -3

Superposition theorem with two Independent Current Sources



[Fig. 3.1: Main Circuit]

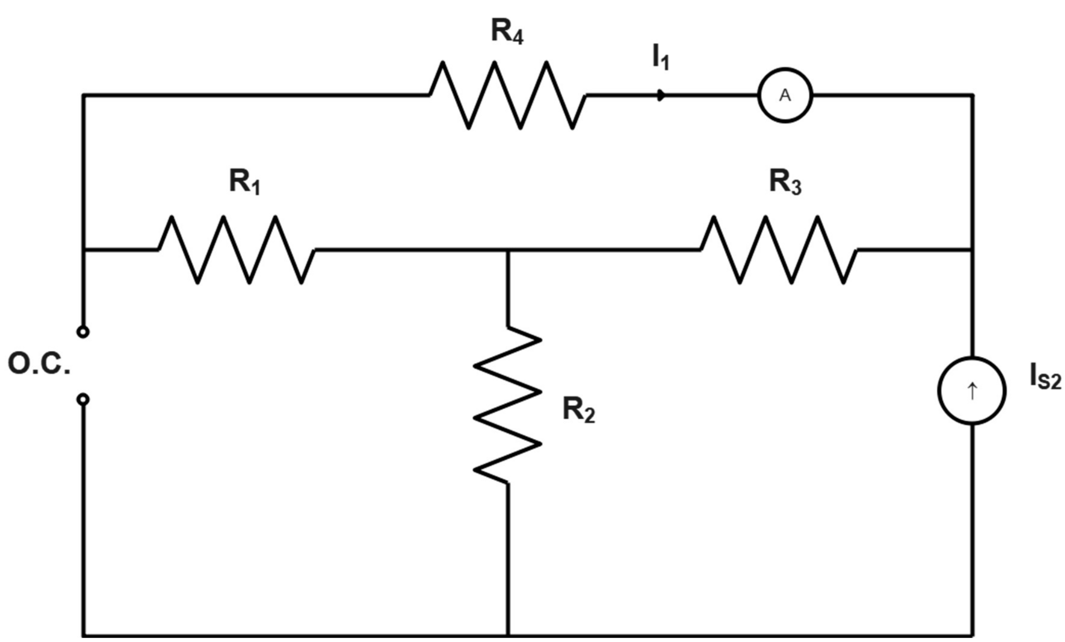
Step 1: Computation of I from main circuit, by connecting ammeter in series with R_4



[Fig 3.2: circuit diagram with ammeter]

$$I=\frac{I_{s1}R_1-I_{s2}R_3}{R_1+R_3+R_4} \tag{3.1}$$

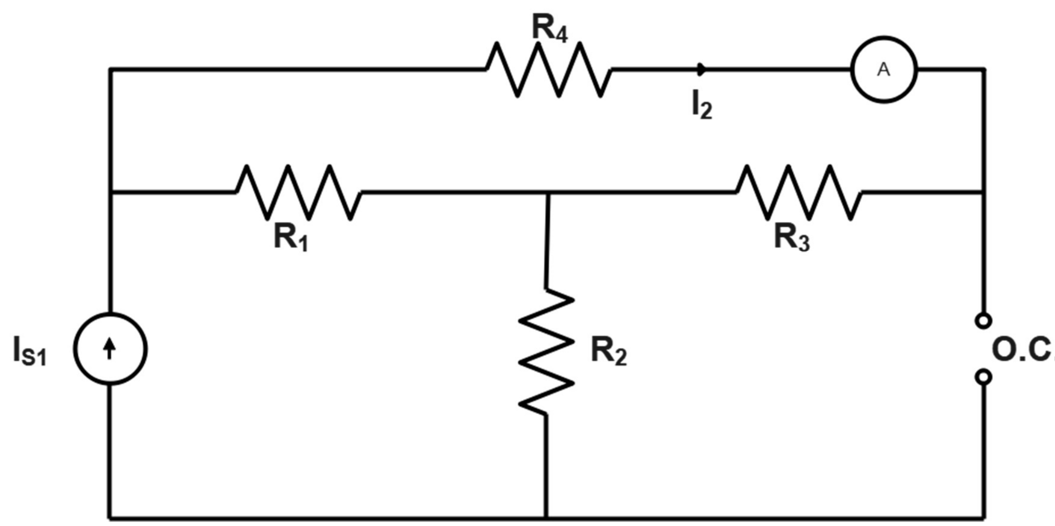
Step 2: Compute I_1, when I_{s1} is open circuited and I_{s2} is acting alone.



[Fig.3.3: Circuit diagram with I_{s1} open circuited]

$$I_1 = \frac{-I_{s2}R_3}{R_1+R_3+R_4} \qquad (3.2)$$

Step 3: Compute I_2 , when I_{s2} is open circuited and I_{s1} is acting alone



[Fig.3.4: Circuit diagram with I_{s2} open circuited]

$$I_2 = \frac{I_{s1}R_1}{R_1+R_3+R_4} \qquad (3.3)$$

Step 4: As per superposition theorem,

I= I_1+I_2

Note:

A **linear circuit** is that whose output is linearly related (or directly proportional) to its input.

A **bilateral circuit** is that which exhibits its properties equally in either direction.

A **short Circuit** is a circuit element with resistance approaching zero.

An **open circuit** is a current element with resistance approaching infinity.

POST-LAB

1. For superposition, it is not required that only one independent source be considered at a time any number of independent sources may be considered simultaneously.

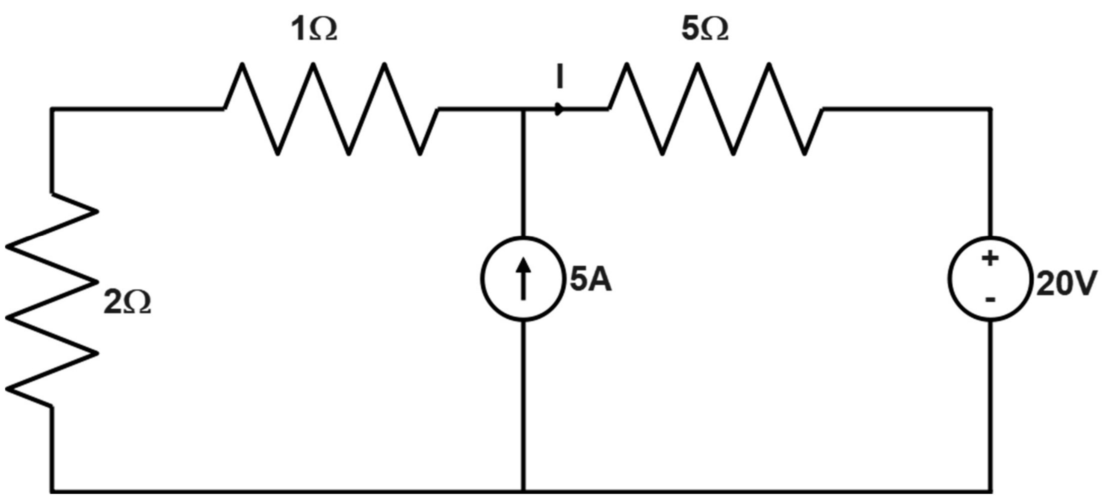
   (a)True (b) False

2. The superposition theorem principle applies to power calculation.

   (a)True (b) False

3. What is the major advantage of implementing this theorem?

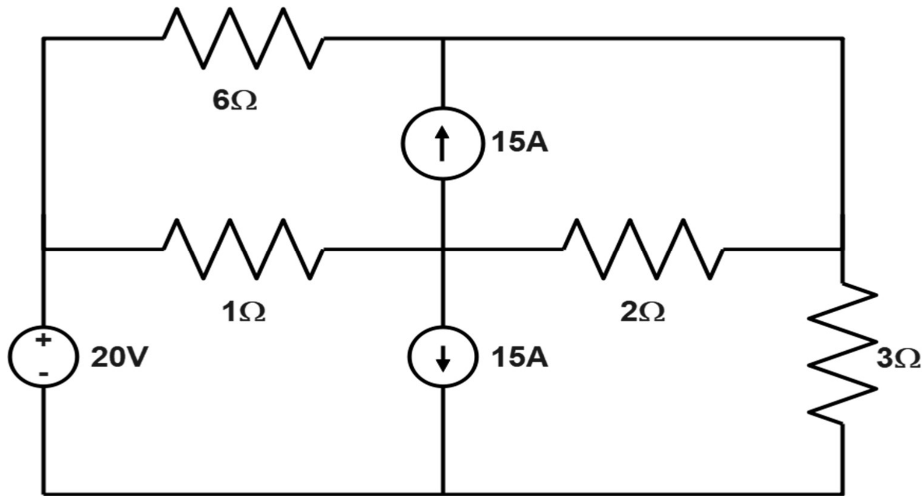
4. Using superposition theorem, find current I across 5Ω in the below figure.



(a)-0.65 (b) -0.625 (c)-0.256 (d) +0.652

5. Why dependent sources are not killed?

6. Use superposition theorem to calculate the voltage drop across the 3Ω resistor from the below circuit?



(a) 16V (b) -16V

(c) 18V (d) -18V