Superposition Theorem:

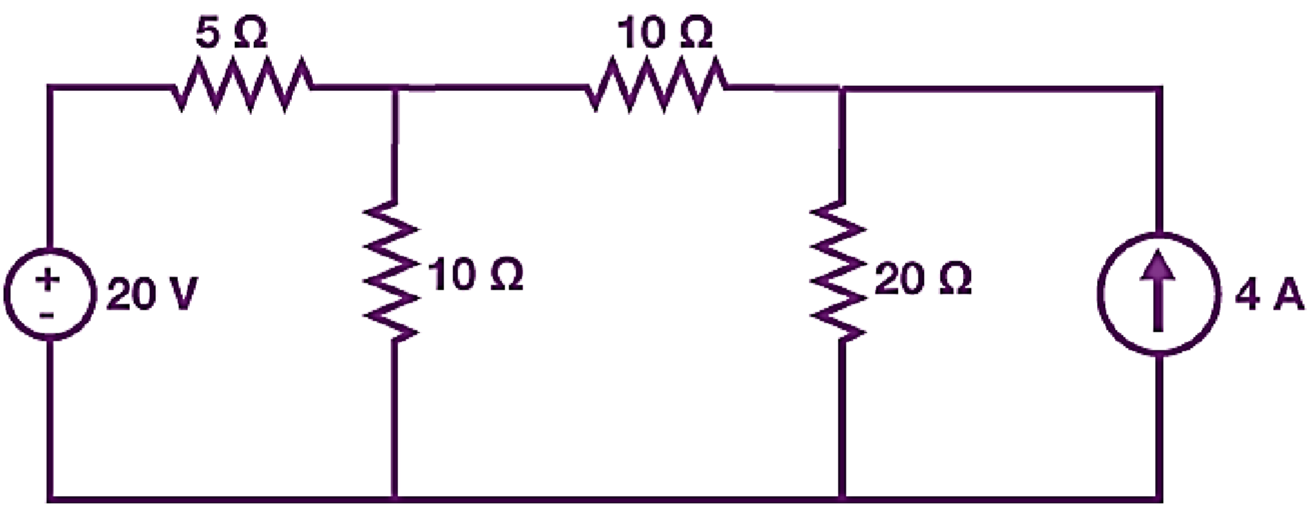
Guidelines to keep in mind while using the superposition theorem

- When you sum the individual contributions of each source, you should be careful while assigning signs to the quantities. It is suggested to assign a reference direction to each unknown quantity. If a contribution from a source has the same direction as the reference direction, it has a positive sign in the sum; if it has the opposite direction, then a negative sign.
- To use the superposition theorem with circuit currents and voltages, all the components must be linear.
- It should be noted that the superposition theorem does not apply to power, as power is not a linear quantity.

How to apply Superposition Theorem?

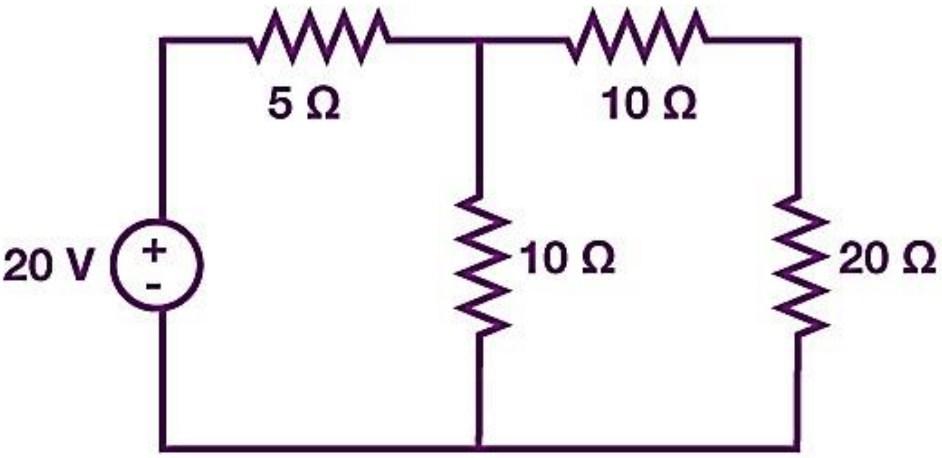
- The first step is to select one source among the multiple sources present in the bilateral network. Among the various sources in the circuit, any one of the sources can be considered first.
- Except for the selected source, all the sources must be replaced by their internal impedance.
- Using a network simplification approach, evaluate the current flowing through or the voltage drop across a particular element in the network.
- The same considering a single source is repeated for all the other sources in the circuit.
- Upon obtaining the respective response for individual source, perform the summation of all responses to get the overall voltage drop or current through the circuit element.
- Superposition Theorem Solved Example:

Example 1: Find the current flowing through 20 Ω using the superposition theorem.



Solution:

Step 1: First, let us find the current flowing through a circuit by considering only the 20 V voltage source. The current source can be open-circuited, hence, the modified circuit diagram is shown in the following figure.



Step 2: The nodal voltage V1 can be determined using the nodal analysis method.

The nodal equation at node 1 is written as follows:

$$V1-205+V110+V110+20=0$$

$$6V1-120+3V1+V130=0$$

$$10V1=120$$

$$V1=12V$$

The current flowing through the 20 Ω resistor can be found out using the following equation:

$$I1=V110+20$$

Substituting the value of the V1 in the above equation, we get

$$I1 = 0.4\ A$$

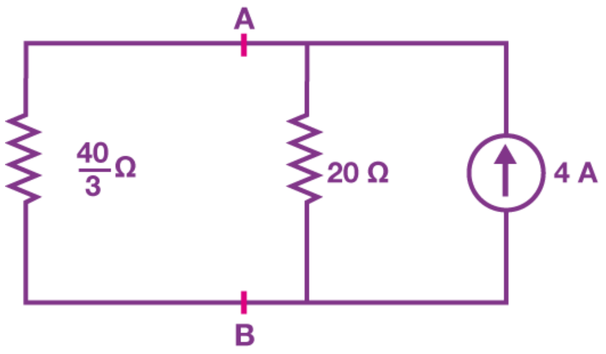
Therefore, the current flowing through the 20 Ω resistor to due 20 V voltage source is 0.4 A.

Step 3: Now let us find out the current flowing through the 20 Ω resistor considering only the 4 A current source. We eliminate the 20 V voltage source by short-circuiting it. The modified circuit, therefore, is given as follows:

In the above circuit, the resistors 5 Ω and 10 Ω are parallel to each other and this parallel combination of resistors is in series with the 10 Ω resistor. Therefore, the equivalent resistance will be:

$RAB=5\times105+10+10=403\Omega$

Now, the simplified circuit is shown as follows:



Now the current flowing through the 20 Ω resistor can be determined using the current division principle.

I2=IsR1R1+R2

Substituting the values, we get

I2=1.6A

Therefore, the current flowing through the circuit when only 4 A current source is 1.6 A.

Step 4: The summation of currents I1 and I2 will give us the current flowing through the 20 Ω resistor. Mathematically, this is represented as follows:

I = I1 + I2

Substituting the values of I1 and I2 in the above equation, we get

I = 0.4+1.6 = 2 A

Therefore, the current flowing through the resistor is 2 A.