Learning Outcomes

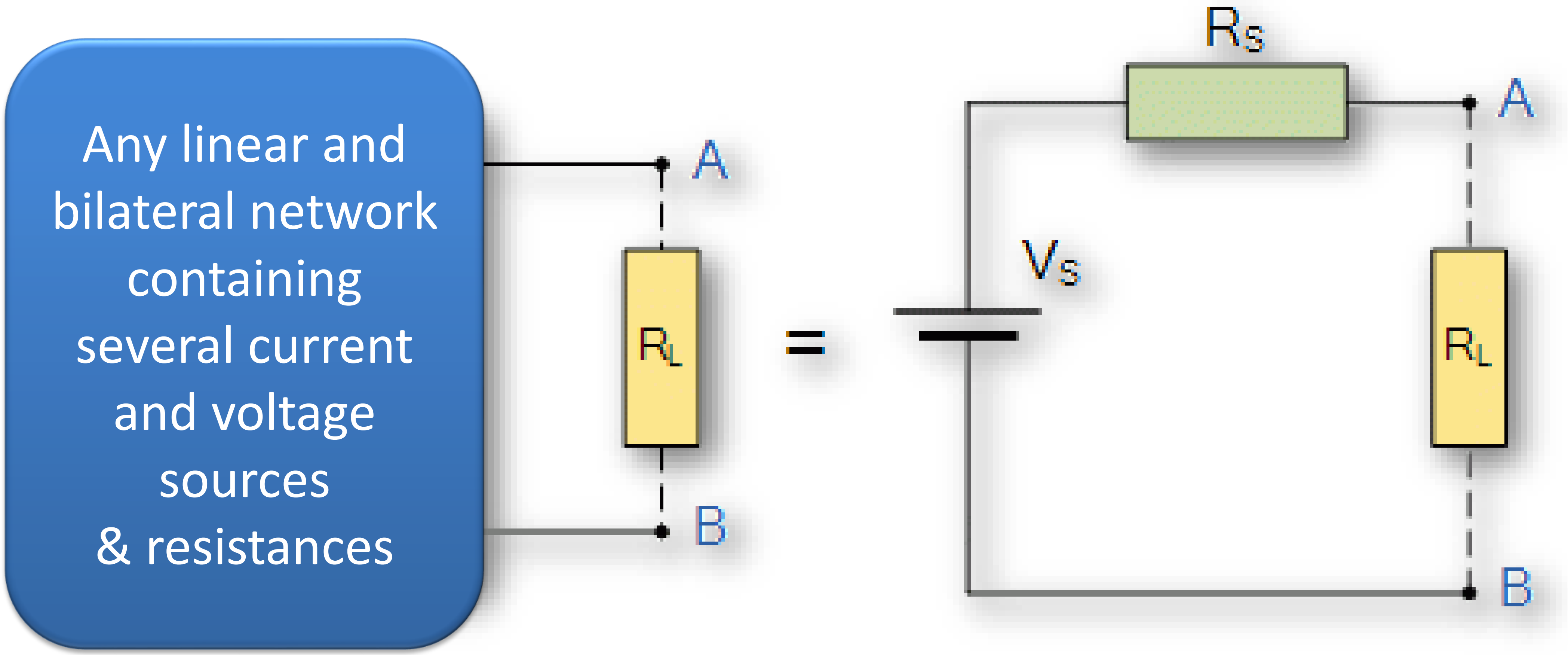
- Understand Linear Network
- Differentiate between unilateral and bilateral Network
- Understand the importance of Thevenin's theorem
- Draw Complex Network into a Thevenin's equivalent circuit

Thevenin's Theorem

Any Linear and bilateral Electric Network or complex circuit with Current and Voltage sources can be replaced by an equivalent circuit containing of a single independent open circuit thevenin's voltage Source V_{TH} in Series with the thevenin's Resistance R_{TH} .along with the load resistance R_L

STEP 6
STEP 5
STEP 4
STEP 3
STEP 2
STEP 1

Thevenin's Theorem



Find the load resistor

STEP 6

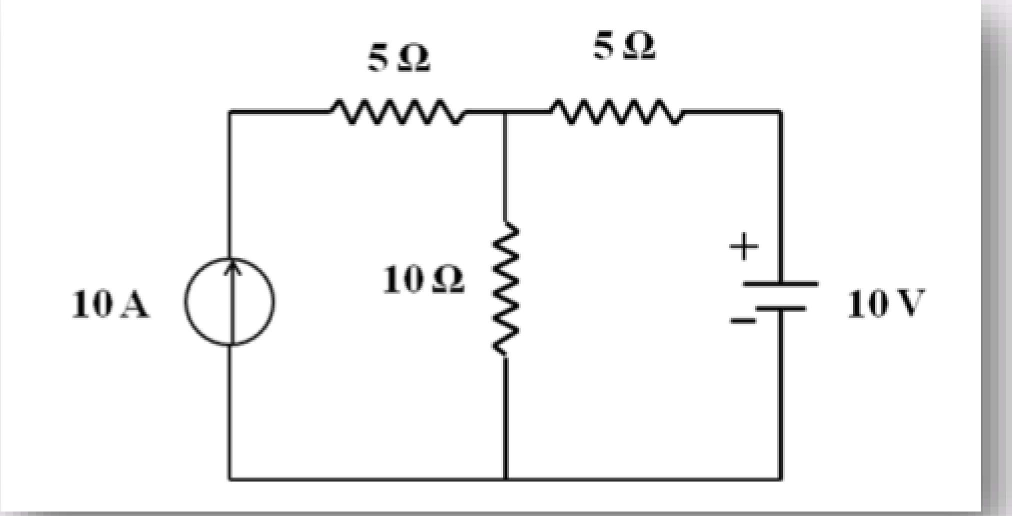
STEP 5

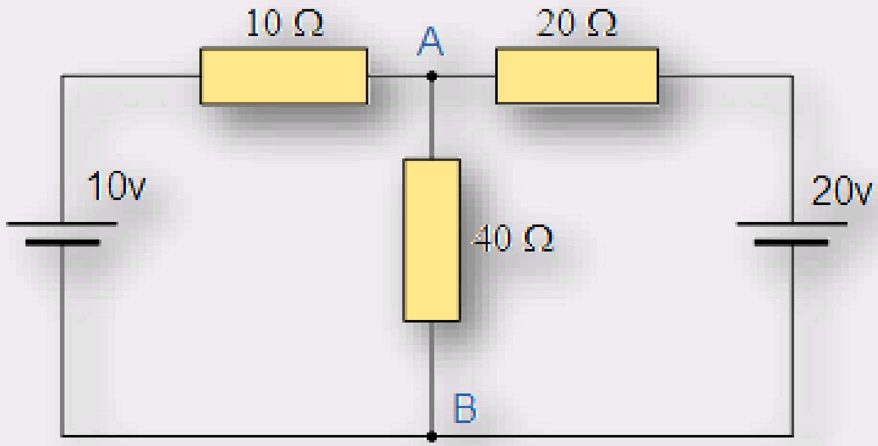
STEP 4

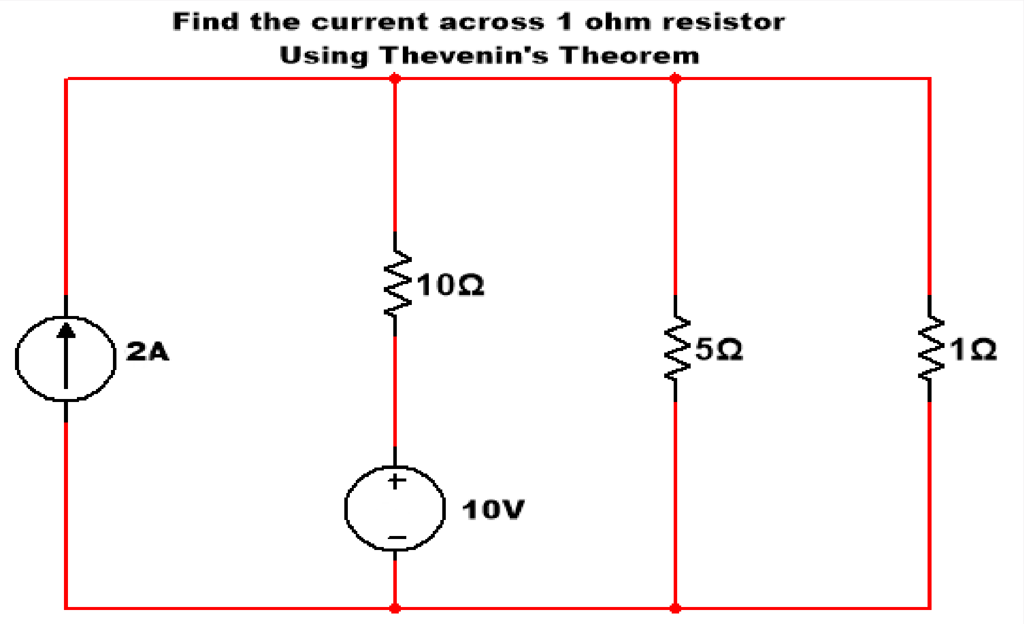
STEP 3

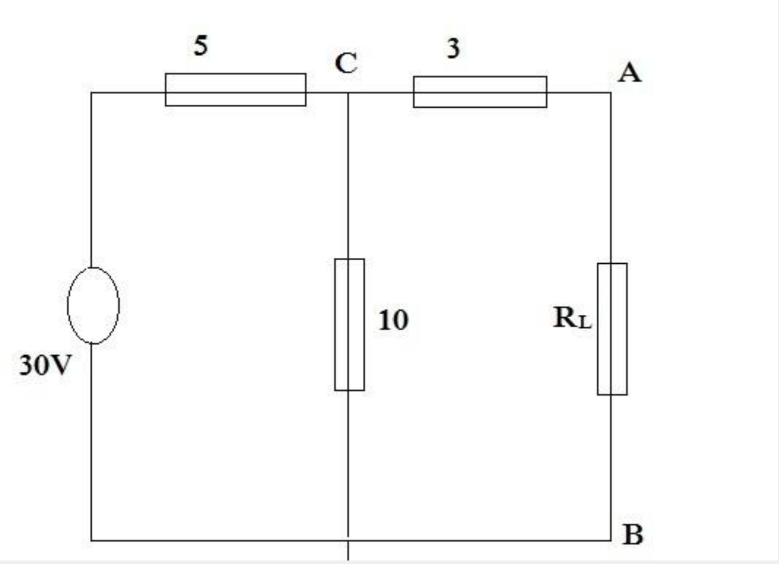
STEP 2

STEP 1









STEP 6

STEP 5

STEP 4

STEP 3

Remove the Load Resistance R_L

Calculate/measure the open circuit Thevenin's voltage V_{TH} across two open ends

STEP 2

STEP 1

STEP 6
STEP 5
STEP 4

Remove the Load Resistance R_L

Replace all active sources with their internal resistance

STEP 3
STEP 2
STEP 1

STEP 6

STEP 5

Remove the Load Resistance R_L

Calculate /measure the equivalent Thevenin's Resistance R_{TH} Across two open ends

STEP 4

STEP 3

STEP 2

STEP 1

STEP 6

Now, Draw the equivalent circuit for given network

This is the Equivalent Thevenin's Circuit

STEP 5

STEP 4

STEP 3

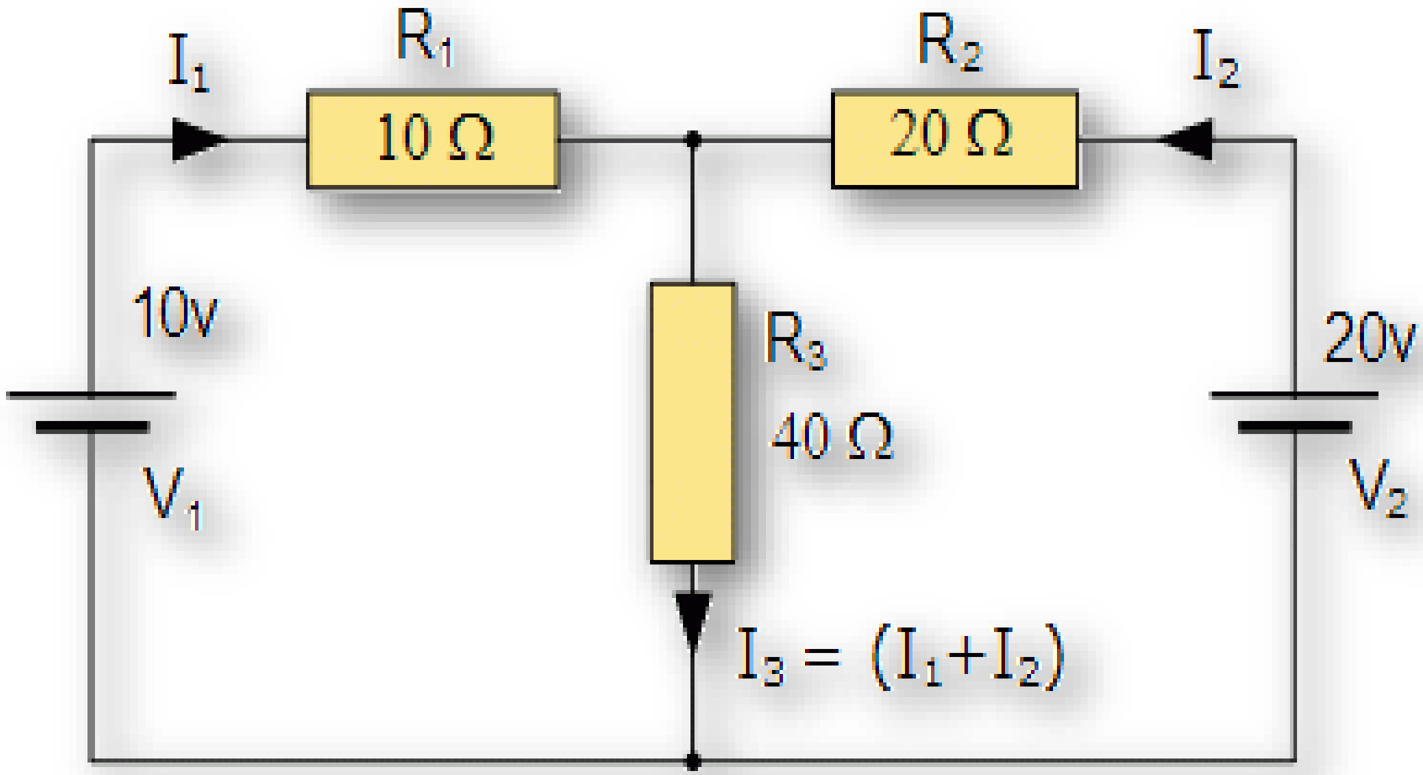
STEP 2

STEP 1

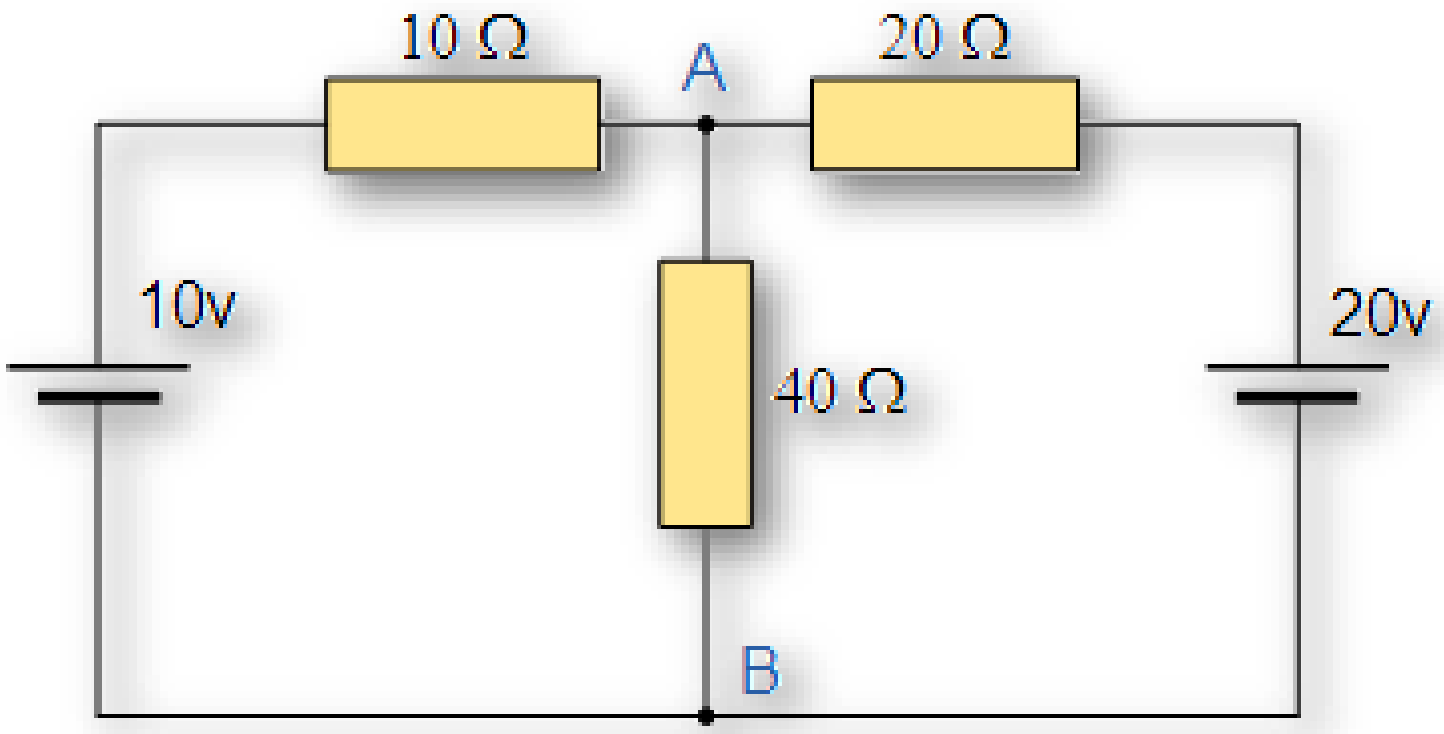
Now find the Load current flowing through the Load Resistor by using given identity

$$I_L = V_{TH} / (R_{TH} + R_L)$$

Example -1



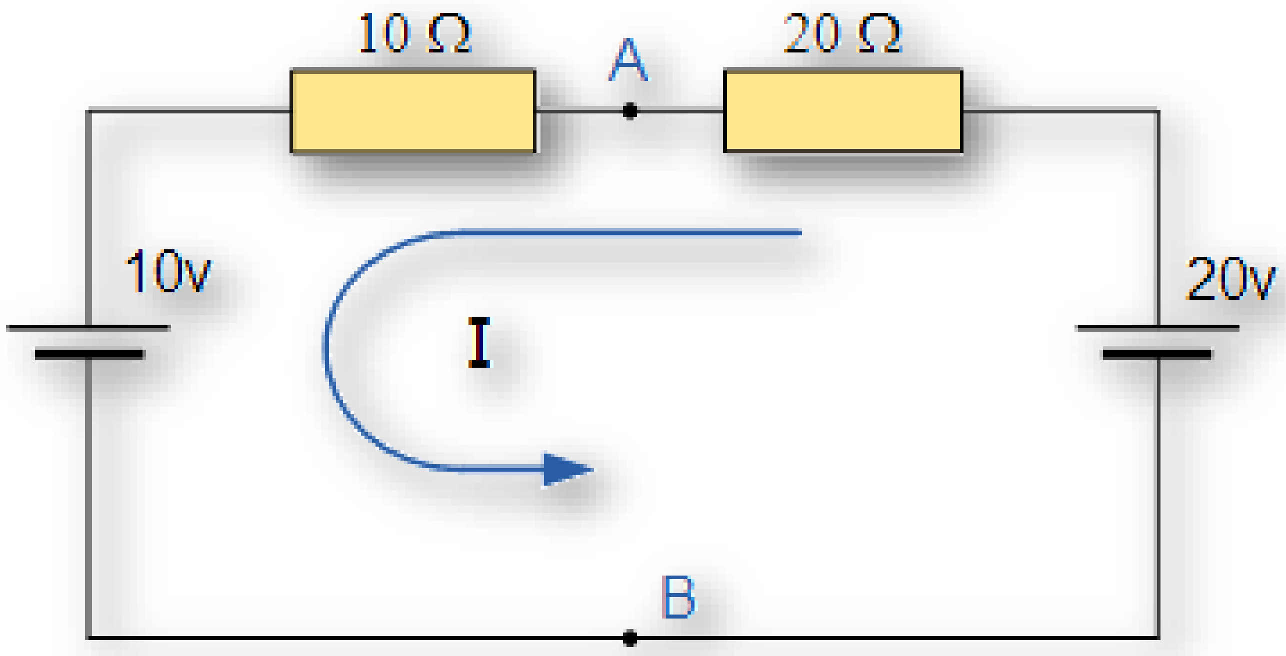
Step -1



$R_L = 40\ \Omega$

Step - 2

Calculate V_{TH}

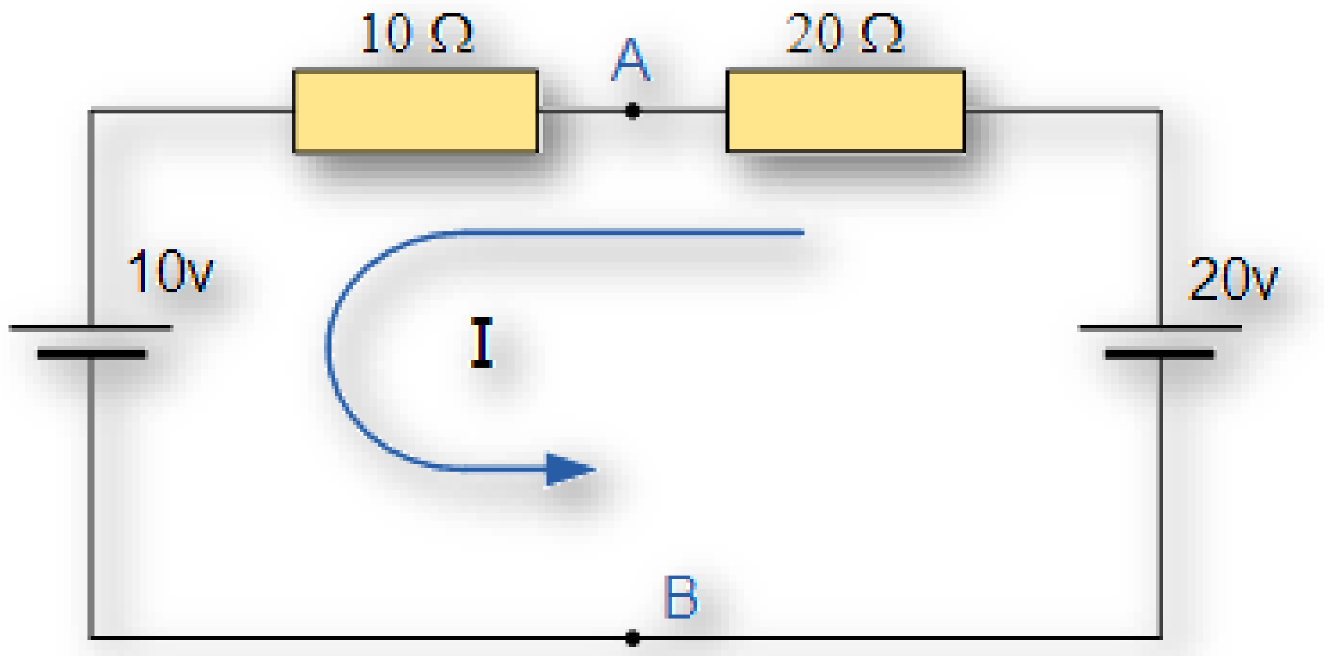


The current flowing around the loop :

$$I = \frac{V}{R} = \frac{20v - 10v}{20\Omega + 10\Omega} = 0.33\ amps$$

Step -2

Calculate V_{TH}



The current flowing around the loop :

$$I = \frac{V}{R} = \frac{20v - 10v}{20\Omega + 10\Omega} = 0.33\ amps$$

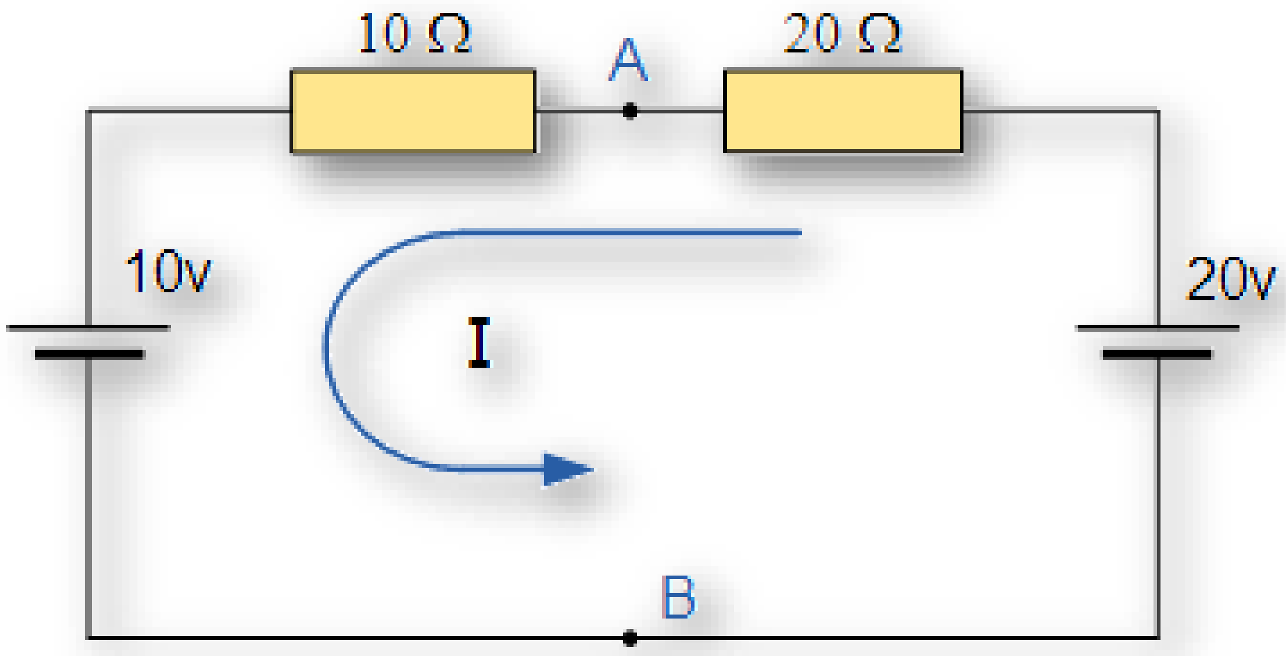
This current of 0.33 amperes is common to both

voltage drop across the 20Ω resistor

V_{AB} = 20 – (20Ω x 0.33amps) = 13.33 volts

.

Step -1, 2 Calculate V_{TH}



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This current of 0.33 amperes is common to both

voltage drop across the 20Ω resistor

V_{AB} = 20 – (20Ω x 0.33amps) = 13.33 volts

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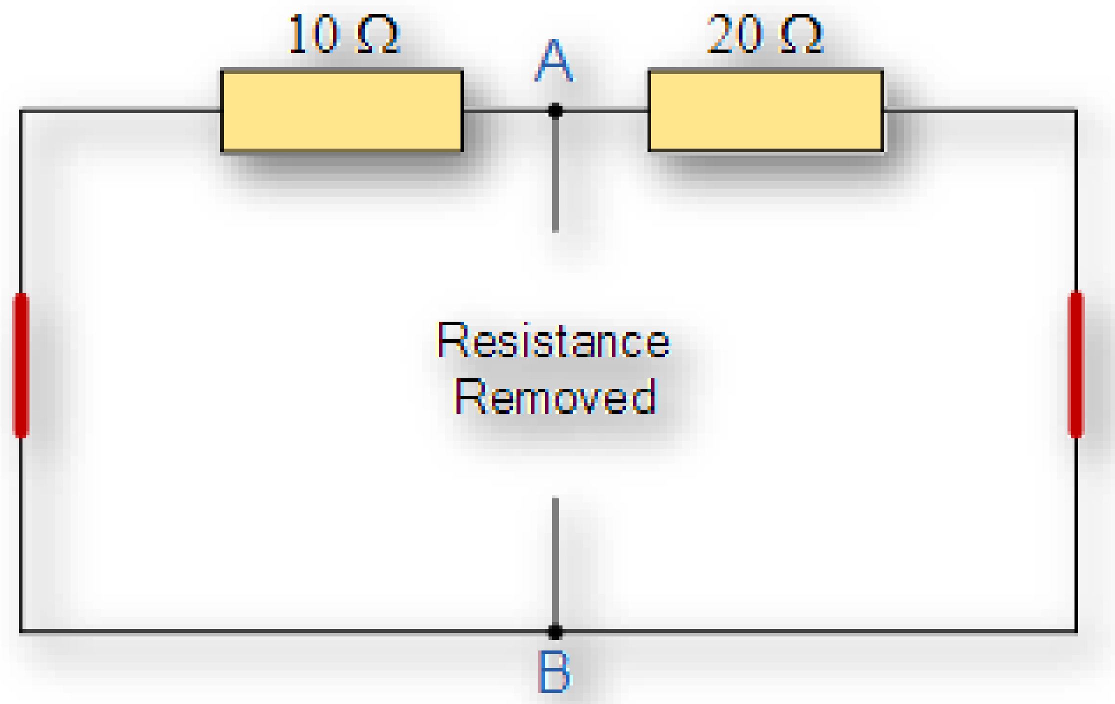
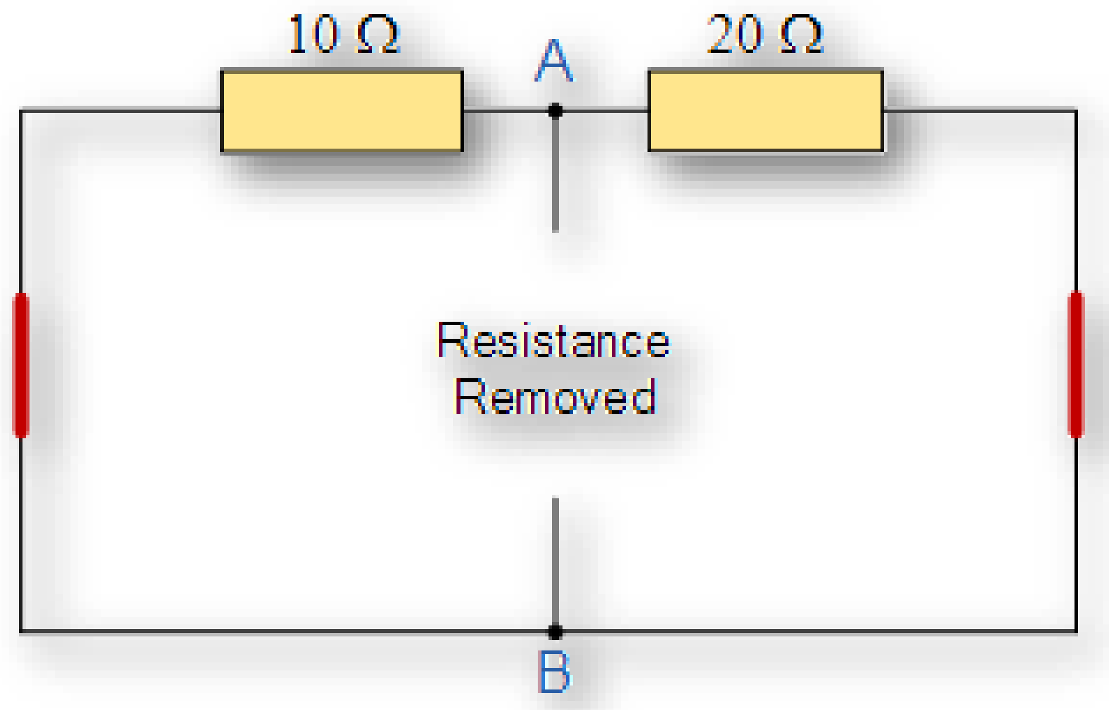
Or across the 10Ω resistor :

V_{AB} = 10 + (10Ω x 0.33amps) = 13.33 volts,

Step – 3



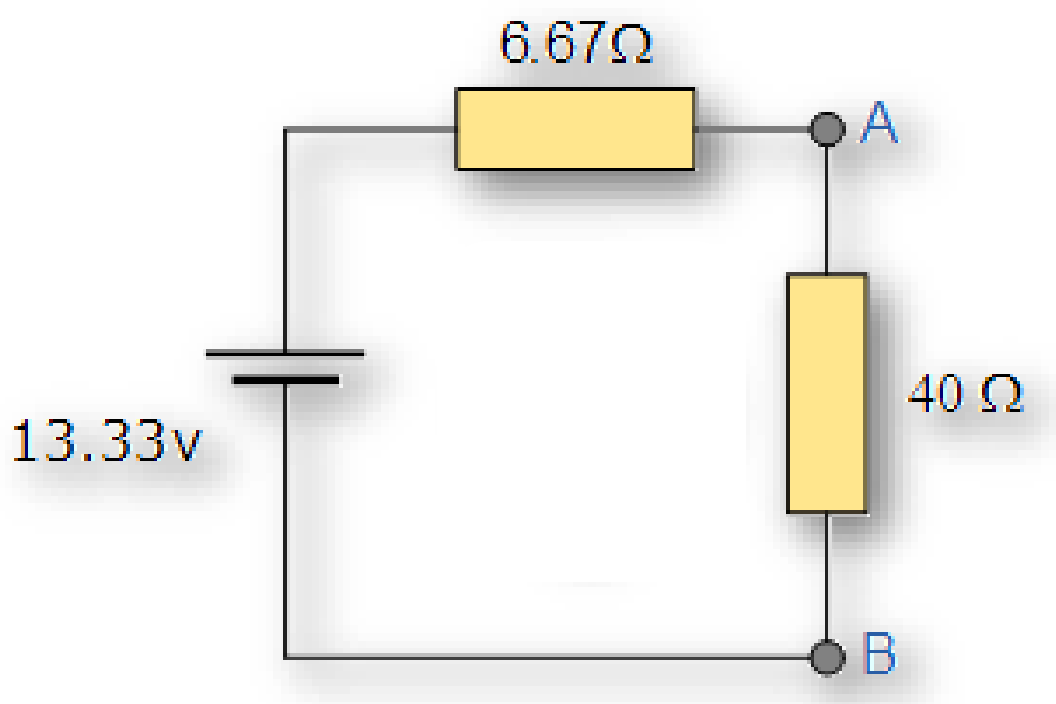
Step – 4 Find R_{TH}

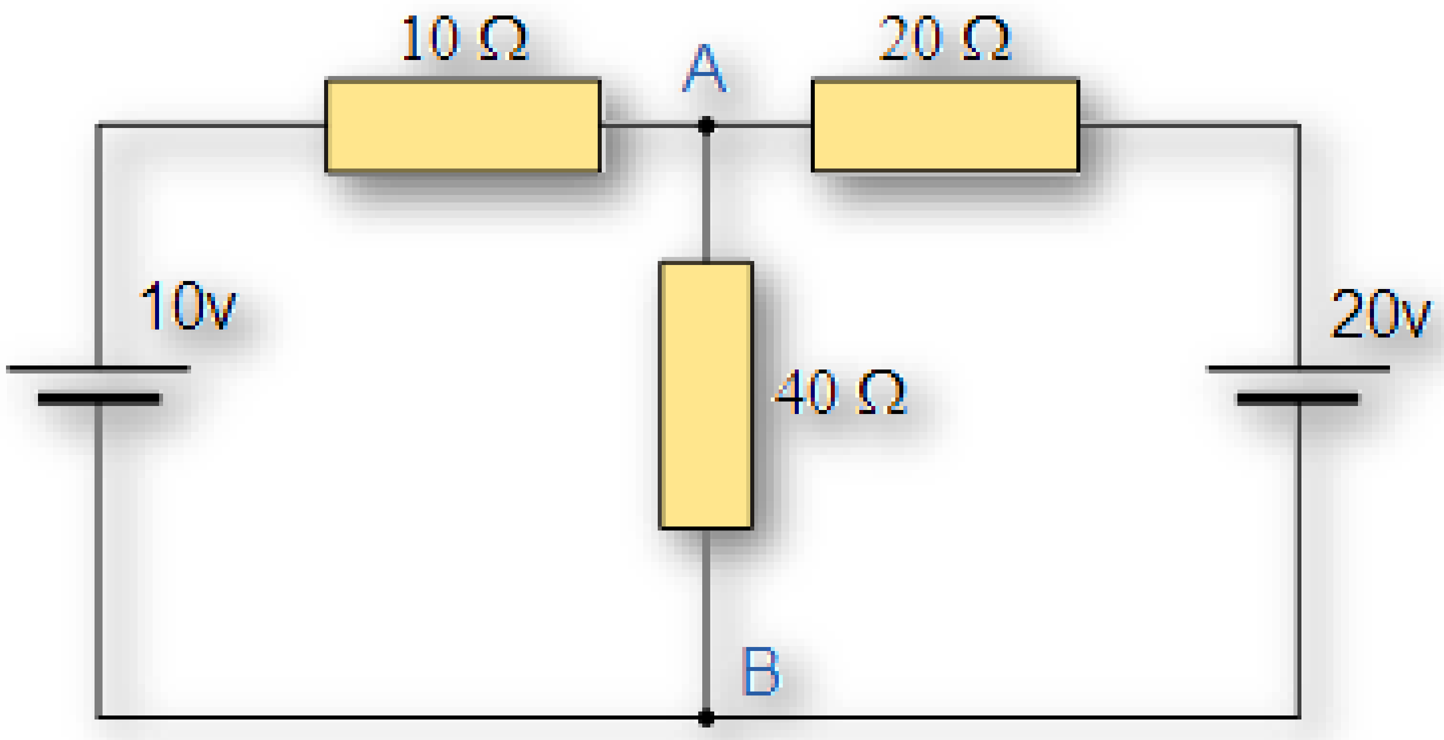


10Ω Resistor in Parallel with the 20Ω Resistor

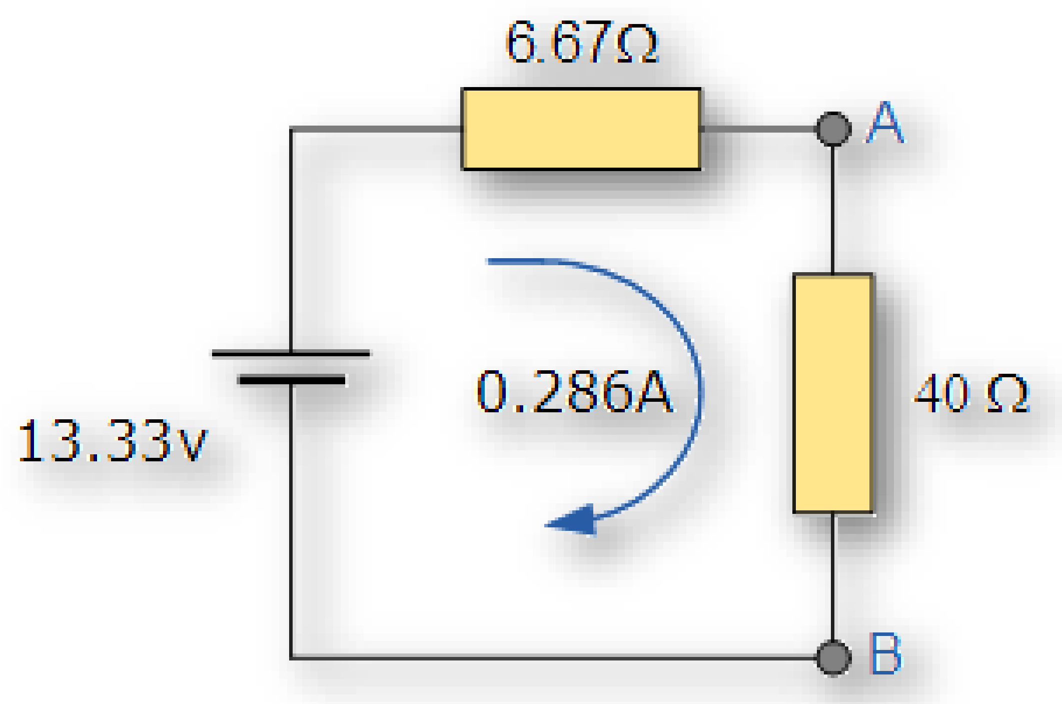
$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{20 \times 10}{20 + 10} = 6.67\Omega$$

Step – 5





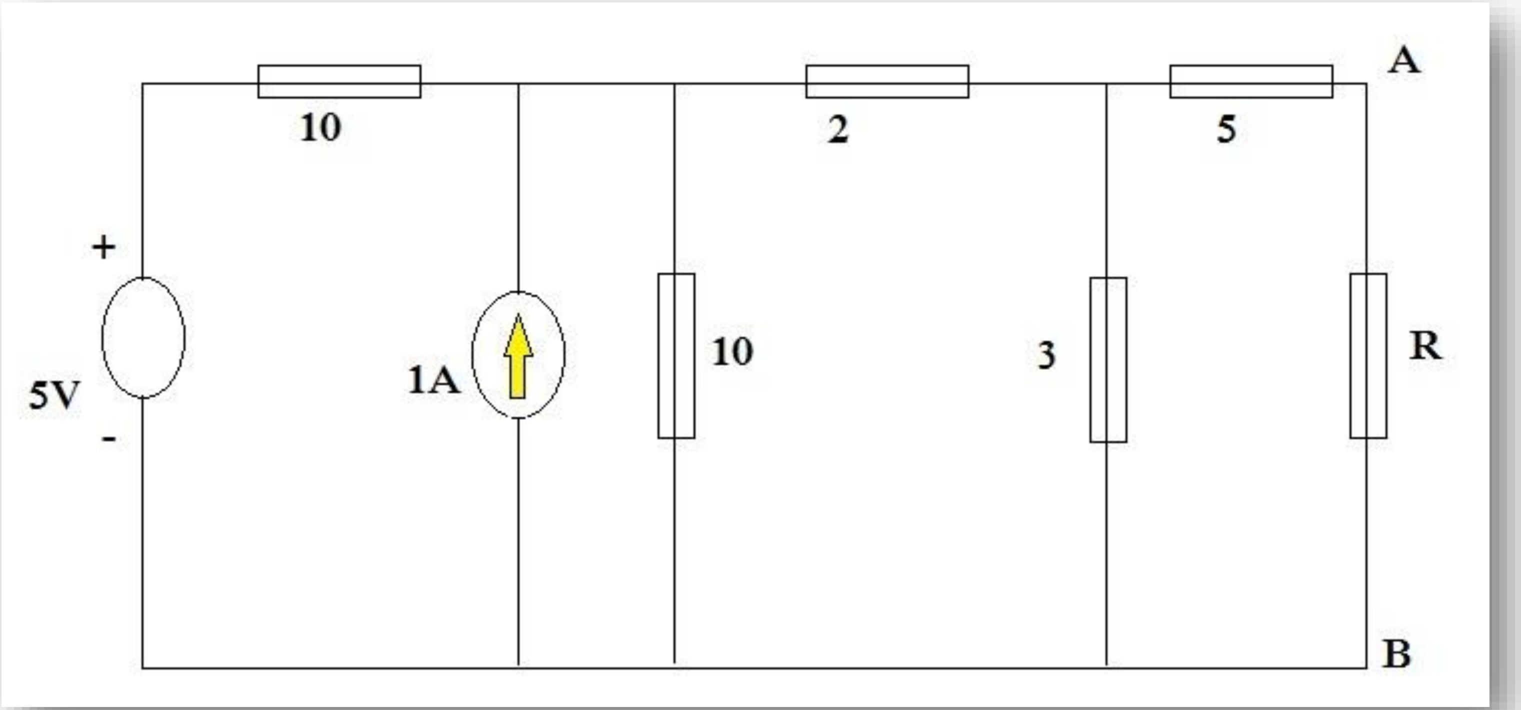
Step – 6



$$I = \frac{V}{R} = \frac{13.33\,v}{6.67\Omega + 40\Omega} = 0.286\ amps$$

Same as found using **Kirchhoff's circuit law**

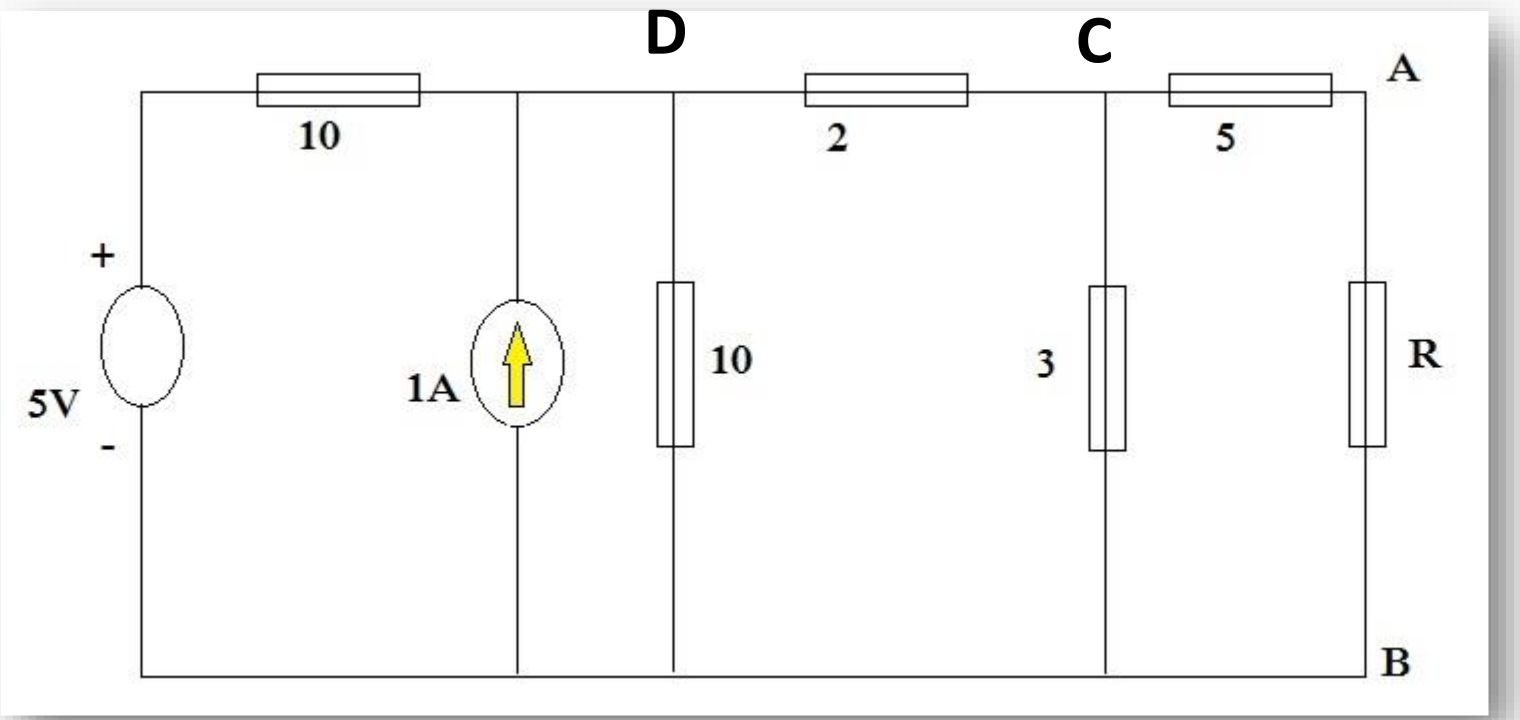
Example -2



Determine the thevenin's equivalent circuit between the terminals A&B.

Given R= 5 Ω

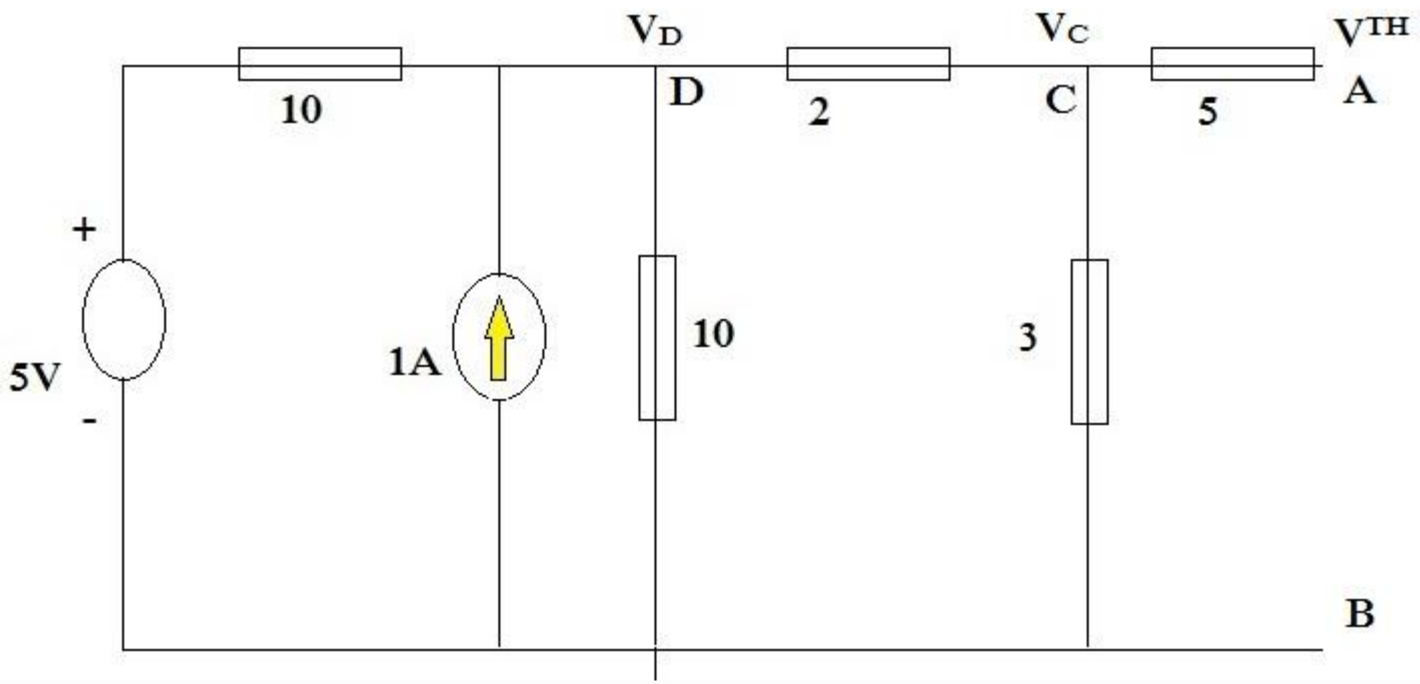
Step -1 R_L ?



Find the value of R_L

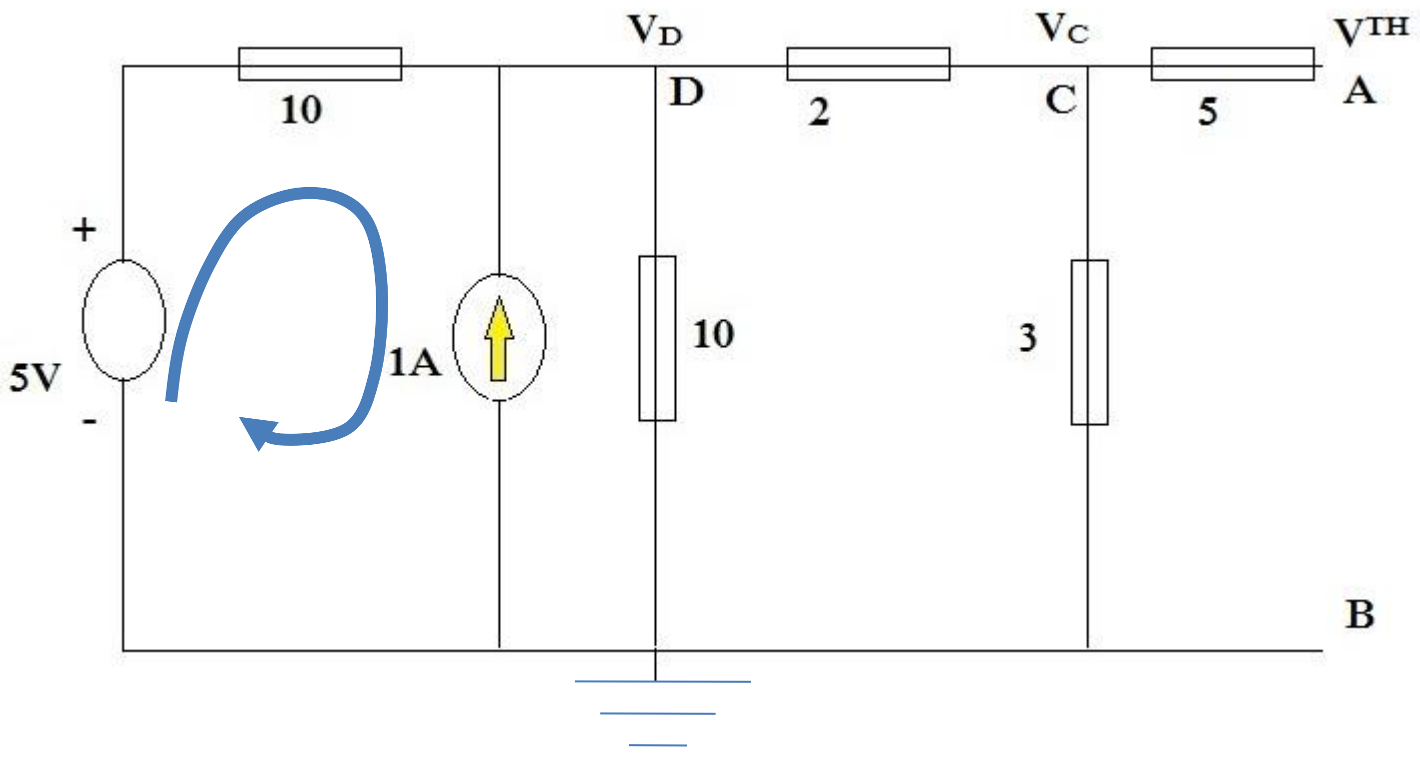
R_L is given R= 5 Ω

Step -2 Remove R_L



Voltage at point C = V_c = V^{th} (as there is no current through 5Ω resistor)

Step -2 Calculate V_{TH}



Grounded the point B

Applying KCL at Nodes C and D

Nodal equation to point C

$(V_C - 0)/3 + (V_C - V_D)/2 = 0$

$5V_C - 3V_D = 0$ ---------------------------------------(1)

Nodal equation to point D

$(V_D - V_C)/2 + (V_D - 0)/10 + (V_D - 5)/10 - 1 = 0$

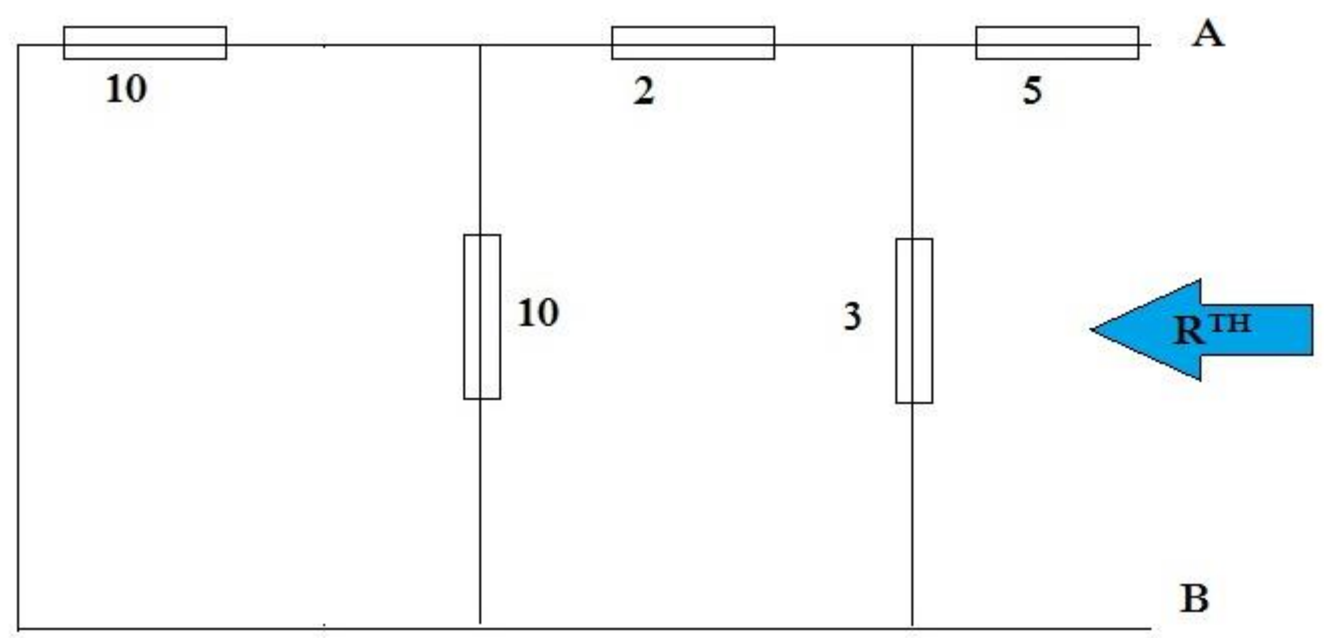
$7V_D - 5V_C = 15$ ---------------------------------------(2)

By solving 1&2

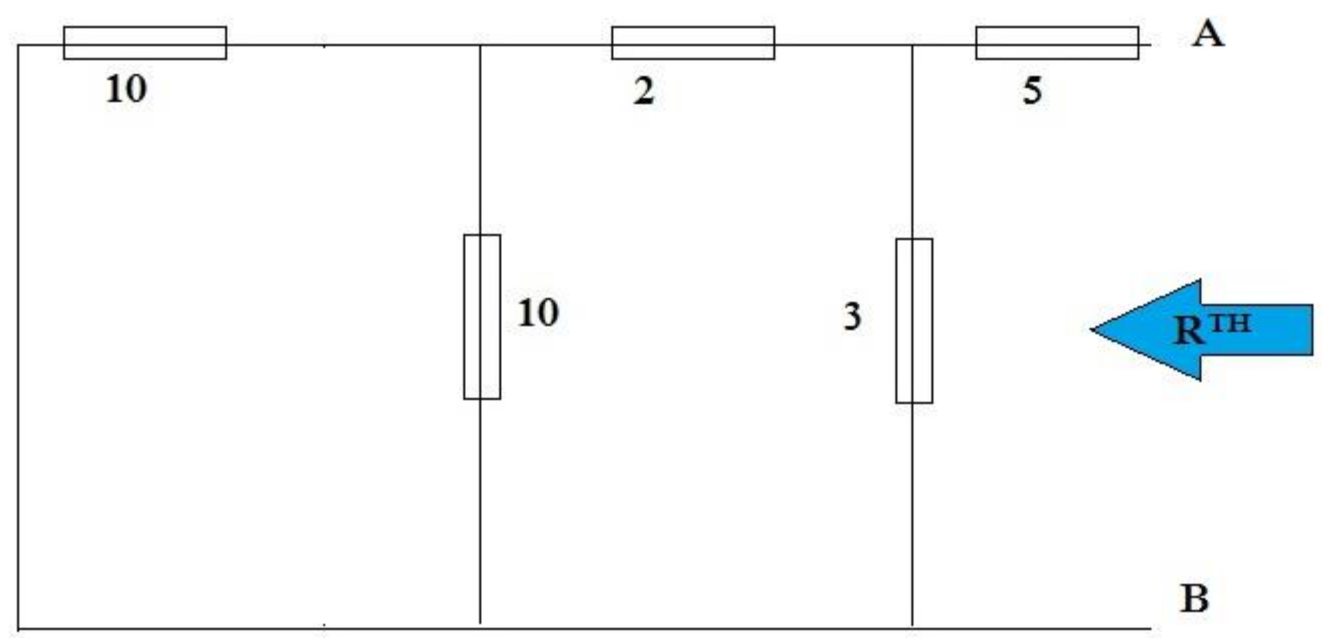
$V_c = 2.25V$ $\quad\quad V_C = V^{TH}$

$V^{TH} = 2.25V$

Step – 3



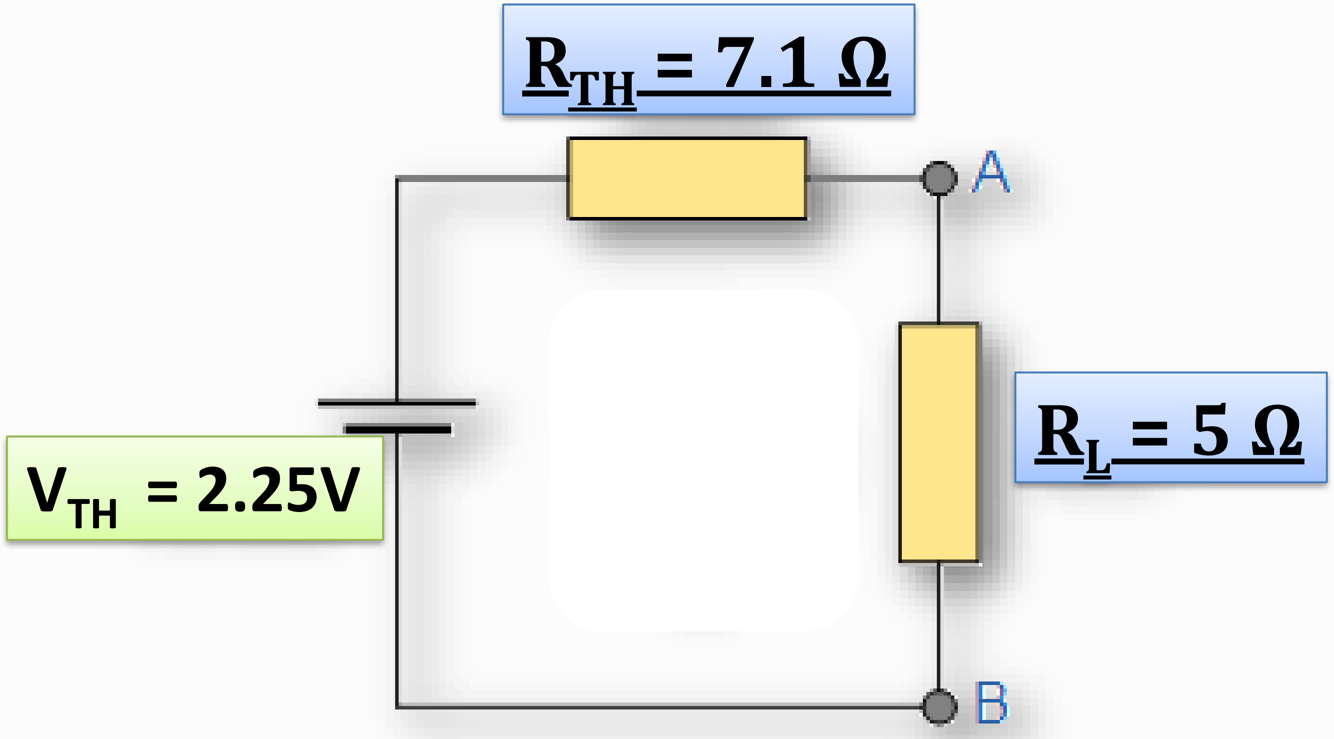
Step – 4 Find R_{TH}



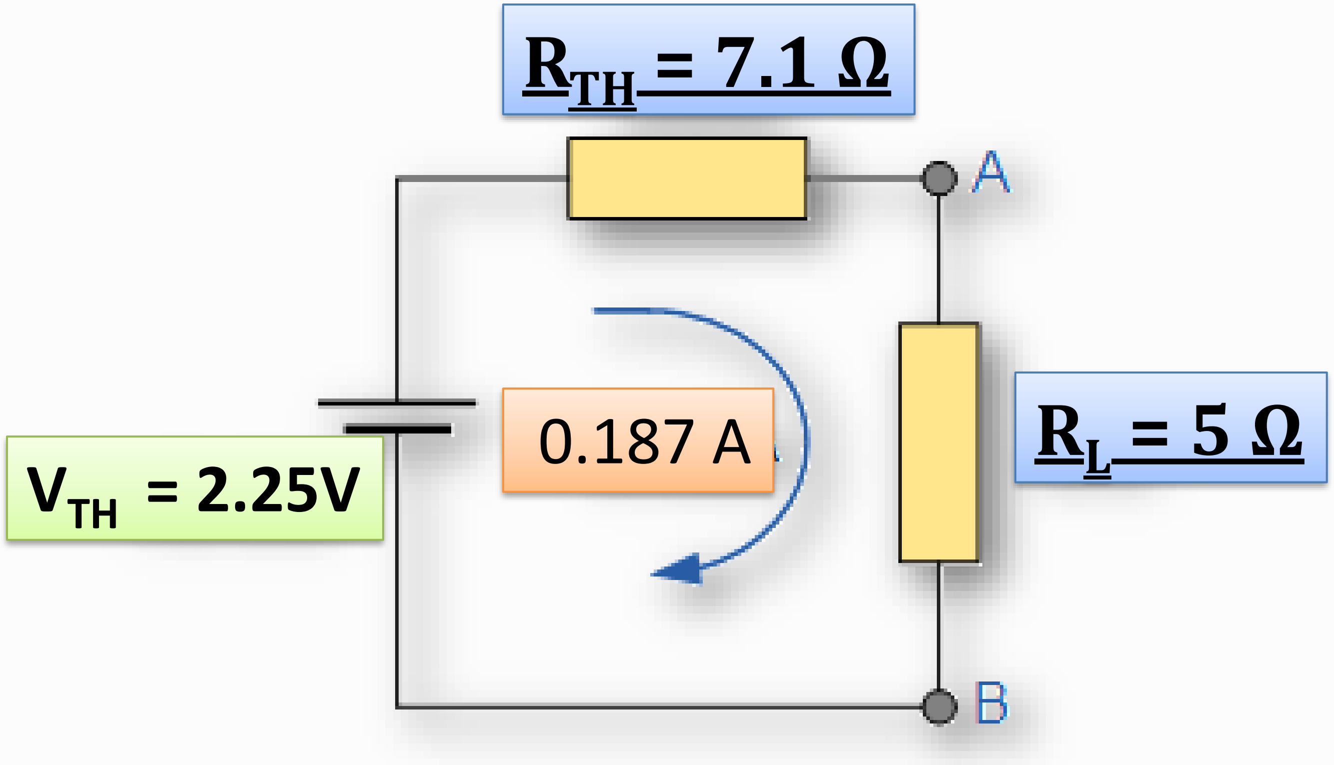
$R^{TH} = 5 + \{ [(10//10) + 2] // 3 \}$

$\underline{R^{TH} = 7.1\ \Omega}$

Step – 5



Step – 6

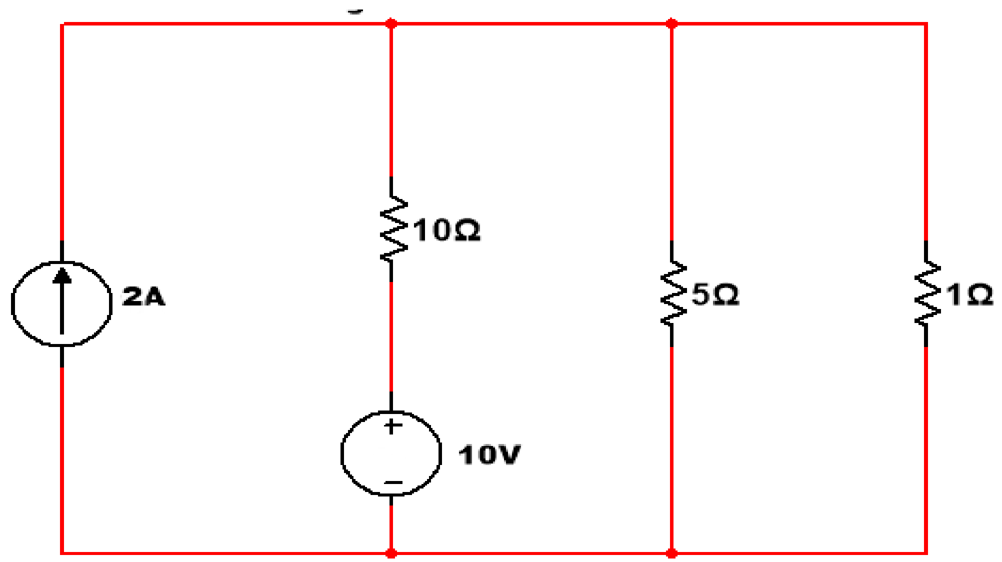


$$I = V / (R_{TH} + R_L)$$

$$I = 2.26 \ / (7.1 + 5)$$

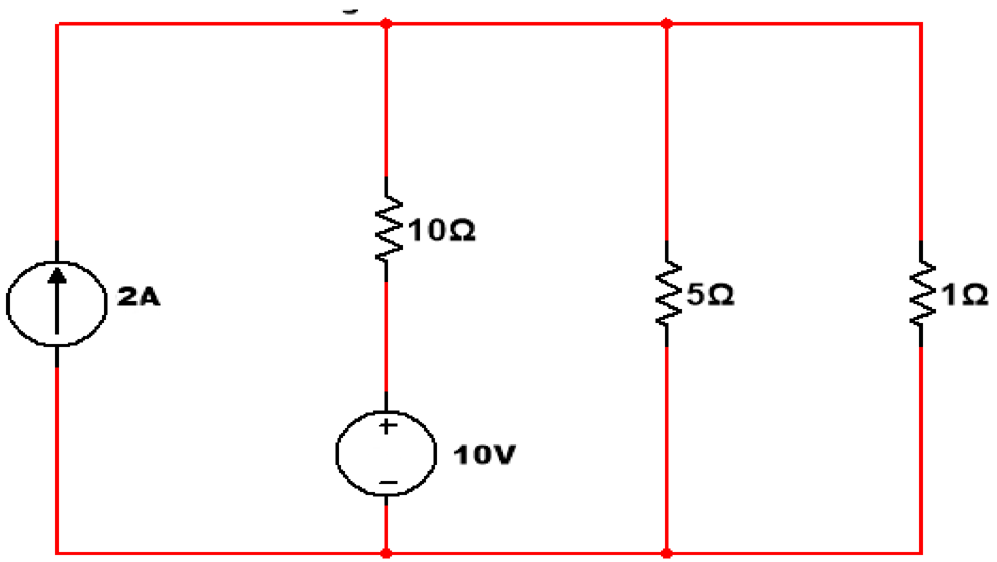
$$I = 0.187\ A$$

Example -3



Find the value of current through 1Ω Resistor in the given circuit using Thevenin's theorem.

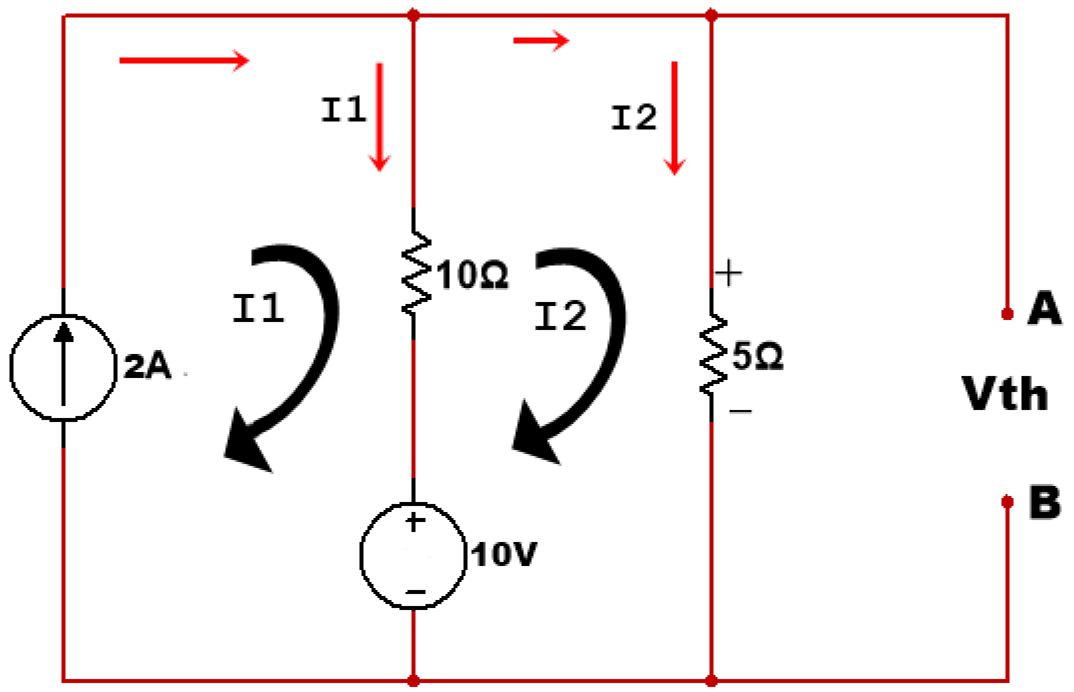
Step -1 R_L ?



Find the value of R_L

$R_L = 1\ \Omega$

Step -2 Calculate V_{TH}



Applying KVL in All meshes.

Mesh 1 $I_1 = 2A$

Mesh 2 $-10 + 10\ I_2 - 10\ I_1 + 5\ I_2 = 0$

Solve $15\ I_2 - 10\ I_1 = 10$

$15 I_2 = 10 + 20$

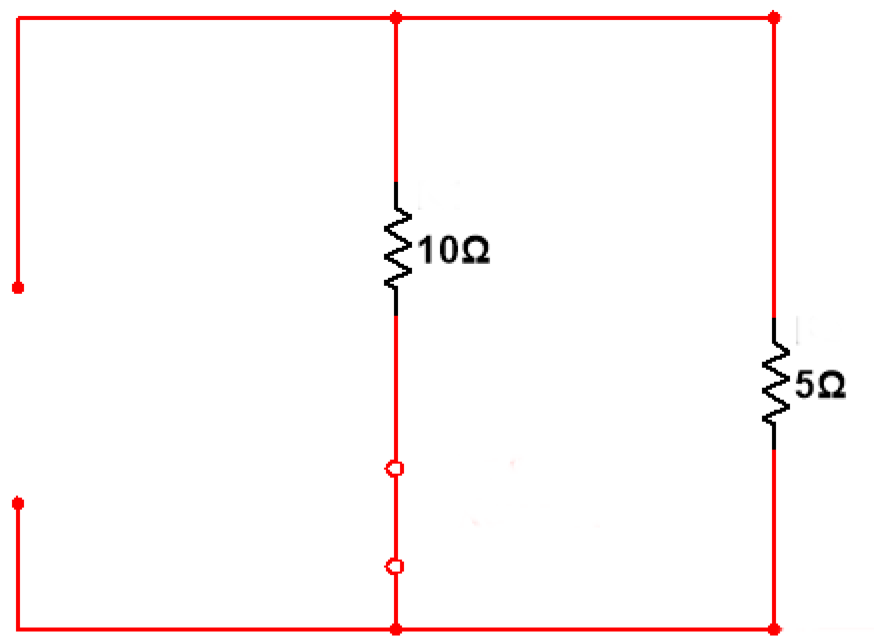
$I_2 = 30/15 = 2A$

The voltage across the 5Ω resistor

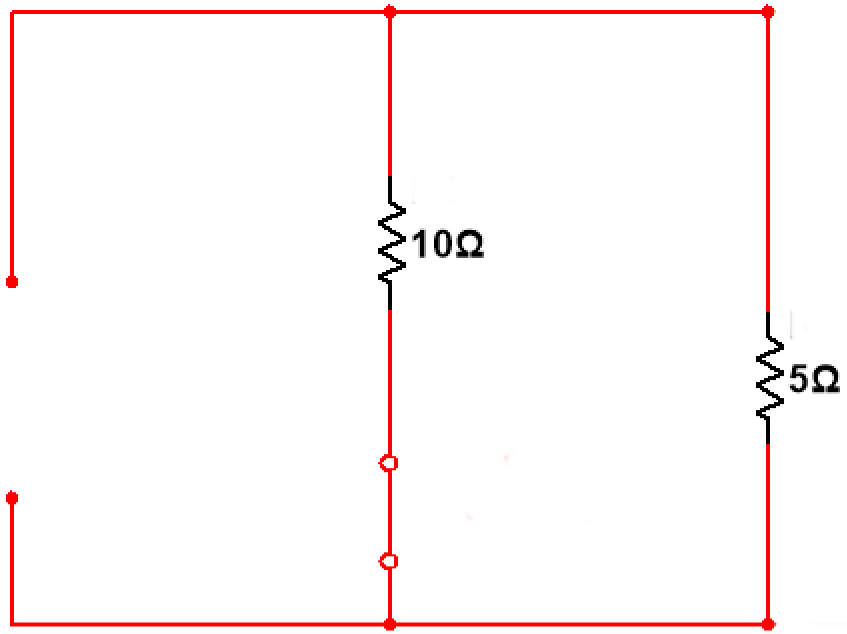
is **V = I * R = 2 * 5 = 1 0 V**

So V_{TH} = 10 V

Step – 3



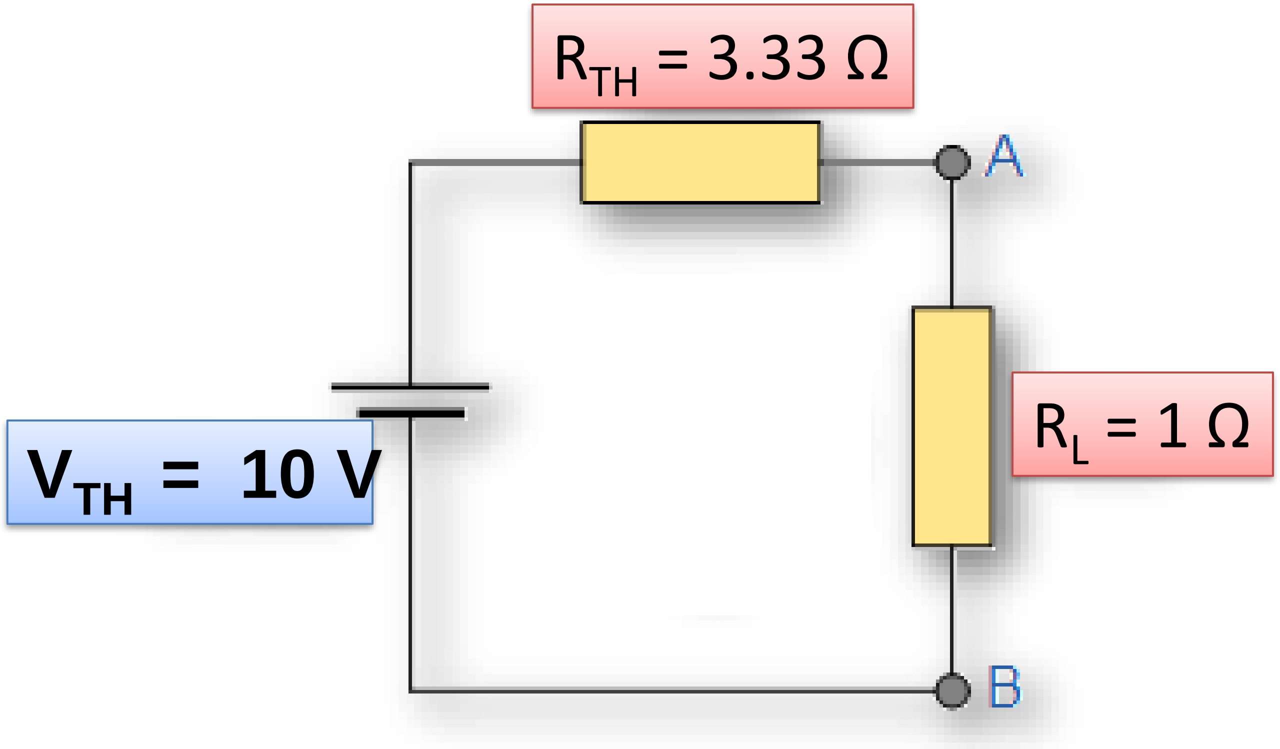
Step – 4 Find R_{TH}



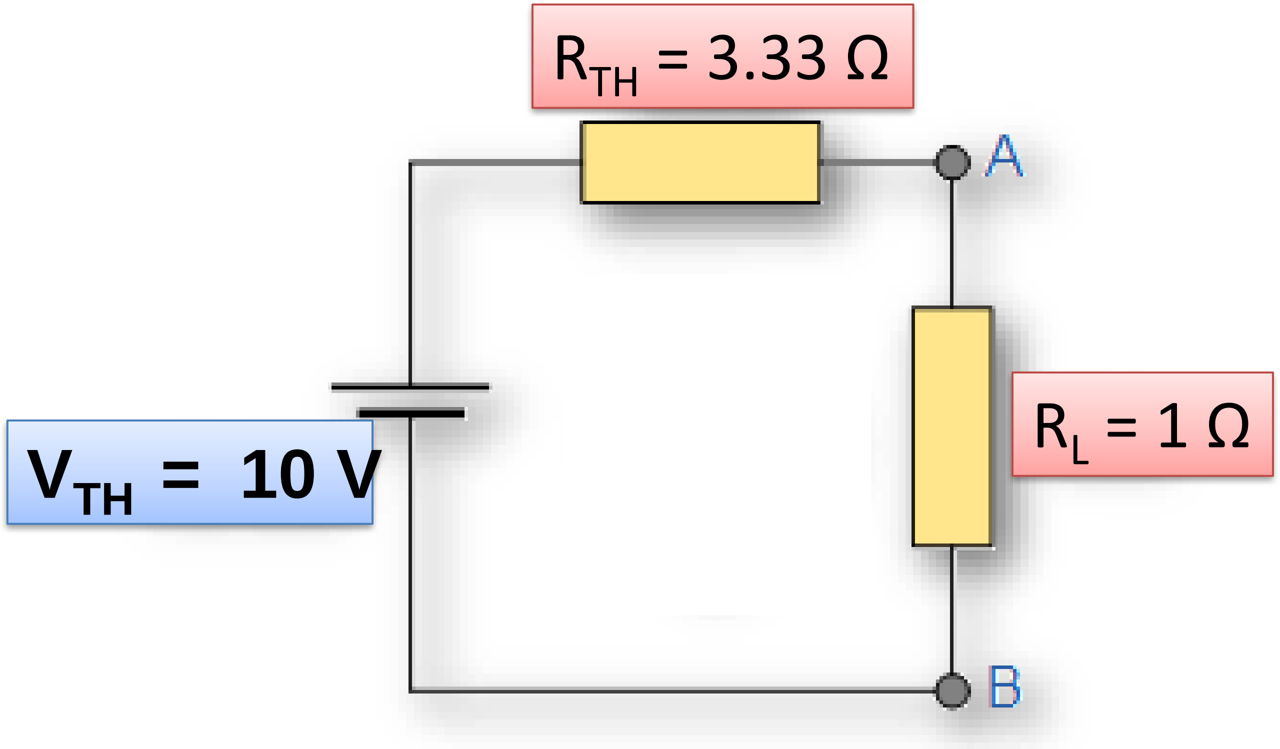
R_{TH} = 10 Ω // 5Ω

R_{TH} = 3.33 Ω

Step – 5



Step – 6



$I = V / (R_{TH} + R_L)$

$I = 10 / (3.33+1)$

$I = 2.31$ A