Lecture No. 7,8

“Thevenins Theorem”

Thevenins theorem :

The current flowing through a load resistance R_L connected across any two terminals A and B of a network as shown in fig. 1 is given by :

$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

Where

V_{th} is the open circuit voltage across the two terminals A and B where R_L is removed .

R_{th} is the internal resistance of the network as viewed back into the network from terminals A and B with voltage source replaced by its internal resistance , while current source replaced by open circuit .

R_L load resistor .

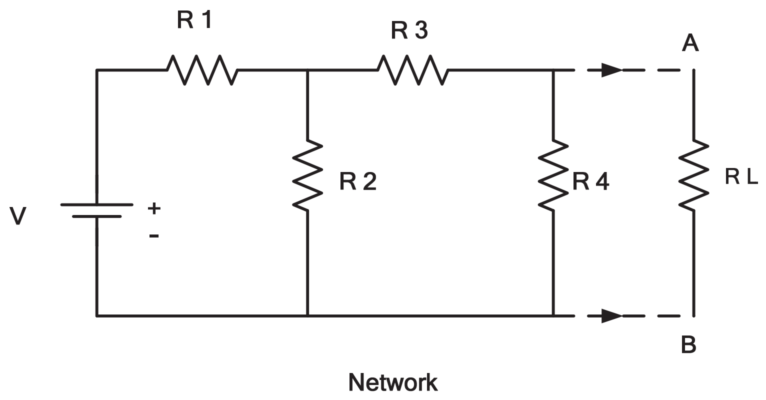
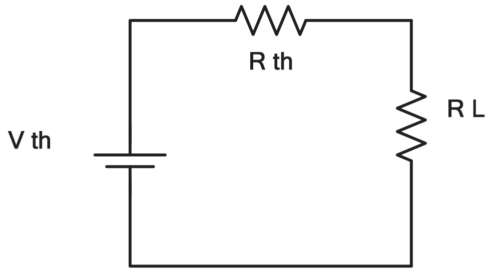


Fig. 1



Thevenins
equivalent
circuit

Now , R_{th} and V_{th} must be found .

R_{th} could be found as follows :

1. Replace voltage source by short circuit (if there is no internal resistance) , while the current source replaced by open circuit .

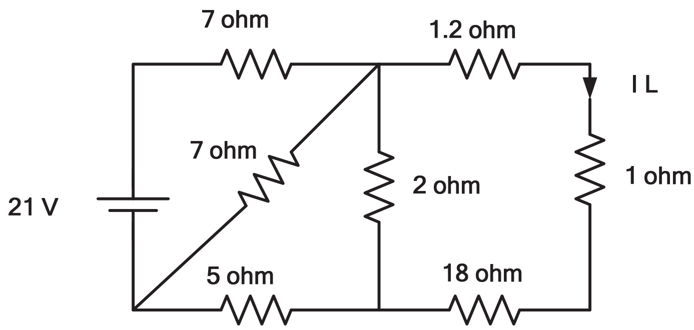
2. Remove R_L from the circuit , then calculate R_{th} viewed from terminals A and B .

V_{th} could be found as follows :

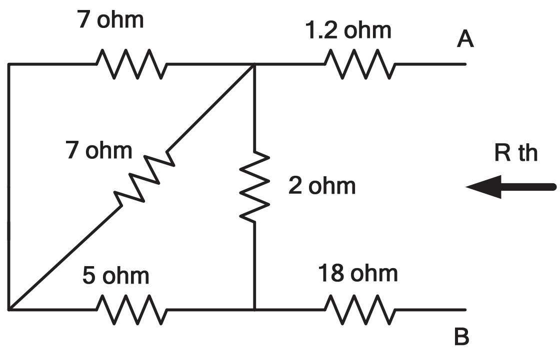
1. Remove R_L and make sure that the voltage or current source is connected .

2. Calculate V_{th} between points A and B .

<u>Example</u> : Using Thevenins theorem , find I_L in the circuit shown below .



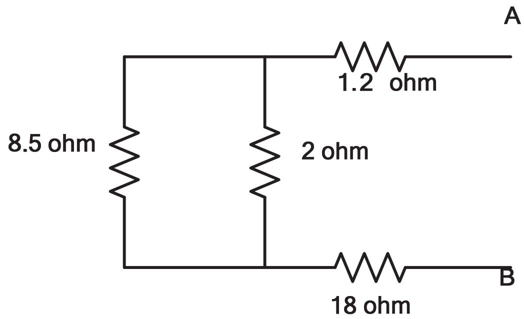
To find R_{th}



7 Ω // 7 Ω

$$\frac{7 \times 7}{7 + 7} = 3.5\ \Omega$$

3.5 + 5 = 8.5 Ω

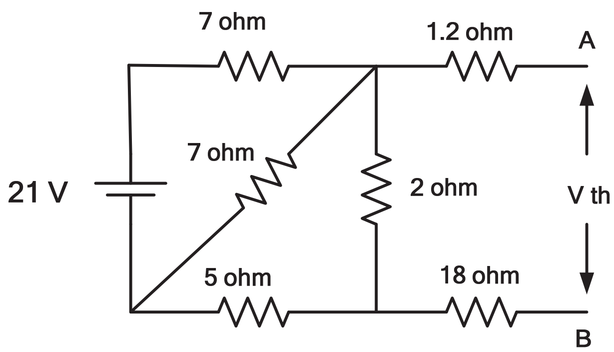


8.5 Ω // 2 Ω

$$\frac{8.5 \times 2}{8.5 + 2} = 1.6\ \Omega$$

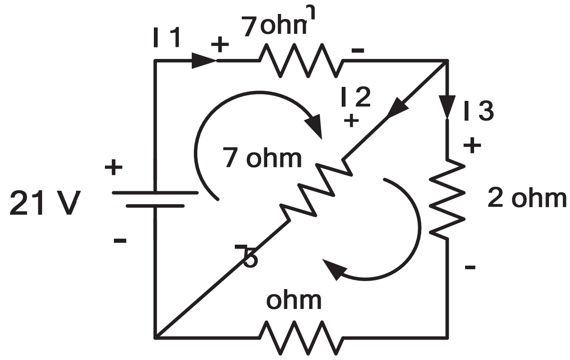
$R_{th} = 1.2 + 1.6 + 18 = 20.8\ \Omega$

To find V_{th}



Since , there is no current flow through 1.2 Ω and 18 Ω , then the above circuit could be simplified to the following circuit .

↓



$I_1 = I_2 + I_3$ -------- (1)

$-21 + 7 I_1 + 7 I_2 = 0$
$7 (I_1 + I_2) = 21$
$I_1 + I_2 = 3$ ---------- (2)

$2 I_3 + 5 I_3 - 7 I_2 = 0$
$7 I_3 = 7 I_2$
$I_2 = I_3$ ------------- (3)

From Equation (2)

$I_1 = 3 - I_2$ ----------- (4)

Sub. Equations (3) and (4) in (1)

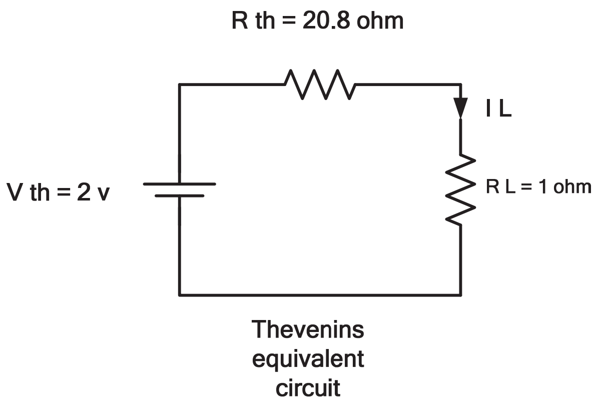
$3 - I_2 = I_2 + I_2$

$3 = 3 I_2$, $I_2 = 1$ A , $I_3 = 1$ A

$I_1 = 1 + 1 = 2$ A

$V_{th} = V_{2\Omega}$

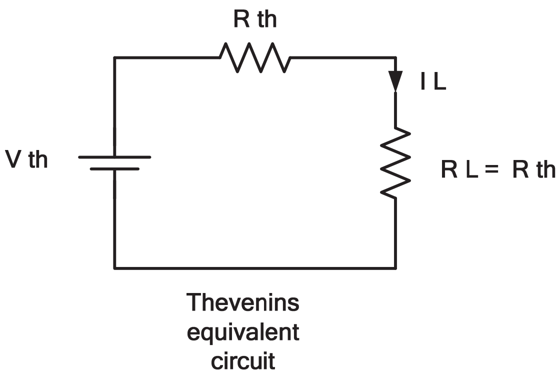
$V_{th} = 2 \times I_3 = 2 \times 1 = 2$ v



$$I_L = \frac{V_{th}}{R_{th} + R_L} = \frac{2}{20.8 + 1} = 0.09 \text{ A}$$

Maximum power transfer theorem :

A resistor load will abstract maximum power from a network when the load resistance is equal to the resistance of the network as viewed from the output terminals with all voltage sources removed leaving behind their internal resistances and all current sources replaced by open circuit .



$$R_L = R_{th}$$

$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

$$I_L = \frac{V_{th}}{2\,R_{th}}$$

$$P = (I_L)^2 \times R_{th}$$

$$P_{max} = \frac{(V_{th})^2}{4\,(R_{th})^2} \times R_{th}$$

$$P_{max} = \frac{(V_{th})^2}{4\,R_{th}}$$