

POSTAL Book Package

2021

Electrical Engineering

Conventional Practice Sets

Electric Circuits

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CHAPTER

Electric Circuits

Basics, Circuit Elements, Nodal & Mesh Analysis

Q1 A 10 V battery with an internal resistance of $1\ \Omega$ is connected across a non-linear load whose V - I characteristics is given by $7I = V^2 + 2\text{ V}$. Find the current delivered by the battery.

Solution:

Using KVL,

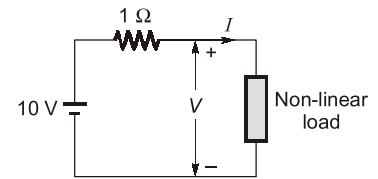
$$V + I = 10 \quad \dots(i)$$

Given, $7I = V^2 + 2\text{ V} \quad \dots(ii)$

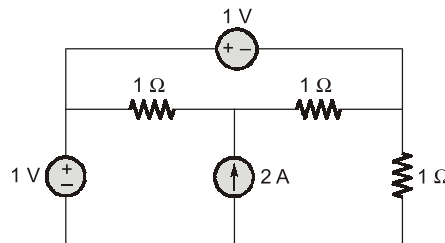
On solving equation (i) and equation (ii)

we get, $V = 5\text{ Volts}$

$$I = 5\text{ A}$$



Q2 Find the power delivered by the current source in the figure shown below.



Solution:

Consider node voltages V_a , V_b , V_x as shown below.

Applying nodal analysis,

$$\begin{aligned} \Rightarrow \quad & \frac{V_x - V_a}{1} + \frac{V_x - V_b}{1} = 2 \\ \Rightarrow \quad & 2V_x - (V_a + V_b) = 2 \quad \dots(i) \end{aligned}$$

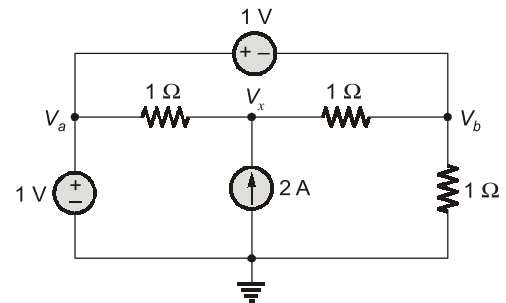
Also, $V_a - V_b = 1\text{ V}$

$$V_a = 1\text{ V}$$

Thus, $V_b = 0\text{ V}$

Solving further, $V_x = \frac{2 + (1 + 0)}{2} = 1.5\text{ V}$

\therefore Power delivered by current source $= V_x \cdot I \quad [I = 2\text{ A (given)}]$
 $= (1.5) \times 2 = 3\text{ Watts}$



Q3 Two identical coils connected in parallel across 100 V dc supply, take 10 A current from the supply. Power dissipated in one coil is 600 W. What is the resistance of each coil?

Solution:

Given, Power dissipated in one coil $= 600\text{ W}$

$$I = I_1 + I_2$$

$$I_1 = I_2$$

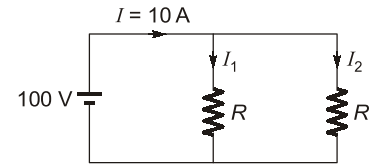
$$I_1 = I_2 = \frac{10 \text{ A}}{2} = 5 \text{ A}$$

$$P = I_1^2 R$$

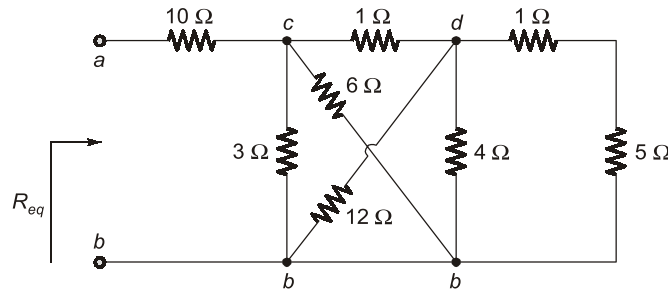
$$R = \frac{P}{I_1^2} = \frac{600}{(5)^2} = 24 \Omega$$

Power dissipated,

Hence, resistance of coil,



Q.4 Calculate equivalent resistance R_{eq} in the circuit shown.



Solution:

3 Ω and 6 Ω resistors in parallel because they are connected to same two nodes c and b. Their combined resistance is

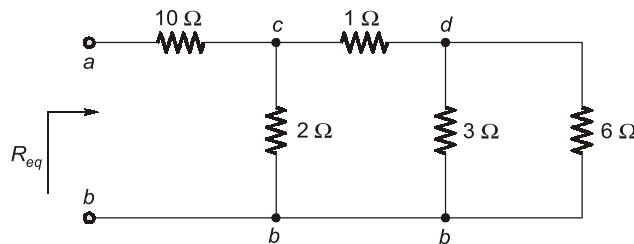
$$= \frac{3 \times 6}{3 + 6} = 2 \Omega$$

Similarly, 12 Ω and 4 Ω resistors are in parallel since they are connected to same two nodes d and b.

$$\text{Hence, } 12 \Omega || 4 \Omega = \frac{12 \times 4}{12 + 4} = 3 \Omega$$

Also, 1 Ω and 5 Ω resistors are in series, hence combined resistance,

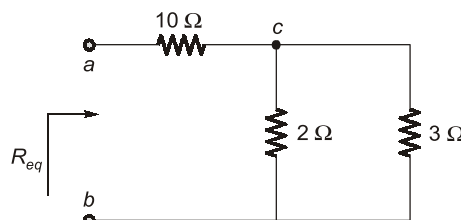
$$1 \Omega + 5 \Omega = 6 \Omega$$



$$\text{Further } 3 \Omega \text{ and } 6 \Omega \text{ in parallel gives equivalent resistance} = \frac{3 \Omega \times 6 \Omega}{(3 + 6) \Omega} = 2 \Omega$$

This 2 Ω in series with 1 Ω .

Given equivalent as (2 + 1) Ω = 3 Ω as shown below.



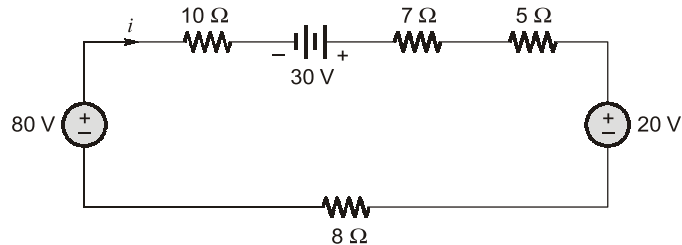
Now 2 Ω and 3 Ω parallel's combination in series with 10 Ω resistance.

Hence,

$$R_{ab} = R_{eq} = 10\Omega + (2\Omega \parallel 3\Omega)$$

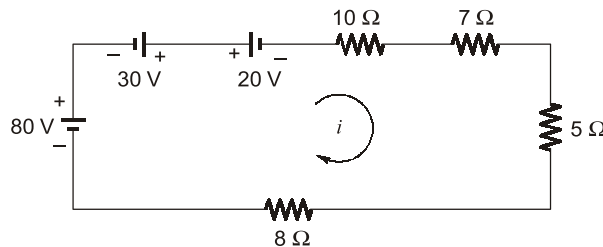
$$= 10 + \frac{2 \times 3}{2+3} = 11.2\Omega$$

Q5 Use resistance and source combinations to determine the current i in figure shown and power delivered by 80 V source.



Solution:

The circuit can be redrawn as,



Further combining the three voltage sources into an equivalent source of 90 V as shown below.

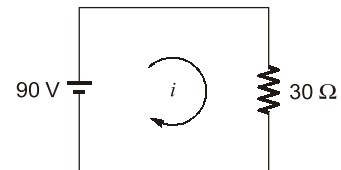
All the resistance, combined in series as,

$$R_{eq} = (10 + 7 + 5 + 8)\Omega = 30\Omega$$

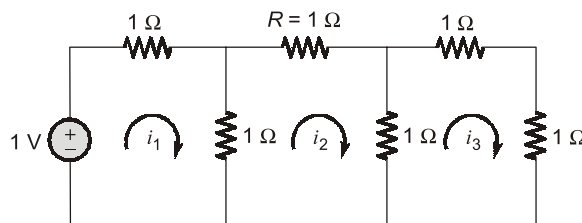
Simply applying KVL, $-90 + 30i = 0$

Hence, $i = 3\text{ A}$

Power delivered by 80 V source = $80\text{ V} \times 3\text{ A} = 240\text{ W}$



Q6 Find the power dissipated in the resistor R in the ladder network shown in the figure below.



Solution:

Using KVL in loop,

$$1 = 2i_1 - i_2 \quad \dots(1)$$

$$0 = 3i_2 - i_1 - i_3 \quad \dots(2)$$

$$0 = 3i_3 - i_2 \quad \dots(3)$$

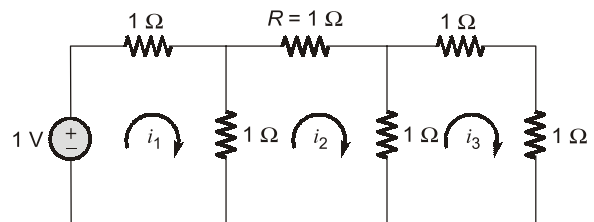
\therefore

$$i_3 = \frac{i_2}{3}$$

By solving the equations, we get,

$$i_2 = \frac{3}{13}\text{ A}$$

\therefore Power dissipated in the resistor $R = i^2 R = \frac{9}{169}\text{ W}$



Q7 The following mesh equations pertain to a network:

$$\begin{aligned} 8I_1 - 5I_2 - I_3 &= 110 \\ -5I_1 + 10I_2 + 0 &= 0 \\ -I_1 + 0 + 7I_3 &= 115 \end{aligned}$$

Draw network showing each element.

Solution:

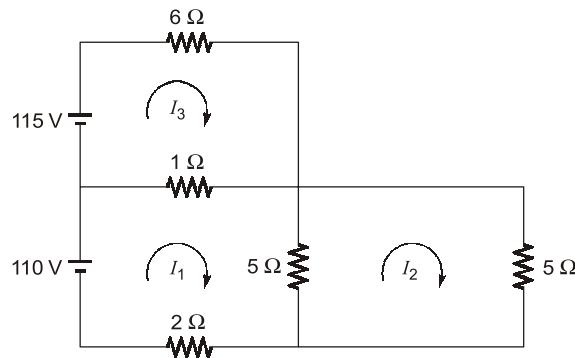
All the mesh equations can be rearrangement as,

$$\Rightarrow \begin{aligned} 8I_1 - 5I_2 - I_3 &= 110 \\ 5(I_1 - I_2) + (I_1 - I_3) + 2I_1 &= 110 \end{aligned} \quad \dots(1)$$

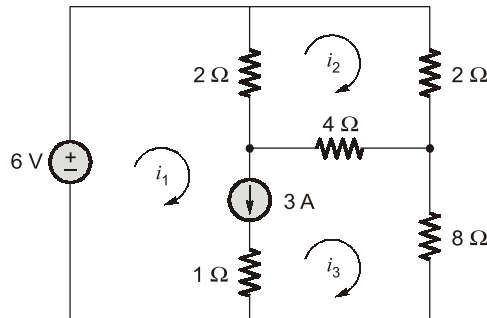
$$\Rightarrow \begin{aligned} -5I_1 + 10I_2 + 0 &= 0 \\ 5(I_2 - I_1) + 5I_2 &= 0 \end{aligned} \quad \dots(2)$$

$$\Rightarrow \begin{aligned} -I_1 + 0 + 7I_3 &= 115 \\ (I_3 - I_1) + 6I_3 &= 115 \end{aligned} \quad \dots(3)$$

On the basis of equation (1), (2) and (3), we can draw the network as,



Q8 Find mesh currents in the circuit,



Solution:

$$i_1 - i_3 = 3 \text{ A} \quad \dots(1)$$

By KVL for super mesh,

$$\begin{aligned} 2(i_1 - i_2) + 4(i_3 - i_2) + 8i_3 &= 6 \\ 2i_1 - 6i_2 + 12i_3 &= 6 \end{aligned} \quad \dots(2)$$

By KVL for second mesh,

$$\begin{aligned} 2i_2 + 4(i_2 - i_3) + 2(i_2 - i_1) &= 0 \\ 8i_2 - 4i_3 - 2i_1 &= 0 \end{aligned} \quad \dots(3)$$

Solving equations (1), (2) and (3), we get

$$\begin{aligned} i_1 &= 3.473 \text{ A} \\ i_2 &= 1.105 \text{ A} \\ i_3 &= 0.473 \text{ A} \end{aligned}$$