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POSTAL BOOK PACKAGE 2025

ELECTRONICS ENGINEERING

CONVENTIONAL Practice Sets

CONTENTS

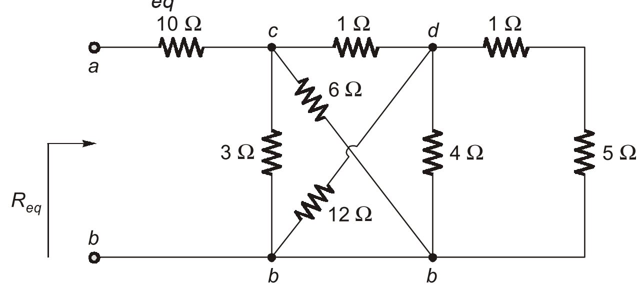
NETWORK THEORY

Network Theory

1 CHAPTER

Basics, Circuit Elements, Nodal & Mesh Analysis

Q.1 Calculate equivalent resistance R_{eq} in the circuit shown.



Solution:

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

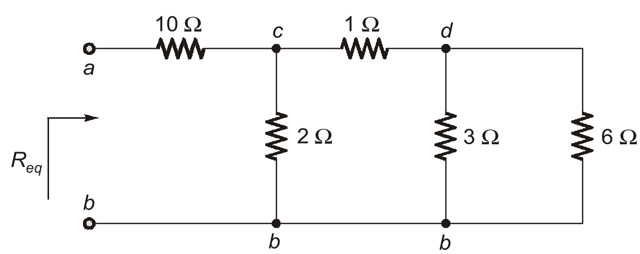
$$3\,\Omega || 4\,\Omega = \frac{3\times 6}{3+6} = 2\,\Omega$$

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

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,

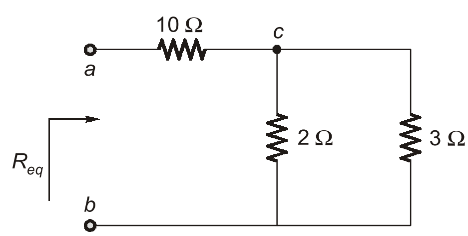
$$1\,\Omega + 5\,\Omega = 6\,\Omega$$



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

This 2 Ω is in series with 1 Ω.

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

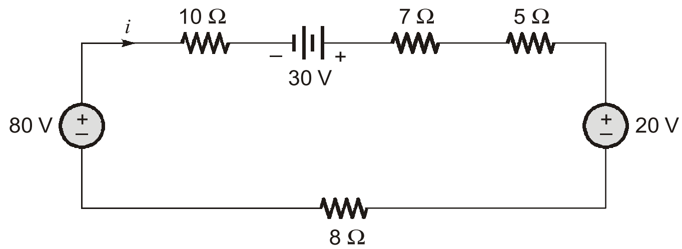


Now 2 Ω and 3 Ω parallel's combination in series with 10 Ω resistance.

Hence, $$R_{ab} = R_{eq} = 10\,\Omega + (2\,\Omega || 3\,\Omega)$$

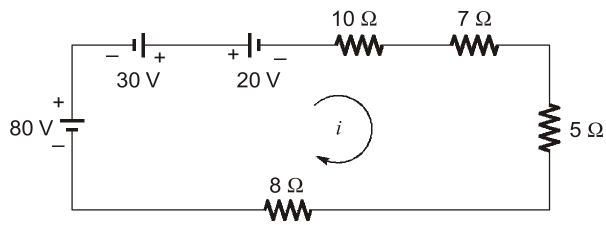
$$= 10 + \frac{2\times 3}{2+3} = 11.2\,\Omega$$

Q.2 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.

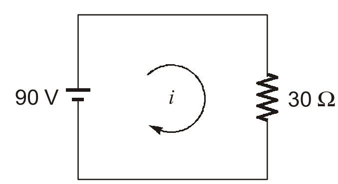
All the resistance, combined in series as,

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

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

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

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



Q.3 The following mesh equations pertain to a network:

$$8I_1 - 5I_2 - I_3 = 110$$
$$-5I_1 + 10I_2 + 0 = 0$$
$$-I_1 + 0 + 7I_3 = 115$$

Draw network showing each element.

Solution:

All the mesh equations can be rearrangement as,

$$8I_1 - 5I_2 - I_3 = 110$$

$$\Rightarrow \quad 5(I_1 - I_2) + (I_1 - I_3) + 2I_1 = 110 \qquad ...(1)$$

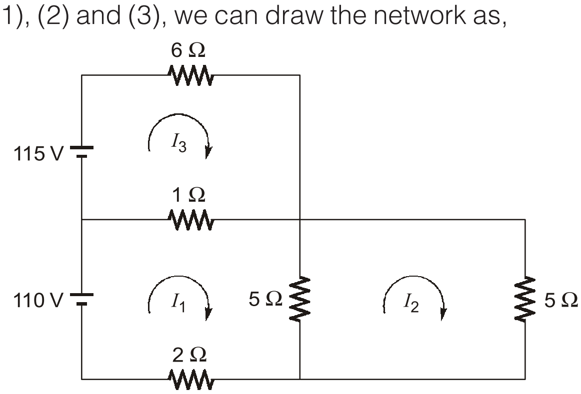
$$-5I_1 + 10I_2 + 0 = 0$$

$$\Rightarrow \quad 5(I_2 - I_1) + 5I_2 = 0 \qquad ...(2)$$

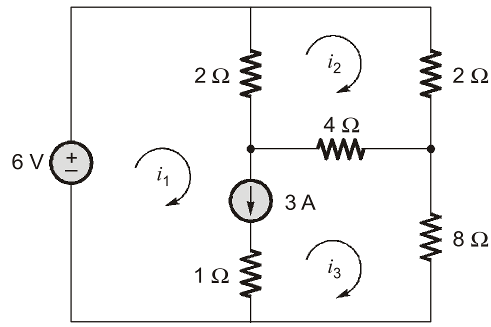
$$-I_1 + 0 + 7I_3 = 115$$

$$\Rightarrow \quad (I_3 - I_1) + 6I_3 = 115 \qquad ...(3)$$

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



Q4 Find mesh currents in the circuit,



Solution:

$$i_1 - i_3 = 3\text{ A} \qquad \text{...(1)}$$

BY KVL for super mesh,

$$2(i_1 - i_2) + 4(i_3 - i_2) + 8i_3 = 6$$

$$2i_1 - 6i_2 + 12i_3 = 6 \qquad \text{...(2)}$$

By KVL for second mesh,

$$2i_2 + 4(i_2 - i_3) + 2(i_2 - i_1) = 0$$

$$8i_2 - 4i_3 - 2i_1 = 0 \qquad \text{...(3)}$$

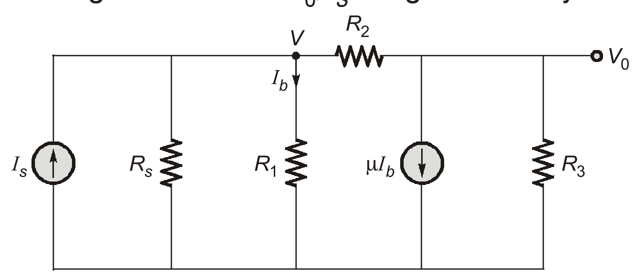
Solving equations (1), (2) and (3), we get

$$i_1 = 3.473\text{ A}$$

$$i_2 = 1.105\text{ A}$$

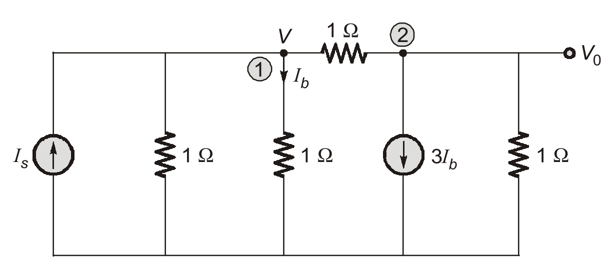
$$i_3 = 0.473\text{ A}$$

Q5 For the circuit shown in the figure determine V_0/I_S using nodal analysis.



$R_1 = R_2 = R_3 = R_s = 1\ \Omega$, $\mu = 3$

Solution:



$R_1 = R_2 = R_3 = R_s = 1\ \Omega$, $\mu = 3$

$$V = I_b \qquad \text{...(1)}$$

Node (1),

$$\frac{V}{1} + \frac{V}{1} + \frac{V - V_0}{1} - I_s = 0$$

$$3V - V_0 = I_s \qquad \text{...(2)}$$

Node (2),

$$\frac{V_0}{1} + \frac{V_0 - V}{1} + 3I_b = 0$$

$$2V_0 - V = -3I_b \qquad \text{...(3)}$$

From equation (1), $I_b = V$ put in equation (3)

$$2V_0 - V = -3\text{ V}$$

$$2V_0 = -2\text{ V}$$

$\Rightarrow$ $$V = -V_0$$

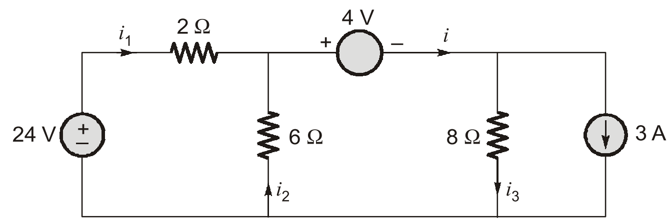
Putting, $V = -V_0$ in equation (2)

$$3(-V_0) - V_0 = I_s$$

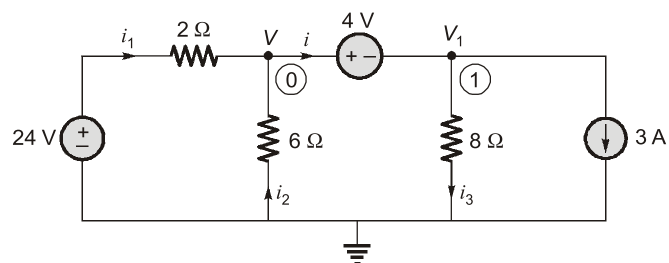
$$-4V_0 = I_s$$

$$\frac{V_0}{I_s} = -\frac{1}{4} = -0.25$$

Q.6 For the circuit shown in figure, determine the currents i_1, i_2 and i_3 using nodal analysis.



Solution:



By nodal analysis, $-i_1 - i_2 + i = 0$

$$-\left(\frac{24-V}{2}\right)+\left[-\frac{0-V}{6}\right]+i = 0$$

$$\frac{V-24}{2}+\frac{V}{6}+i = 0 \quad \text{...(1)}$$

$$V_1 = V - 4$$

KCL at node 1,

$$-i+\frac{V_1}{8}+3 = 0$$

$$i = \left(\frac{V-4}{8}+3\right) \quad \text{...(2)}$$

Combining (1) and (2),

$$\frac{V-24}{2}+\frac{V}{6}+\frac{V-4}{8}+3 = 0$$

Solving, $V = 12$ V

$$V_1 = 8 \text{ V}$$

$$i_1 = \frac{24-12}{2} = 6 \text{ A}$$

$$i_2 = -\frac{12}{6} = -2 \text{ A}$$

$$i = i_3 + 3 \quad \because i = i_1 + i_2$$

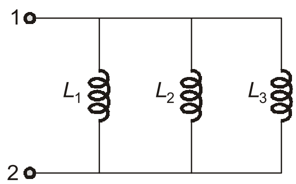
$$i_3 = i_1 + i_2 - 3$$

$$i_3 = 6 - 2 - 3 = 1 \text{ A}$$

$$i_3 = 1 \text{ A}$$

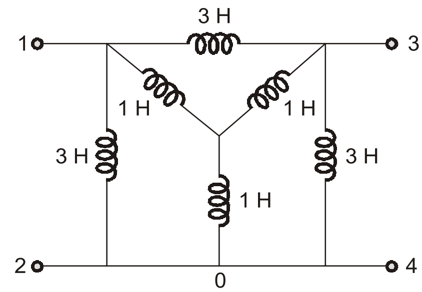
Q.7 Determine equivalent inductance at terminal '1-2' for circuits.

(a)



$L_1 = 20$ mH
$L_2 = 30$ mH
$L_3 = 10$ mH

(b)



Solution:

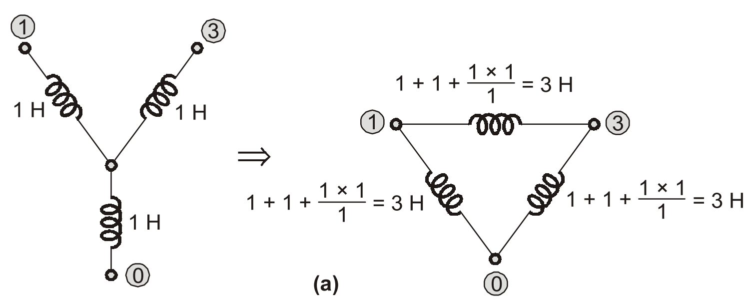
(a) All the inductances are in parallel thus overall equivalent inductance is

$$\boxed{\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}}$$

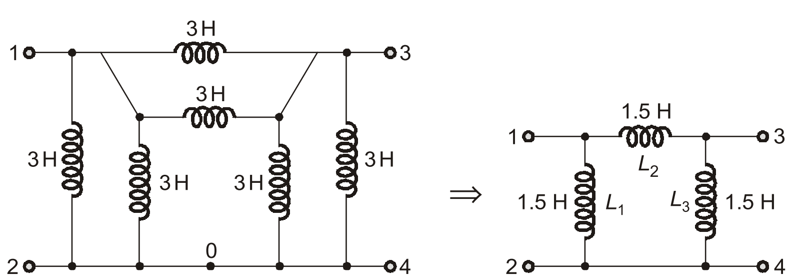
$$\frac{1}{L_{eq}} = \frac{1}{20 \text{ mH}} + \frac{1}{30 \text{ mH}} + \frac{1}{10 \text{ mH}}$$

On solving,
$$L_{eq} = \frac{60}{11} \text{ mH} = 5.45 \text{ mH}$$

(b) This problem can be best solved utilising star to delta transformation.
Let us first convert the interconnected inductances to an equivalent delta. This is shown in figure (a)
Hence the equivalent circuit configuration of figure given becomes as shown in figure (b).



(a)



(b)

Redrawing circuits,
Thus the equivalent inductance across 1-2 is given by

$$L_{1-2} = L_1 \parallel (L_2 + L_3) = 1.5 \parallel 3 = \frac{1.5 \times 3}{1.5 + 3}.$$

Hence,
$$L_{12} = L_{eq} = 1 \text{ H}$$