NORTH SOUTH UNIVERSITY
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

Assignment-2

Summer 2022

EEE141: Electrical Circuits I

Section: 08

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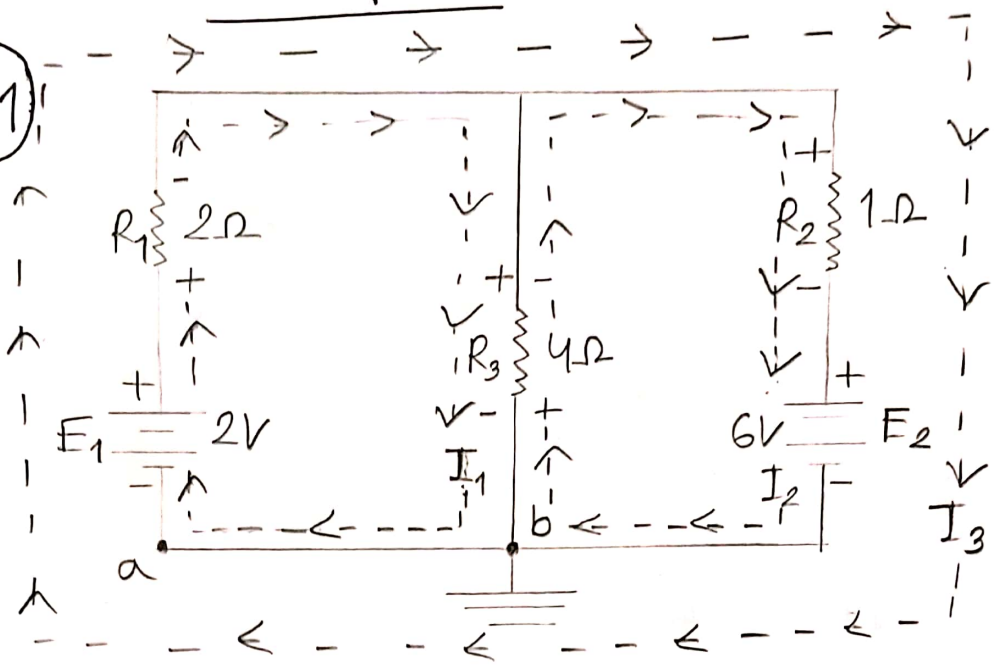
Date: 18-08-2022

Chapter-08

Example

8.11



loop 1:

$$E_1 - V_1 - V_3 = 0$$

$$\Rightarrow 2 - 2.I_1 - 4.(I_1 - I_2) = 0$$

$$\Rightarrow 2 - 2I_1 - 4I_1 + 4I_2 = 0.$$

$$\Rightarrow -6I_1 + 4I_2 = -2$$

$$\Rightarrow 6I_1 - 4I_2 = 2 \quad \ldots\ldots\ldots (i)$$

loop 2:

$$-V_3 - V_2 - E_2 = 0.$$

$$\Rightarrow -4.(I_2 - I_1) - 1.I_2 - 6 = 0.$$

$$\Rightarrow -4I_2 + 4I_1 - I_2 - 6 = 0.$$

$$\Rightarrow 4I_1 - 5I_2 = 6 \quad \ldots\ldots\ldots (ii)$$

From (i) and (ii),

$$6I_1 - 4I_2 = 2$$

$$4I_1 - 5I_2 = 6.$$

$\therefore I_1 = -1\,A$ and $I_2 = -2A.$

From loop 1, $I_{R_3} = I_1 - I_2$

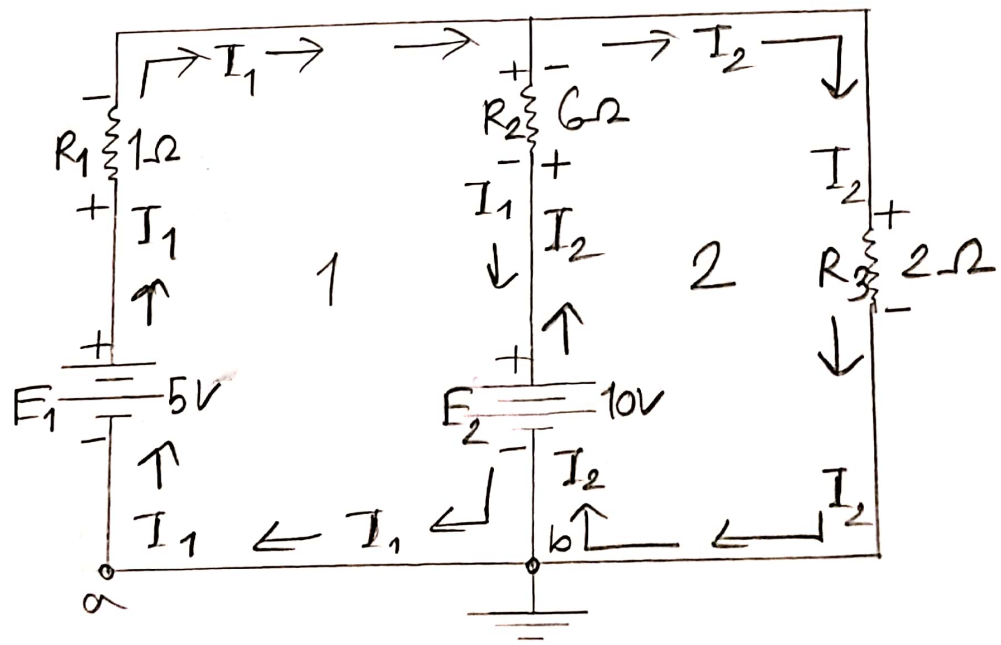
$\Rightarrow I_{4\Omega} = I_1 - I_2 = -1A + 2A$

$\Rightarrow I_{4\Omega} = 1A\downarrow$

$\therefore I_{4\Omega} = 1A$ (in the direction of I_1)

(Ans).

8.12



Loop 1: $E_1 - V_1 - V_2 - E_2 = 0$

$\Rightarrow E_1 - 1.I_1 - 6.(I_1 - I_2) - E_2 = 0.$

$\Rightarrow 5 - I_1 - 6I_1 + 6I_2 - 10 = 0.$

$\Rightarrow -7I_1 + 6I_2 = 5 \ldots\ldots\ldots (i)$

Loop 2 : $E_2 - V_2 - V_3 = 0$

$\Rightarrow 10 - 6(I_2 - I_1) - 2 \cdot I_2 = 0.$

$\Rightarrow 10 - 6I_2 + 6I_1 - 2I_2 = 0.$

$\Rightarrow 6I_1 - 8I_2 = -10$

$\Rightarrow -6I_1 + 8I_2 = 10 \ldots\ldots\ldots (ii)$

From (i) and (ii),

$-7I_1 + 6I_2 = 5$

$-6I_1 + 8I_2 = 10$

$\therefore I_1 = 1A$ and $I_2 = 2A.$

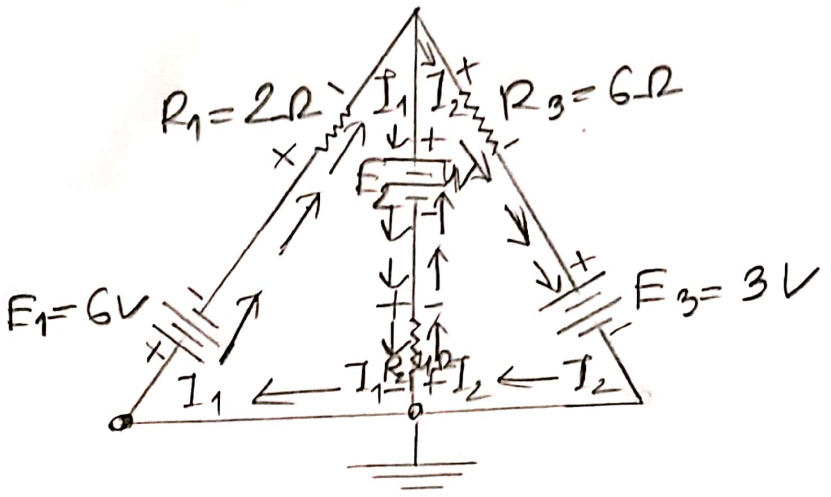
Since $I_2 > I_1$, from loop 2, $I_{R_2} = I_2 - I_1$

$\Rightarrow I_{6\Omega} = 2A - 1A = 1A \uparrow$

$\therefore I_{6\Omega} = 1A$ (in the direction of I_2).

(Ans).

8.13



Loop 1 : $-E_1 - V_1 - E_2 - V_2 = 0.$

$\Rightarrow -6 - 2.I_1 - 4 - 4.(I_1 - I_2) = 0$

$\Rightarrow -6 - 2I_1 - 4 - 4I_1 + 4I_2 = 0.$

$\Rightarrow -6I_1 + 4I_2 = 10 \ldots\ldots\ldots (i)$

Loop 2 : $-V_2 + E_2 - V_3 - E_3 = 0.$

$\Rightarrow -4(I_2 - I_1) + 4 - 6.I_2 - 3 = 0.$

$\Rightarrow -4I_2 + 4I_1 - 6I_2 + 1 = 0.$

$\Rightarrow 4I_1 - 10I_2 = -1 \ldots\ldots\ldots (ii)$

From (i) and (ii),

$-6I_1 + 4I_2 = 10$

$4I_1 - 10I_2 = -1$

$\therefore I_1 = -2.18\,A$ and $I_2 = -0.77A.$

(c)

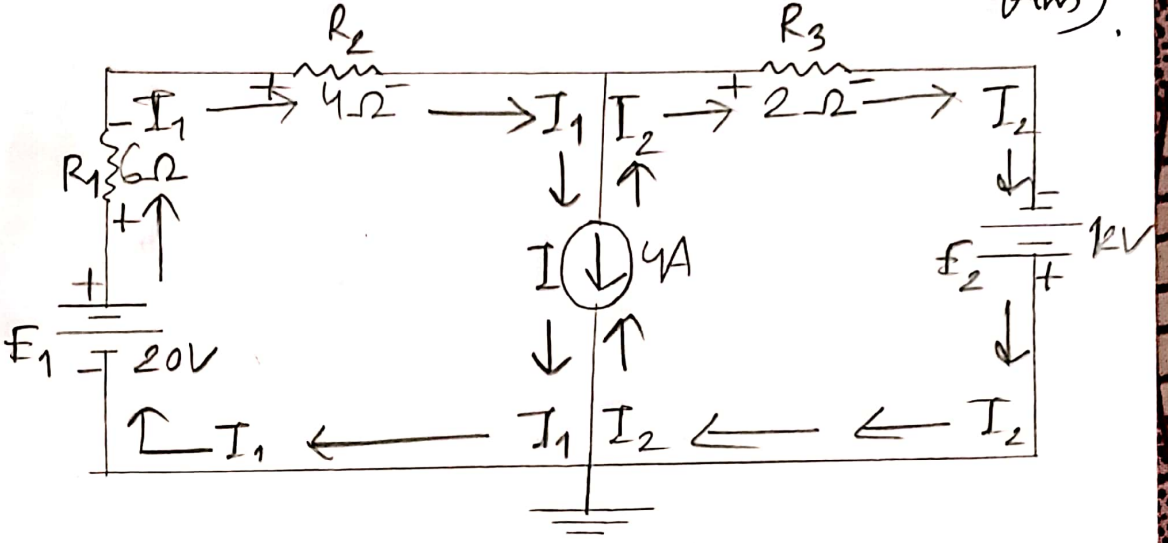
Since $I_2 > I_1$, from loop 2, $I_{R_2} = I_2 - I_1$

$\Rightarrow I_{4\Omega} = -0.77A + 2.18A = 1.41A\uparrow$

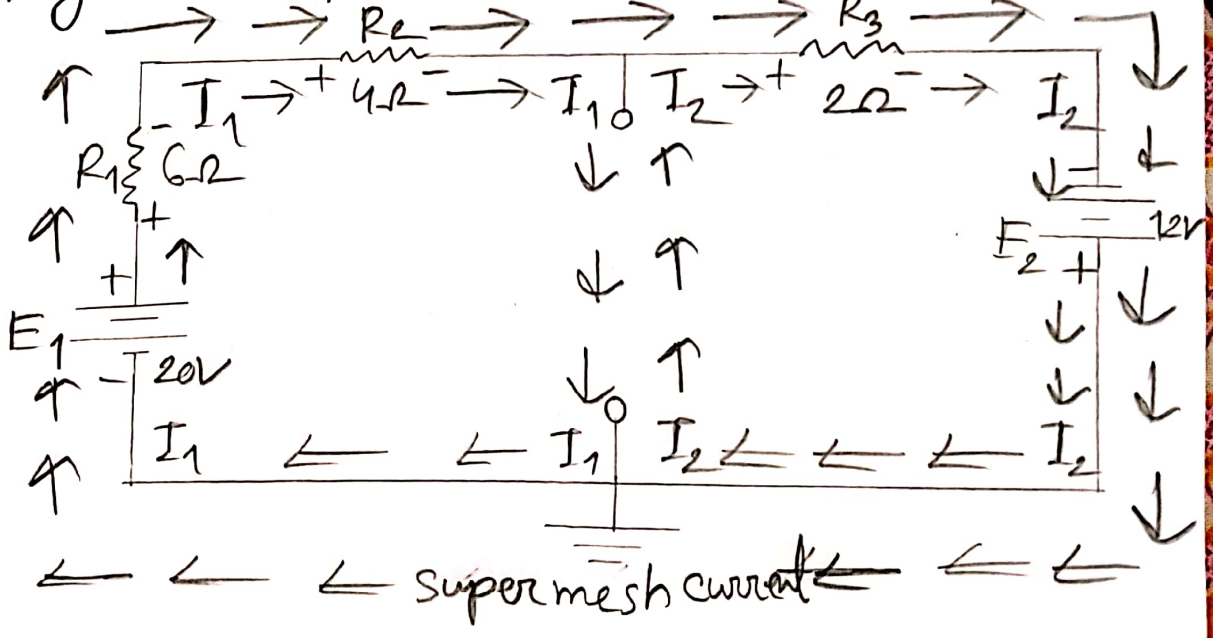
$\therefore I_{4\Omega} = 1.41A$ (in the direction of I_2)

(Ans).

8.14



Defining the supermesh current,



Here,

$E_1 - R_1 - R_2 - R_3 + E_2 = 0.$

$\Rightarrow 20 - 6.I_1 - 4I_1 - 2I_2 + 12 = 0.$

$\Rightarrow -10I_1 - 2I_2 = -32 \ldots\ldots\ldots (i)$

Again,

$I_1 - I_2 = 4 \ldots\ldots\ldots\ldots (ii)$

From (i) and (ii),

$-10I_1 - 2I_2 = -32$

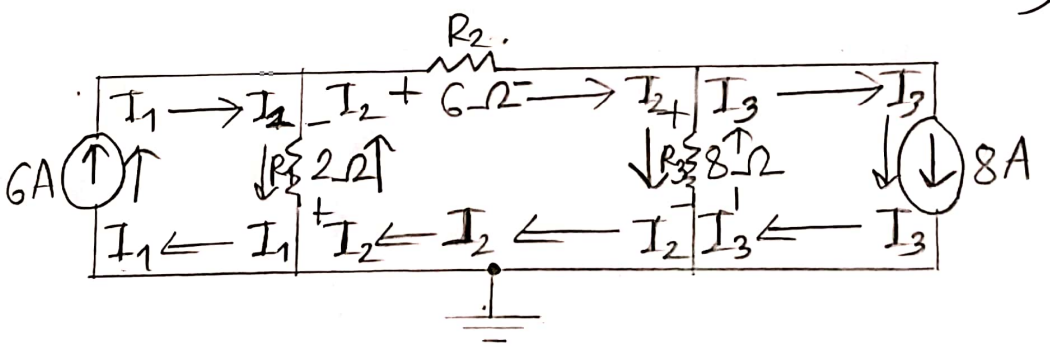
$I_1 - I_2 = 4$

$\therefore I_1 = 3.33A\downarrow$ and $I_2 = -0.67A$.

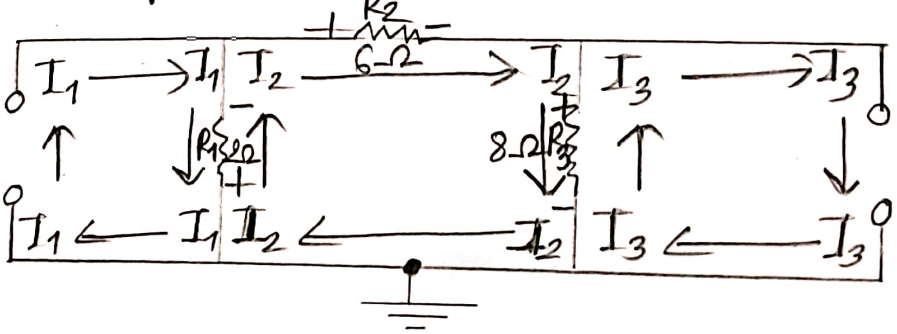
$\therefore I_2 = 0.67A\uparrow$

(Ans).

8.15



Defining the supermesh current,



Here,

$-V_1 - V_2 - V_3 = 0$

$\Rightarrow 2(I_2 - I_1) - 6I_2 - 8(I_2 - I_3) = 0.$

$\Rightarrow -2I_2 + 2I_1 - 6I_2 - 8I_2 + 8I_3 = 0$

$\Rightarrow 2I_1 - 16I_2 + 8I_3 = 0 \ldots\ldots\ldots$ (i)

Again,

$I_1 = 6A \ldots\ldots\ldots$ (ii)

$I_3 = 8A \ldots\ldots\ldots$ (iii)

From (i), (ii) and (iii),

$2(6) - 16I_2 + 8(8) = 0$

$\Rightarrow -16I_2 + 76 = 0.$

$\Rightarrow I_2 = \frac{76}{16}$

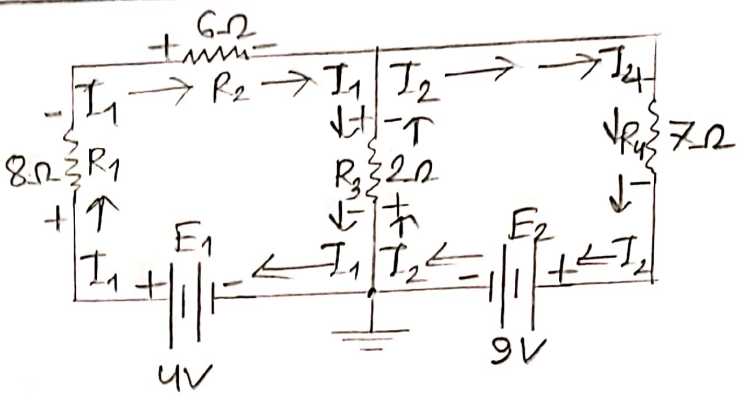
$\therefore I_2 = 4.75A.$

$\therefore I_{R_1} = I_{2\Omega} = I_1 - I_2 = (6 - 4.75) = 1.25A \downarrow$

$\therefore I_{R_3} = I_{8\Omega} = I_3 - I_2 = (8 - 4.75) = 3.25A \uparrow$

(Ans)

8.16



Loop 1 :

$$E_1 - V_1 - V_2 - V_3 = 0$$

$$\Rightarrow 4 - 8.I_1 - 6.I_1 - 2(I_1 - I_2) = 0.$$

$$\Rightarrow 4 - 14I_1 - 2I_1 + 2I_2 = 0.$$

$$\Rightarrow -16I_1 + 2I_2 = -4$$

$$\Rightarrow 16I_1 - 2I_2 = 4 \quad \ldots\ldots\ldots\ldots (i)$$

Loop 2 :

$$-V_3 - V_4 - E_2 = 0.$$

$$\Rightarrow -2(I_2 - I_1) - 7I_2 - 9 = 0.$$

$$\Rightarrow -2I_2 + 2I_1 - 7I_2 - 9 = 0.$$

$$\Rightarrow 2I_1 - 9I_2 = 9 \quad \ldots\ldots\ldots\ldots (ii)$$

From (i) and (ii),

$$16I_1 - 2I_2 = 4$$

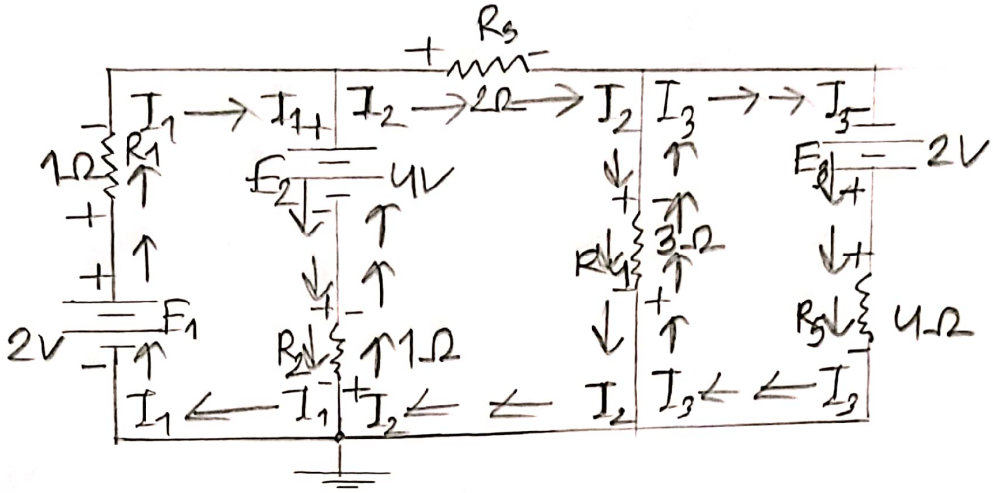
$$2I_1 - 9I_2 = 9$$

$\therefore I_1 = 0.129A$ and $I_2 = -0.971A$

$\therefore I_{7\Omega} = I_{R_4} = I_2 = -0.971A = 0.971A \uparrow$

(Ans).

8.17



Loop 1 :

$E_1 - V_1 - E_2 - V_2 = 0.$

$\Rightarrow 2 - 1.I_1 - 4 - 1.(I_1 - I_2) = 0.$

$\Rightarrow -I_1 - 2 - I_1 + I_2 = 0.$

$\Rightarrow -2I_1 + I_2 = 2 \quad \ldots\ldots\ldots\ldots (i)$

Loop 2 :

$E_2 - V_3 - V_4 - V_2 = 0$

$\Rightarrow 4 - 2I_2 - 3(I_2 - I_3) - 1(I_2 - I_1) = 0.$

$\Rightarrow 4 - 2I_2 - 3I_2 + 3I_3 - I_2 + I_1 = 0.$

$\Rightarrow I_1 - 6I_2 + 3I_3 = -4. \quad \ldots\ldots (ii).$

Loop 3 :

$E_3 - V_5 - V_4 = 0$

$\Rightarrow 2 - 4I_3 + 3(I_3 - I_2) = 0$

$\Rightarrow 2 - 4I_3 - 3I_3 + 3I_2 = 0$

$\Rightarrow 3I_2 - 7I_3 = -2. \quad \ldots\ldots (iii)$

From (i), (ii), (iii),

$$-2I_1 + I_2 = 2$$

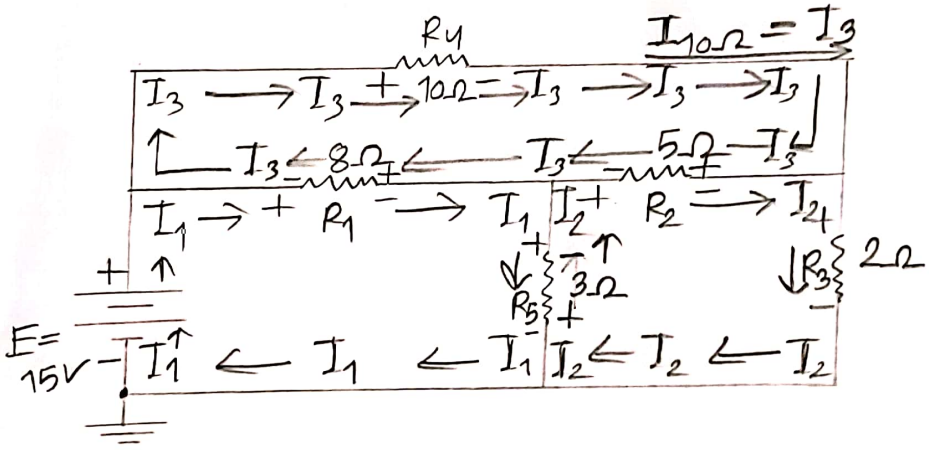
$$I_1 - 6I_2 + 3I_3 = -4$$

$$3I_2 - 7I_3 = -2$$

$\therefore I_1 = -0.542\,A$, $I_2 = 0.915\,A$, $I_3 = 0.678\,A$

$\therefore I_1 = 0.542\,A\uparrow$, $I_2 = 0.915\,A\downarrow$, $I_3 = 0.678\,A\downarrow$ (Ans)

8.18



Loop 1:

$$E - V_1 - V_5 = 0$$

$$\Rightarrow 15 - 8(I_1 - I_3) - 3(I_1 - I_2) = 0.$$

$$\Rightarrow 15 - 8I_1 + 8I_3 - 3I_1 + 3I_2 = 0$$

$$\Rightarrow -11I_1 + 3I_2 + 8I_3 = -15 \quad \ldots\ldots (i)$$

Loop 2:

$$-V_3 + V_5 + V_2 = 0$$

$$\Rightarrow 2I_2 + 3(I_2 - I_1) + 5(I_2 - I_3) = 0.$$

$$\Rightarrow 2I_2 + 3I_2 - 3I_1 + 5I_2 - 5I_3 = 0.$$

$\Rightarrow -3I_1 + 10I_2 - 5I_3 = 0 \ldots\ldots\ldots (ii)$

Loop 3 :

$V_4 + V_2 + V_1 = 0$

$\Rightarrow 10.I_3 + 5(I_3 - I_2) + 8(I_3 - I_1) = 0.$

$\Rightarrow 10I_3 + 5I_3 - 5I_2 + 8I_3 - 8I_1 = 0$

$\Rightarrow -8I_1 - 5I_2 + 23I_3 = 0 \ldots\ldots\ldots (iii)$

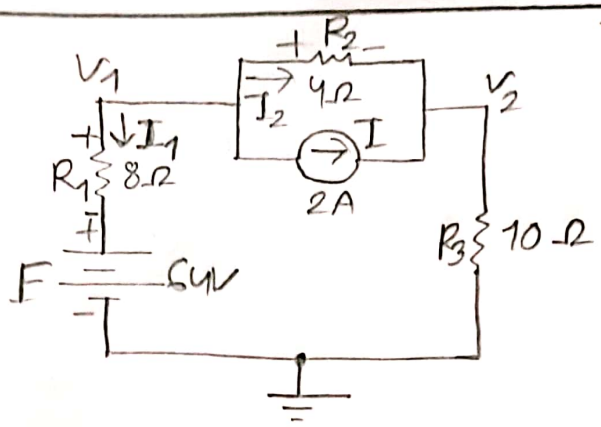
From (i), (ii), (iii),

$$-11I_1 + 3I_2 + 8I_3 = -15$$
$$-3I_1 + 10I_2 - 5I_3 = 0$$
$$-8I_1 - 5I_2 + 23I_3 = 0.$$

$\therefore I_1 = 2.63A\downarrow$, $I_2 = 1.3998\,A\downarrow$, $I_3 = 1.22A\downarrow$

$\therefore I_{10\Omega} = I_{R_4} = I_3 = 1.22A\downarrow$ (Ans).

8.20



For node V_1,

$$I_1 + I_2 + I = 0.$$

$$\Rightarrow \frac{V_1 - E}{R_1} + \frac{V_1 - V_2}{R_2} + 2 = 0.$$

$$\Rightarrow \frac{V_1}{R_1} - \frac{E}{R_1} + \frac{V_1}{R_2} - \frac{V_2}{R_2} + 2 = 0.$$

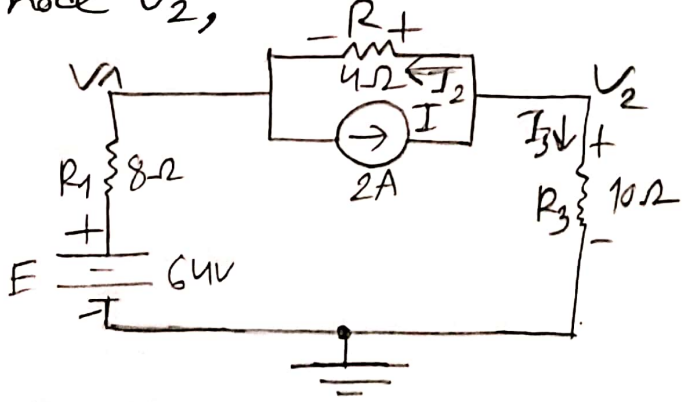
$$\Rightarrow V_1\left(\frac{1}{R_1} + \frac{1}{R_2}\right) - \frac{V_2}{R_2} = \frac{E}{R_1} - 2$$

$$\Rightarrow V_1\left(\frac{1}{8} + \frac{1}{4}\right) - \frac{V_2}{4} = \frac{64}{8} - 2$$

$$\Rightarrow \frac{3V_1}{8} - \frac{V_2}{4} = 6$$

$$\Rightarrow 0.375V_1 - 0.25V_2 = 6 \quad \ldots\ldots\ldots \text{(i)}.$$

For node V_2,



$$I = I_2 + I_3$$

$$\Rightarrow 2 = \frac{V_2 - V_1}{R_2} + \frac{V_2}{R_3}$$

$$\Rightarrow 2 = \frac{V_2}{R_2} - \frac{V_1}{R_2} + \frac{V_2}{R_3}$$

$$\Rightarrow V_2\left(\frac{1}{4}+\frac{1}{10}\right)-\frac{V_1}{8}=2$$

$$\Rightarrow \frac{7V_2}{20}-\frac{V_1}{8}=2$$

$$\Rightarrow 0.35V_2 - 0.25V_1 = 2 \quad \ldots\ldots\ldots (ii)$$

From (i) & (ii),

$$0.375V_1 - 0.25V_2 = 6$$

$$-0.25V_1 + 0.35V_2 = 2$$

$\therefore V_1 = 37.82V$ and $V_2 = 32.73V$

Since $E > V_1$, $I_{R1} = \frac{E-V_1}{R_1} = \frac{64-37.82}{8} A$

$= 3.27A \uparrow$

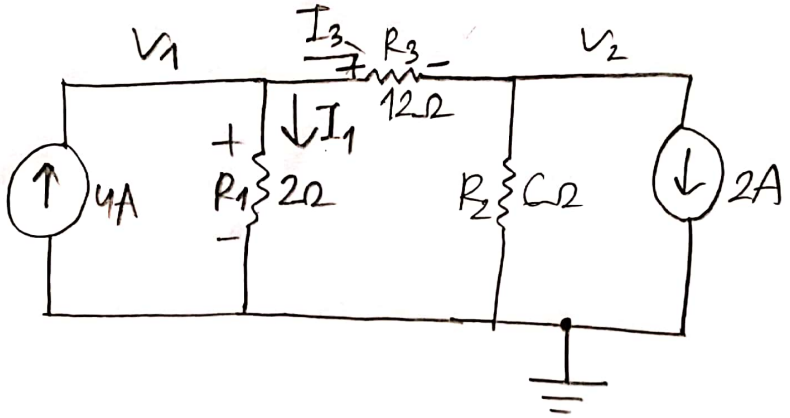
$$I_{R3} = \frac{V_{R3}}{R_3} = \frac{V_2}{R_3} = \frac{32.73}{10} = 3.27A \downarrow$$

Since $V_1 > V_2$, $I_{R2} = \frac{V_1-V_2}{R_2} = \frac{37.82-32.73}{4} A$

$= 1.27A \uparrow$

(Ans)

8.21



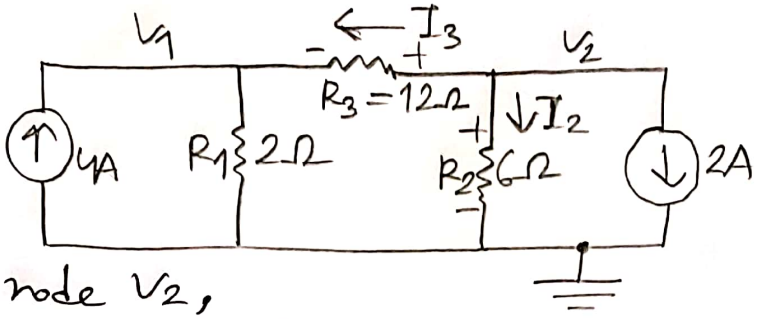
For node V_1,

$$4 = I_1 + I_3$$

$$\Rightarrow 4 = \frac{V_1 - 0}{R_1} + \frac{V_1 - V_3}{R_3}$$

$$\Rightarrow 4 = \frac{V_1}{2} + \frac{V_1}{12} - \frac{V_3}{12}.$$

$$\Rightarrow 0.583V_1 - 0.083V_2 = 4 \quad \ldots\ldots (i)$$



For node V_2,

$$I_3 + I_2 + 2 = 0$$

$$\Rightarrow \frac{V_2 - V_1}{R_3} + \frac{V_2 - 0}{R_2} + 2 = 0.$$

$$\Rightarrow \frac{V_2}{12} - \frac{V_1}{12} + \frac{V_2}{6} + 2 = 0.$$

$$\Rightarrow -0.083V_1 + 0.25V_2 = -2 \quad \ldots\ldots (ii)$$

From (i) and (ii),

$$0.583V_1 - 0.083V_2 = 4$$

$$-0.083V_1 + 0.25V_2 = -2$$

$\therefore V_1 = 6V$ and $V_2 = -6V$

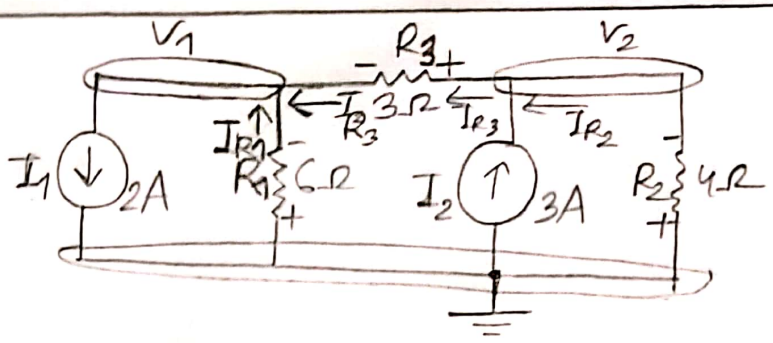
Since $V_1 > V_2$, $I_{R_3} = \frac{V_1 - V_2}{R_3} = \frac{6+6}{12} A = 1A \uparrow$

$$I_{R1} = \frac{V_{R1}}{R_1} = \frac{V_1}{R_1} = \frac{6V}{2\Omega} = 3A \downarrow$$

$$I_{R2} = \frac{V_{R2}}{R_2} = \frac{V_2}{R_2} = \frac{6V}{6\Omega} = 1A \uparrow$$

(Ans).

8.23



$$I_{R_1} + I_{R_3} = I_1$$

$$\Rightarrow \frac{V_1 - 0}{R_1} + \frac{V_1 - V_2}{R_3} = 2$$

$$\Rightarrow \frac{V_1}{6} + \frac{V_1}{3} - \frac{V_2}{3} = 2$$

$$\Rightarrow \frac{6V_1}{2} - \frac{V_2}{3} = 2 \quad \ldots\ldots\ldots\ldots \text{(i)}$$

$$I_{R_2} + I_2 = I_{R_3}$$

$$\Rightarrow \frac{V_2 - 0}{R_2} + 3 = \frac{V_1 - V_2}{R_3}$$

$$\Rightarrow \frac{V_2}{4} - \frac{V_1}{3} + \frac{V_2}{3} = -3$$

$$\Rightarrow \frac{-V_1}{3} + \frac{7V_2}{12} = -3 \quad \ldots\ldots\ldots \text{(ii)}$$

From (i) & (ii),

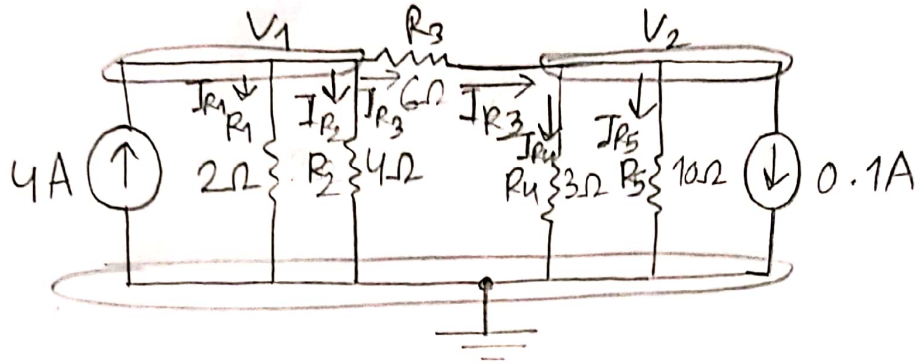
$$0.5\,V_1 - 0.33V_2 = 2$$

$$-0.33V_1 + 0.583V_2 = -3$$

$\therefore V_1 = 0.964\,V$ and $V_2 = -4.6\,V$

(Ans)

8.24



$$4 = I_{R_1} + I_{R_2} + I_{R_3}$$

$$\Rightarrow 4 = \frac{V_1 - 0}{R_1} + \frac{V_1 - 0}{R_2} + \frac{V_1 - V_2}{R_3}$$

$$\Rightarrow 4 = \frac{V_1}{2} + \frac{V_1}{4} + \frac{V_1}{6} - \frac{V_2}{6}$$

$$\Rightarrow \frac{11V_1}{12} - \frac{V_2}{6} = 4 \quad \ldots\ldots\ldots (i)$$

$$0.1 + I_{R_5} + I_{R_4} = I_{R_3}$$

$$\Rightarrow 0.1 + \frac{V_2 - 0}{R_5} + \frac{V_2 - 0}{R_4} = \frac{V_1 - V_2}{R_3}$$

$$\Rightarrow 0.1 + \frac{V_2}{10} + \frac{V_2}{3} = \frac{V_1}{6} - \frac{V_2}{6}$$

$$\Rightarrow 0.1 + \frac{V_2}{10} + \frac{V_2}{3} - \frac{V_1}{6} + \frac{V_2}{6} = 0$$

$$\Rightarrow \frac{V_1}{6} - \frac{3V_2}{5} = 0.1 \quad \ldots\ldots\ldots (ii)$$

From (i) and (ii),

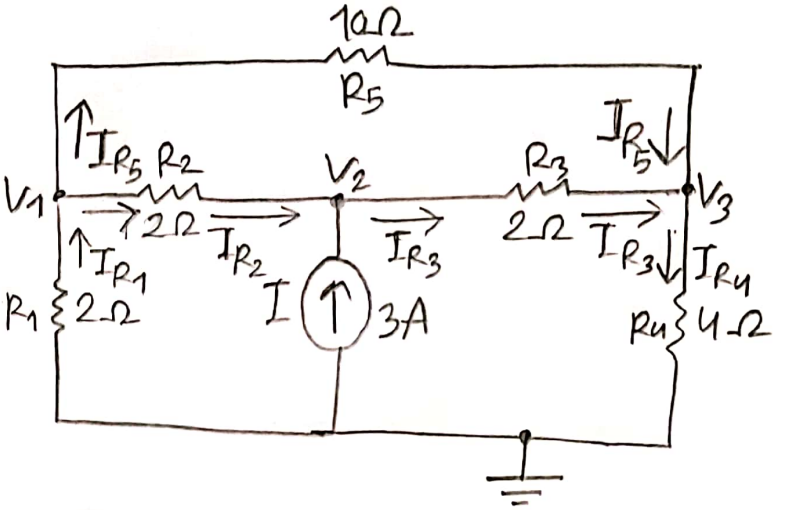
$$0.9167V_1 - 0.167V_2 = 4$$

$$0.167V_1 - 0.6V_2 = 0.1$$

$\therefore V_1 = 4.56V$ and $V_2 = 1.103V$

(Ans)

8.25



$$I_{R_1} = I_{R_2} + I_{R_5}$$

$$\Rightarrow \frac{0 - V_1}{R_1} = \frac{V_1 - V_2}{R_2} + \frac{V_1 - V_3}{R_5}$$

$$\Rightarrow -\frac{V_1}{2} - \frac{V_1}{2} + \frac{V_2}{2} - \frac{V_1}{10} + \frac{V_3}{10} = 0$$

$$\Rightarrow -\frac{11V_1}{10} + \frac{V_2}{2} + \frac{V_3}{10} = 0 \quad \ldots\ldots\ldots (i)$$

$$I_{R_2} + I = I_{R_3}$$

$$\Rightarrow \frac{V_1 - V_2}{R_2} + 3 = \frac{V_2 - V_3}{R_3}$$

$$\Rightarrow \frac{V_1}{2} - \frac{V_2}{2} + 3 - \frac{V_2}{2} + \frac{V_3}{2} = 0$$

$$\Rightarrow \frac{V_1}{2} - V_2 + \frac{V_3}{2} = -3 \quad \ldots\ldots\ldots (ii)$$

$$I_{R_3} + I_{R_5} = I_{R_4}$$

$$\Rightarrow \frac{V_2 - V_3}{R_3} + \frac{V_1 - V_3}{R_5} = \frac{V_3 - 0}{R_4}$$

$$\Rightarrow \frac{V_2}{2} - \frac{V_3}{2} + \frac{V_1}{10} - \frac{V_2}{10} - \frac{V_3}{4} = 0.$$

$$\Rightarrow \frac{V_1}{10} + \frac{V_2}{2} - \frac{17V_3}{20} = 0 \quad \ldots\ldots\ldots (iii)$$

From (i), (ii) and (iii),

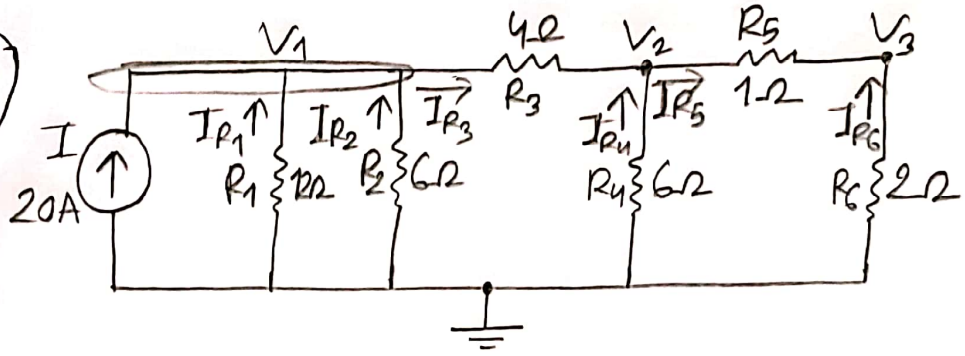
$$-\frac{11V_1}{10}+\frac{V_2}{2}+\frac{V_3}{10}=0$$

$$\frac{V_1}{2}-V_2+\frac{V_3}{2}=-3$$

$$\frac{V_1}{10}+\frac{V_2}{2}-\frac{17V_3}{20}=0.$$

$\therefore V_1 = 3.68V$, $V_2 = 7.16V$ and $V_3 = 4.65V$ (Ans).

8.26



$$I + I_{R_1} + I_{R_2} = I_{R_3}$$

$$\Rightarrow 20 + \frac{0-V_1}{R_1} + \frac{0-V_1}{R_2} = \frac{V_1-V_2}{R_3}.$$

$$\Rightarrow 20 + \frac{V_1}{12} - \frac{V_1}{6} = \frac{V_1}{4} - \frac{V_2}{4}$$

$$\Rightarrow \frac{V_1}{4} + \frac{V_1}{12} + \frac{V_1}{6} + \frac{V_2}{4} = 20$$

$$\Rightarrow \frac{V_1}{2} - \frac{V_2}{4} = 20 \quad \ldots\ldots\ldots \text{(i)}$$

$$I_{R_3} + I_{R_4} = I_{R_5}$$

$$\Rightarrow \frac{V_1-V_2}{R_3} + \frac{0-V_2}{R_4} = \frac{V_2-V_3}{R_5}$$

$$\Rightarrow \frac{V_1}{4} - \frac{V_2}{4} - \frac{V_2}{6} - \frac{V_2}{1} + \frac{V_3}{1} = 0$$

$$\Rightarrow \frac{V_1}{4} - \frac{17}{12}V_2 + V_3 = 0 \quad \ldots\ldots \text{(ii)}$$

$$I_{R_5} + I_{R_6} = 0.$$

$$\Rightarrow \frac{V_2 - V_3}{R_5} + \frac{0 - V_3}{R_6} = 0.$$

$$\Rightarrow \frac{V_2}{1} - \frac{V_3}{1} - \frac{V_3}{2} = 0.$$

$$\Rightarrow V_2 - \frac{3}{2}V_3 = 0 \ldots\ldots\ldots \text{(iii)}$$

From (i), (ii) and (iii),

$$\frac{V_1}{2} - \frac{V_2}{4} = 20$$

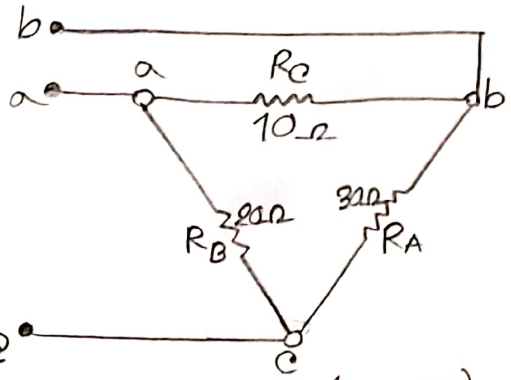
$$\frac{V_1}{4} - \frac{17}{12}V_2 + V_3 = 0$$

$$V_2 - \frac{3}{2}V_3 = 0.$$

$\therefore V_1 = 48V$, $V_2 = 16V$ and $V_3 = 10.67V$

(Ans)

8.27

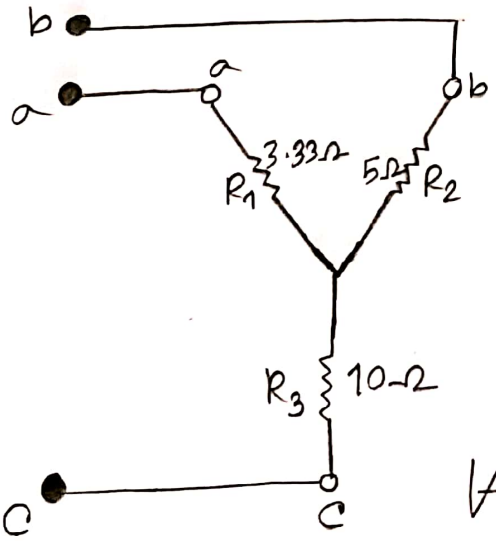


$$R_1 = \frac{R_B R_C}{R_A + R_B + R_C} = \frac{(20.10)}{30+20+10} = \frac{200}{60} = 3.33\Omega$$

$$R_2 = \frac{R_A R_C}{R_A + R_B + R_C} = \frac{(30.10)}{30+20+10} = \frac{300}{60} = 5\Omega$$

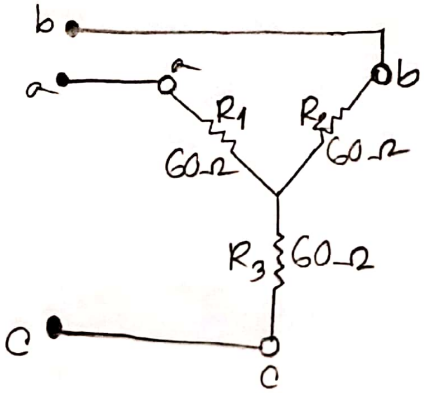
$$R_3 = \frac{R_A R_B}{R_A + R_B + R_C} = \frac{(20.30)}{30+20+10} = \frac{600}{60} = 10\Omega$$

(Ans).



(Ans)

8.28



$$R_A = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1} = \frac{(60.60)+(60.60)+(60.60)}{60}\ \Omega$$

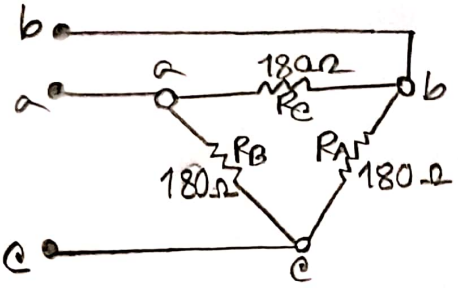
$$= \frac{3600+3600+3600}{60} = \frac{10800}{60}\ \Omega$$

$$= 180\ \Omega$$

The three resistors for Y are equal, so

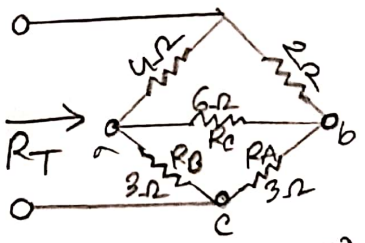
$$R_\Delta = 3R_Y = 3.(60\ \Omega) = 180\ \Omega$$

$$\therefore R_B = R_C = 180\ \Omega \quad (Ans)$$



(Ans).

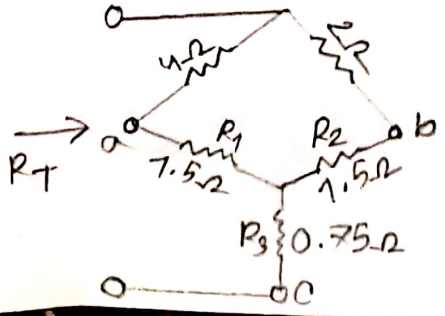
8.29



$$R_1 = \frac{R_BR_C}{R_A+R_B+R_C} = \frac{(3.6)}{3+3+6} = \frac{18}{12} = 1.5\ \Omega$$

$$R_2 = \frac{R_AR_C}{R_A+R_B+R_C} = \frac{(3.6)}{3+3+6} = \frac{18}{12} = 1.5\ \Omega$$

$$R_3 = \frac{R_AR_B}{R_A+R_B+R_C} = \frac{(3.3)}{3+3+6} = \frac{9}{12} = 0.75\ \Omega$$



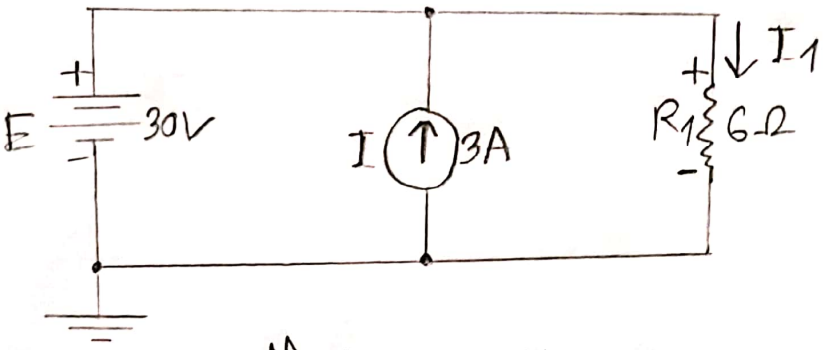
$$R_T = R_3 + \frac{(4+R_1)(2+R_2)}{(4+R_1)+(2+R_2)} = 0.75 + \frac{(4+1.5)(2+1.5)}{(4+1.5)+(2+1.5)}$$

$$= (0.75 + 2.139)\,\Omega$$

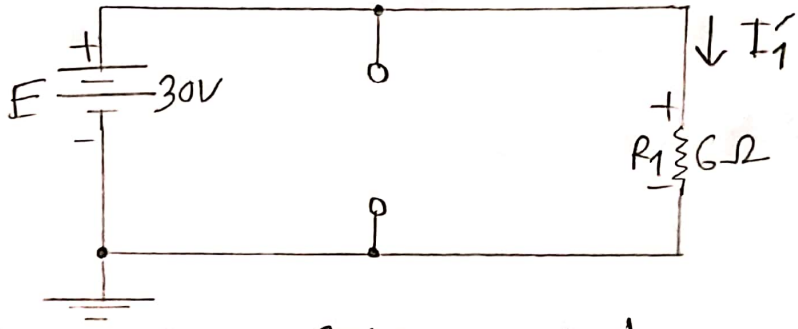
$$\therefore R_T = 2.89\,\Omega \quad \text{(Ans)}.$$

Chapter-09

9.1

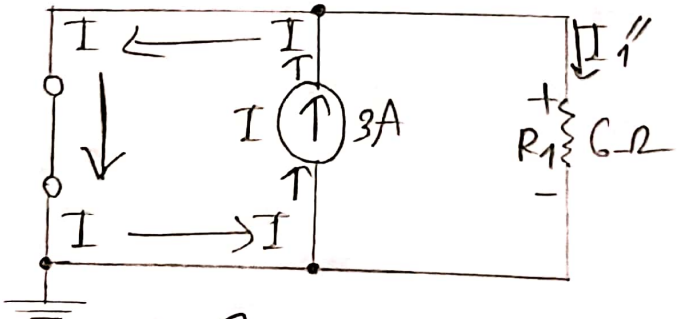


Determining the effect of the E=30V,



$$\therefore I_1' = \frac{V_1}{R_1} = \frac{E}{R_1} = \frac{30V}{6\Omega} = 5A.\downarrow$$

Determining the effect of the 3A current source,

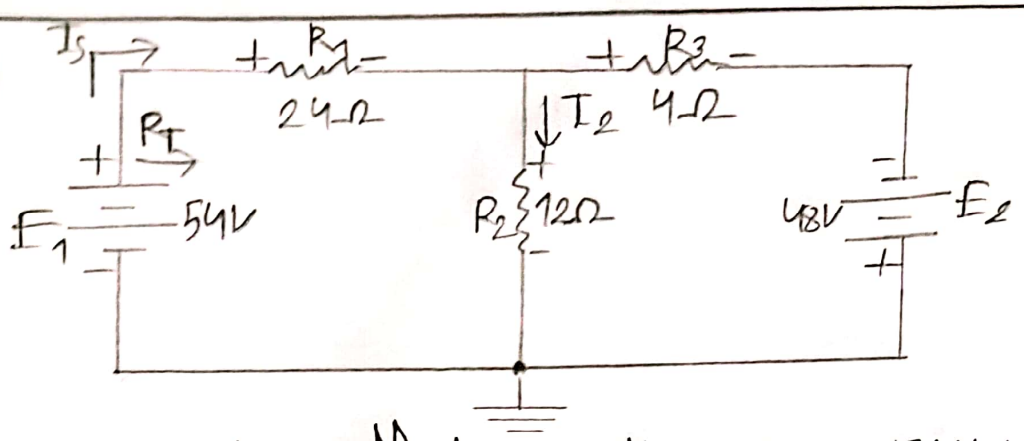


$$\therefore I_1'' = \frac{R_{sc} I}{R_{sc} + R_1} = \frac{0.3}{0+6} = 0A$$

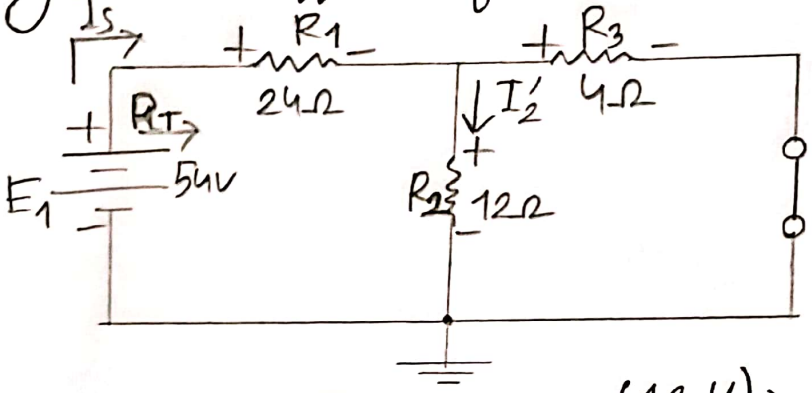
$$\therefore I_1 = I_1' + I_1'' = 5A + 0A = 5A\downarrow$$

(Ans)

(9.2)



Determining the effect of the $E_1 = 54V$,

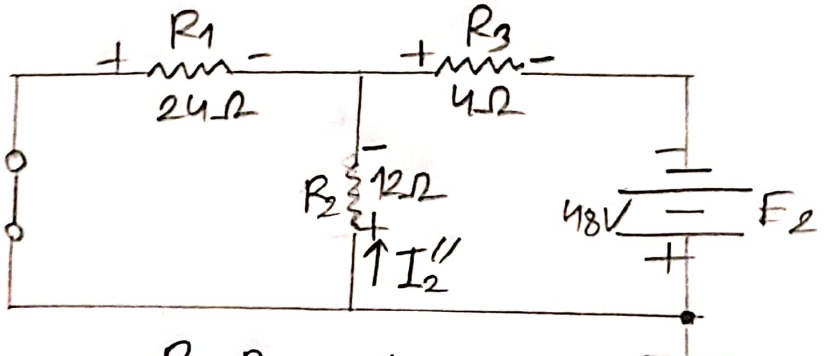


Here, $R_T = R_1 + \frac{R_2 R_3}{R_2 + R_3} = \left(24 + \frac{(12.4)}{12+4}\right)\Omega = 27\Omega$

$I_S = \frac{E_1}{R_T} = \frac{54V}{27\Omega} = 2A.$

$\therefore I_2' = \frac{R_3 I_S}{R_3 + R_2} = \frac{(4.2)}{4+12} = 0.5A \downarrow$

Determining the effect of the $E_2 = 48V$,



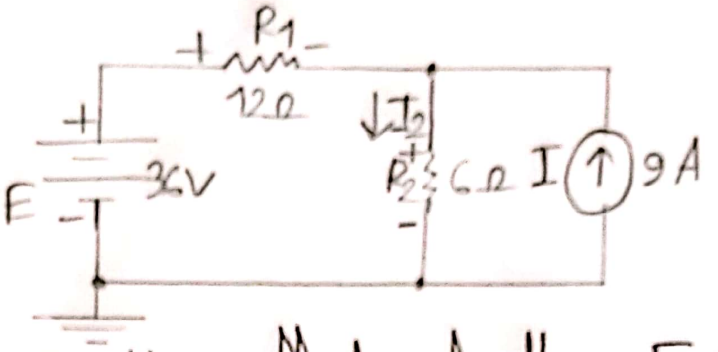
Here, $R_T = R_3 + \frac{R_2 R_1}{R_2 + R_1} = \left(4 + \frac{(12.24)}{12+24}\right)\Omega = 12\Omega$

$\therefore I_S = \frac{E_2}{R_T} = \frac{48V}{12\Omega} = 4A$

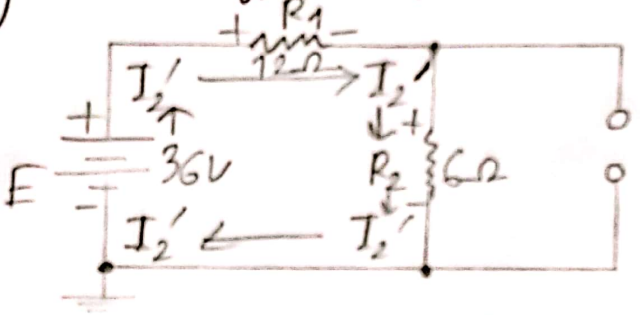
$\therefore I_2'' = \frac{R_1 I_S}{R_1 + R_2} = \frac{(24.4)}{24+12} = 2.67A \uparrow$

$\therefore I_2 = I_2'' - I_2' = (2.67 - 0.5)A = 2.17A \uparrow$ (Ans).

(9.3)

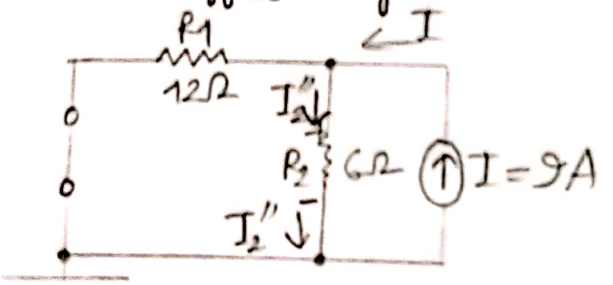


Determining the effect of the E = 36V,



$\therefore I_2' = \frac{E}{R_T} = \frac{E}{R_1+R_2} = \frac{36}{12+6} A = 2A \downarrow$

Determining the effect of the 9A current source,



$\therefore I_2'' = \frac{R.I}{R_1+R_2} = \frac{(12.9)}{12+6} A = 6A \downarrow$

$\therefore I_2 = I_2' + I_2'' = (2+6)A = 8A \downarrow$ (Ans).

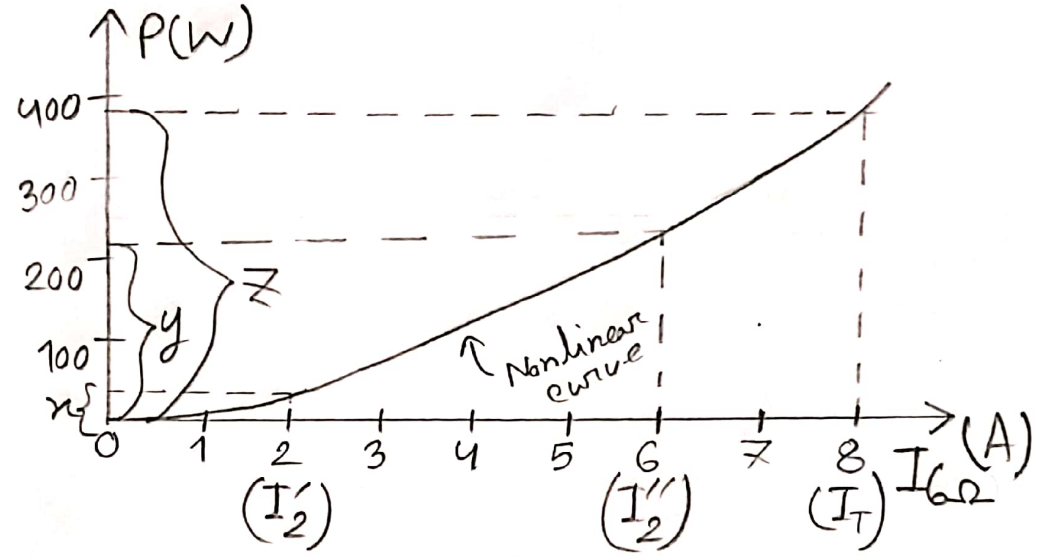
$\therefore P_1 = (I_2')^2 (R_2) = (2)^2 . 6 = 24W$

$\therefore P_2 = (I_2'')^2 (R_2) = (6)^2 . 6 = 216W$

$\therefore P_T = I_2^2 R_2 = (8)^2 . 6 = 384W$

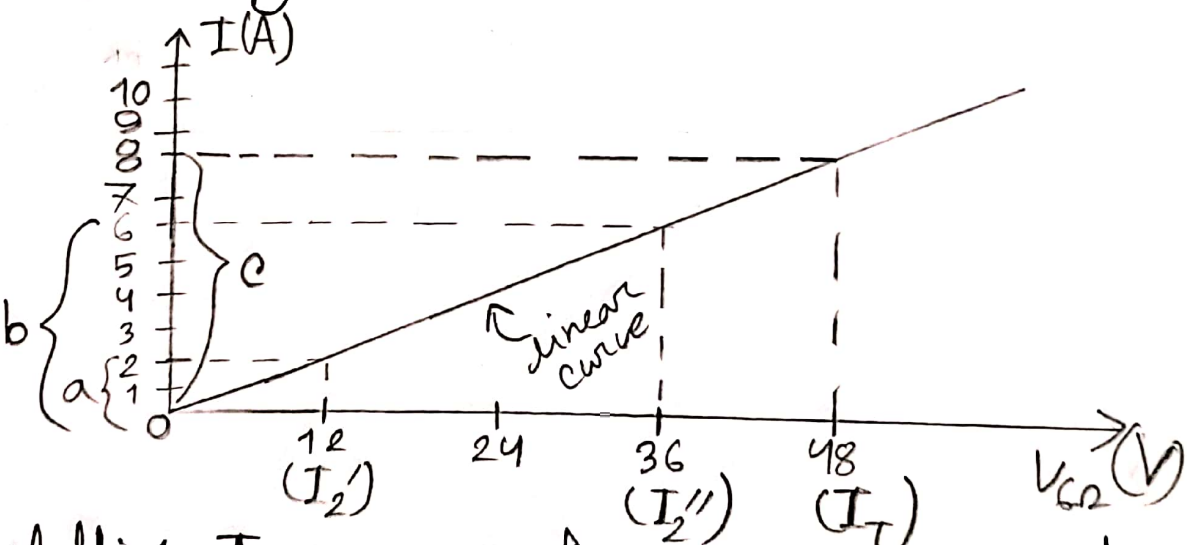
$\therefore P_1 + P_2 = (24 + 216)W = 240W \neq P_T = 348W.$

Therefore, the superposition theorem is not applicable to power levels. (Ans)



plotting power delivered to the 6Ω resistor versus current through resistors

Here, $x + y \neq z$

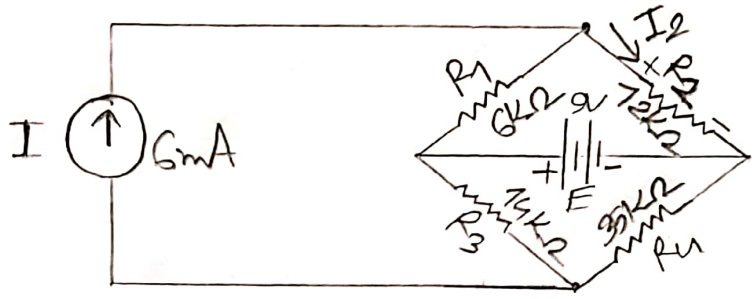


plotting I versus V for the 6Ω resistor

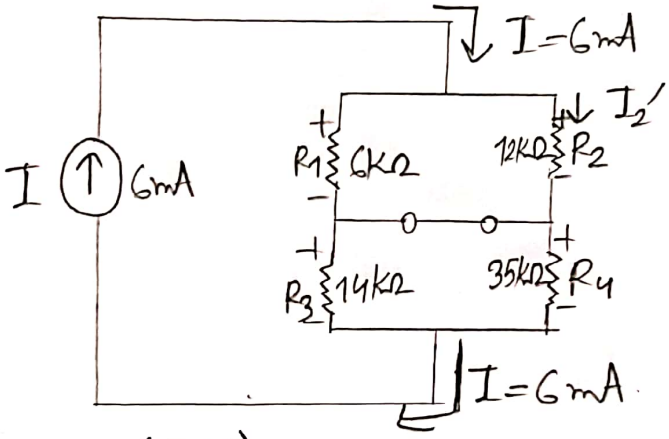
Here,

$c = a + b$. (Ans)

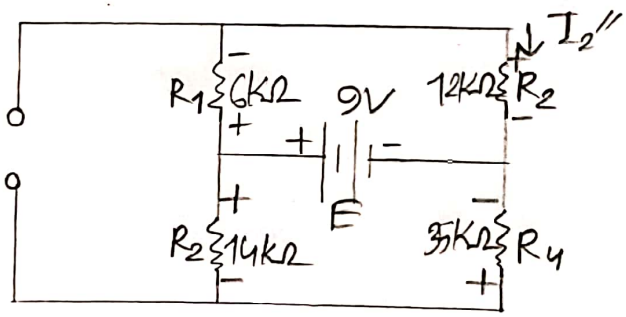
9.4



Determining the effect of the 6mA current source,



$$\therefore I_2' = \frac{R_1 I}{R_1 + R_2} = \frac{(6.6)}{6+12} = 2\text{mA} \downarrow$$

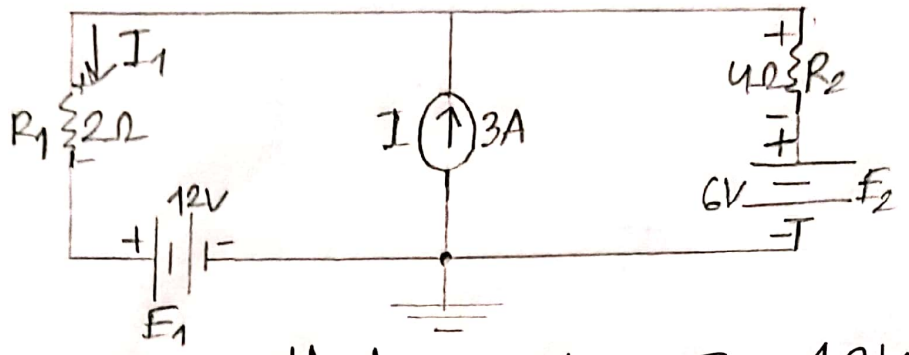


$$\therefore I_2'' = \frac{E}{R_1 + R_2} = \frac{9}{6+12}\text{mA} = 0.5\text{mA} \downarrow$$

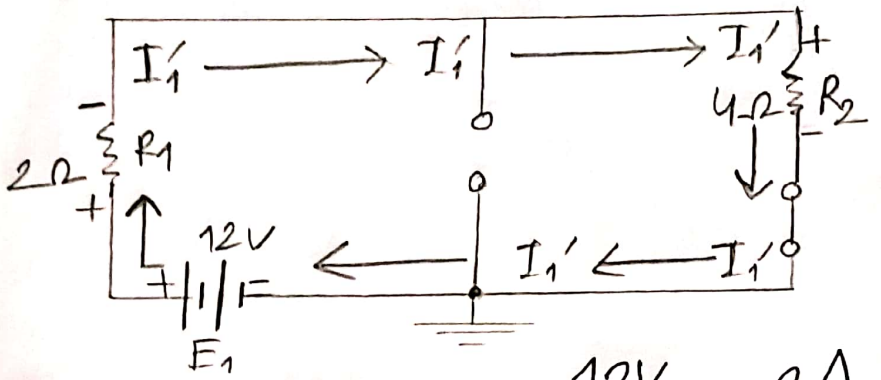
$$\therefore I_2 = I_2' + I_2'' = 2\text{mA} + 0.5\text{mA} = 2.5\text{mA} \downarrow$$

(Ans)

9.5

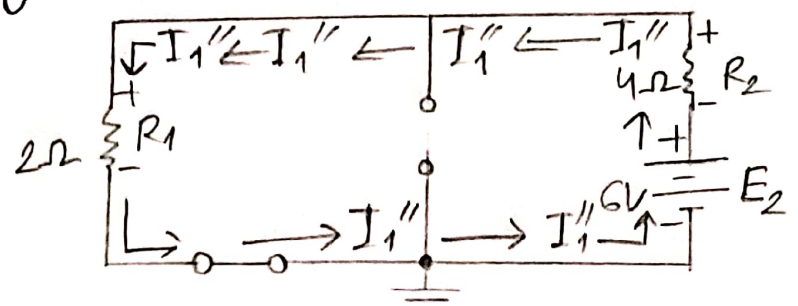


Determining the effect of the $E_1 = 12V$,



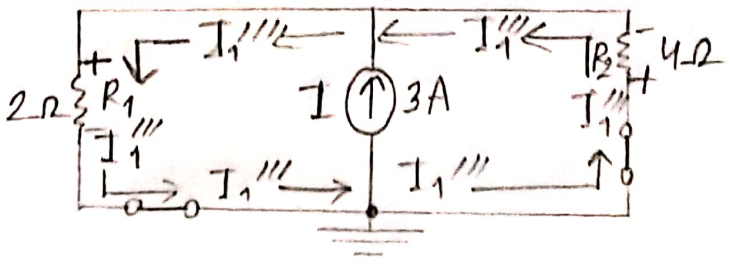
$$I_1' = \frac{E1}{R_1+R_2} = \frac{12V}{2\Omega+4\Omega} = \frac{12V}{6\Omega} = 2A.\uparrow$$

Determining the effect of the $E_2 = 6V$,



$$I_1'' = \frac{E_2}{R_1+R_2} = \frac{6V}{2\Omega+4\Omega} = \frac{6V}{6\Omega} = 1A\downarrow$$

Determining the effect of the 3A current source,

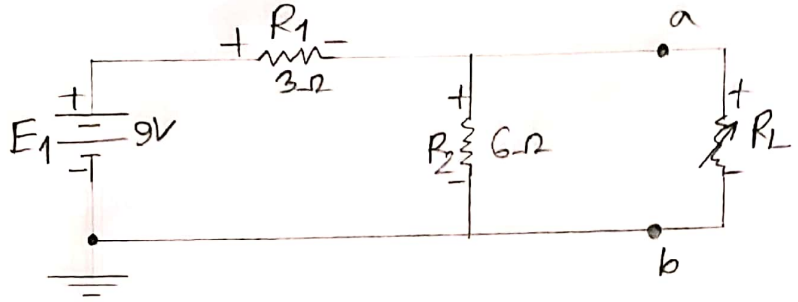


$$I_1''' = \frac{R_2 I}{R_1 + R_2} = \frac{(4.3)}{2+4} A = 2A \downarrow$$

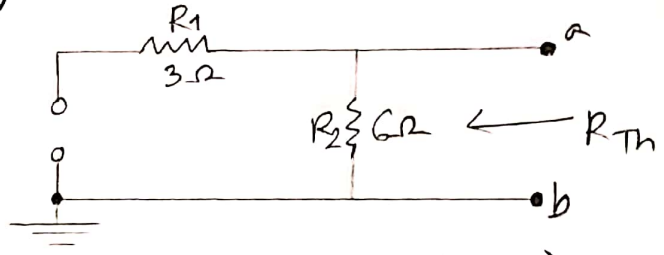
$$\therefore I_1 = -I_1' + I_1'' + I_1''' = -2A + 1A + 2A = 1A \downarrow$$

(Ans).

(9.6)



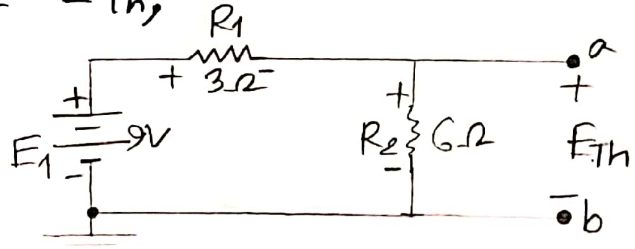
Determining R_{Th},



$$R_{Th} = R_1 || R_2 = \frac{R_1 R_2}{R_1 + R_2} = \frac{(3.6)}{3+6} \Omega = 2\Omega$$

$$\therefore R_L = R_{Th} = 2\Omega$$

Determining E_{Th},



$$E_{th} = \frac{R_2 E}{R_2 + R_1} = \frac{(6.9)}{6+3} V = 6V$$

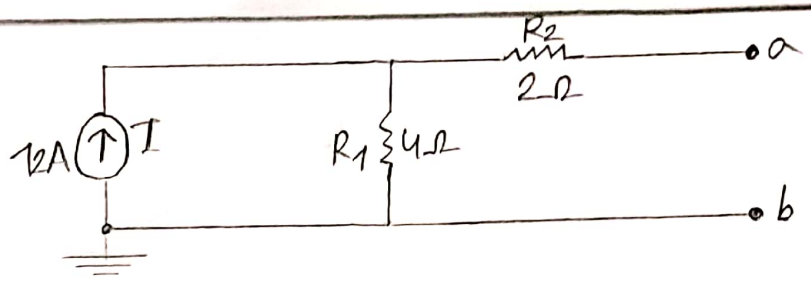
We know, $I_L = \frac{E_{Th}}{R_{Th} + R_L}$

$\therefore R_L = 2\Omega$; $I_L = \frac{6V}{2\Omega + 2\Omega} = 1.5A$

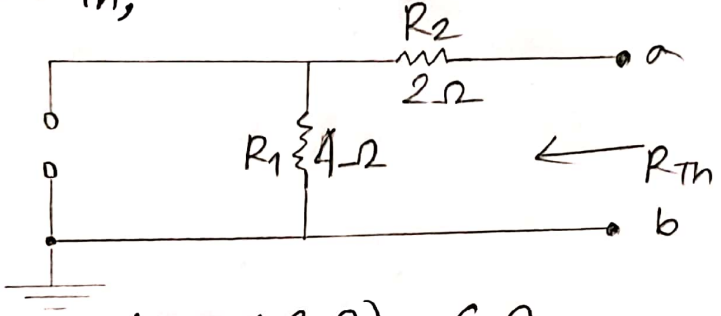
$\therefore R_L = 10\Omega$; $I_L = \frac{6V}{2\Omega + 10\Omega} = 0.5A$

$\therefore R_L = 100\Omega$; $I_L = \frac{6V}{2\Omega + 100\Omega} = 0.06A$ (Ans)

9.7

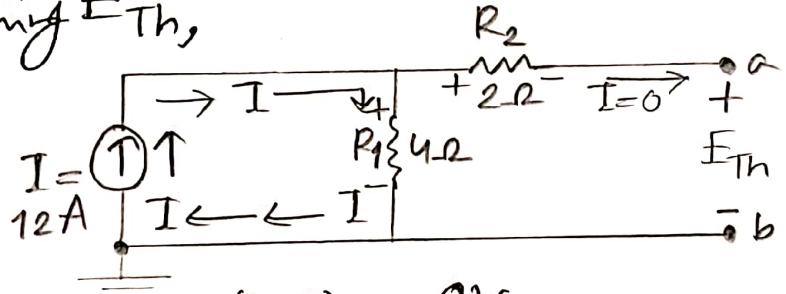


Determining R_{Th},



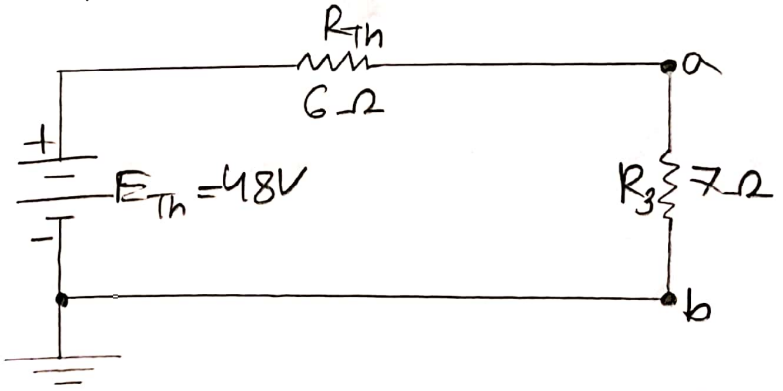
$R_{Th} = R_1 + R_2 = (4\Omega + 2\Omega) = 6\Omega$

Determining E_{Th},



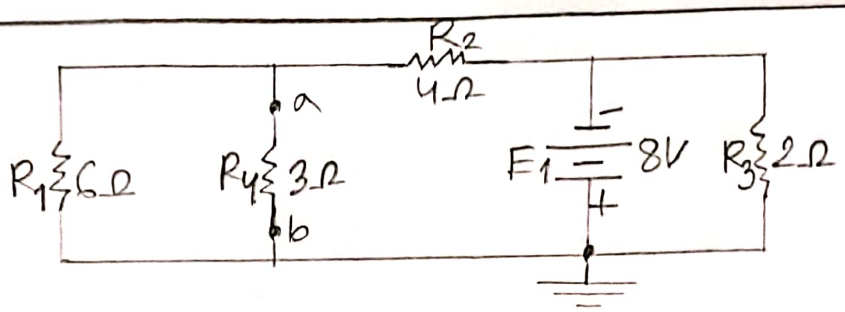
Here, $V_2 = I_2 R_2 = (0.2)V = 0V$

$\therefore E_{Th} = V_1 = I_1 R_1 = (12.4)V = 48V$

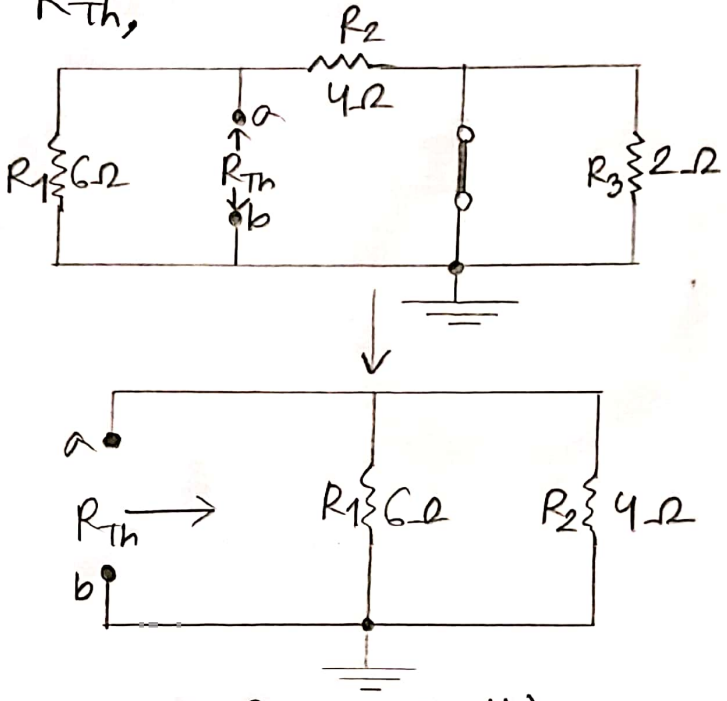


(Ans)

9.8

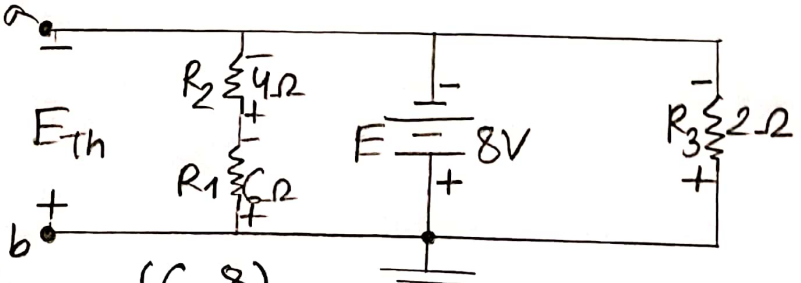


Determining R_{Th},

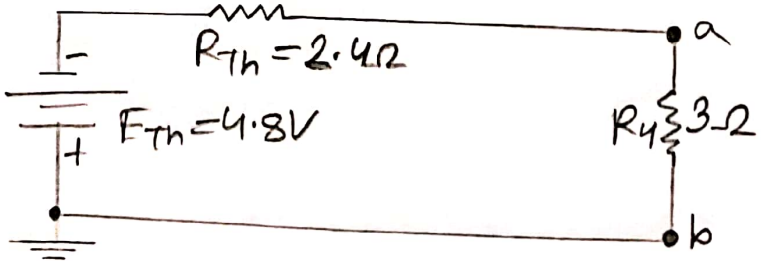


$$R_{Th} = R_1 \| R_2 = \frac{R_1 R_2}{R_1 + R_2} = \frac{(6.4)}{6+4}\,\Omega = 2.4\,\Omega$$

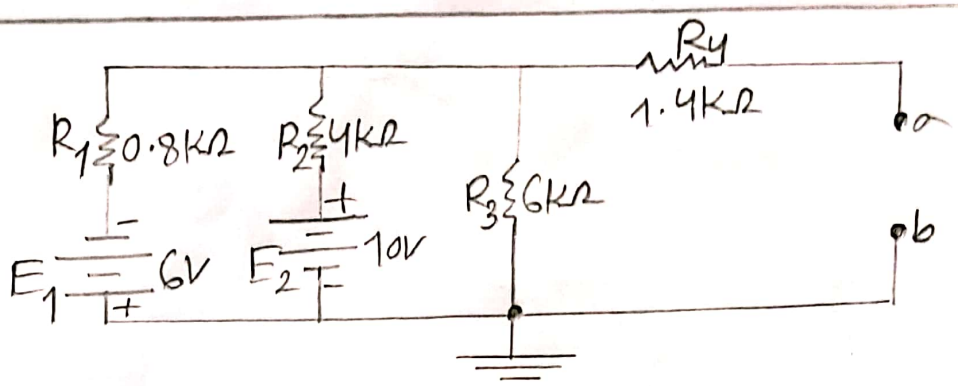
Determining E_{Th},



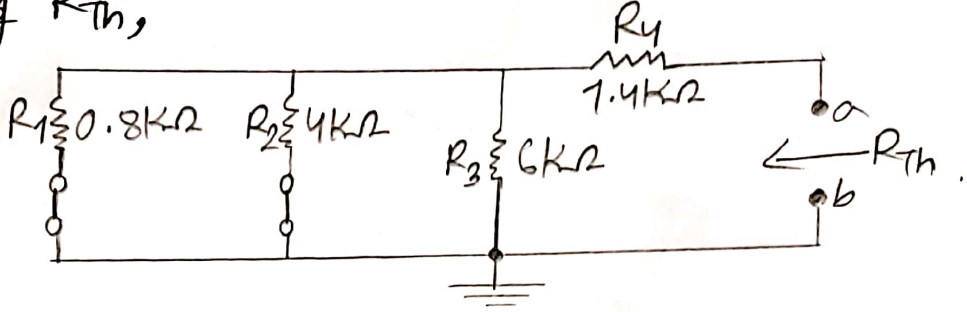
$$E_{Th} = \frac{R_1 E_1}{R_1 + R_2} = \frac{(6.8)}{6+4}\,V = 4.8V$$



9.10



Determining R_{Th},



$$R_{Th} = R_4 + R_1 \| R_2 \| R_3$$

$$= R_4 + R_1 \| \frac{R_2 R_3}{R_2 + R_3}$$

$$= R_4 + R_1 \| \frac{(4.6)}{4+6.}$$

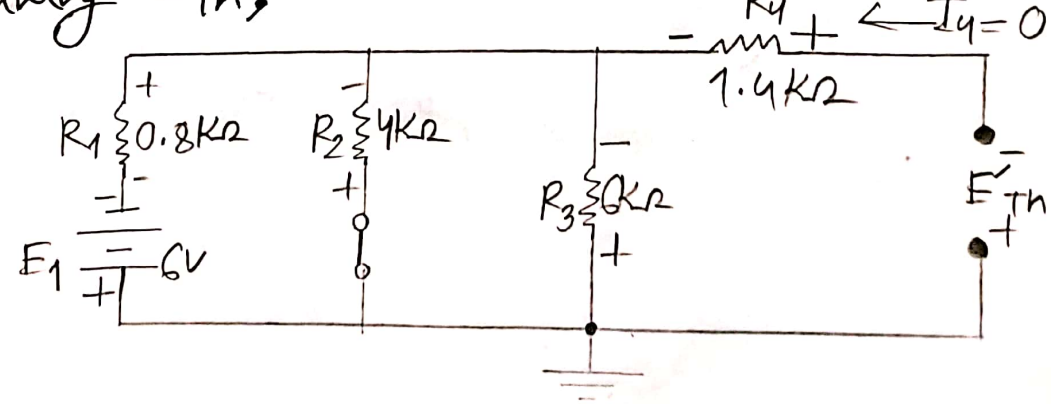
$$= R_4 + R_1 \| 2.4$$

$$= R_4 + \frac{(0.8.2.4)}{0.8+2.4}$$

$$= 1.4 + 0.6$$

$$= 2K\Omega$$

Determining E'_{Th},

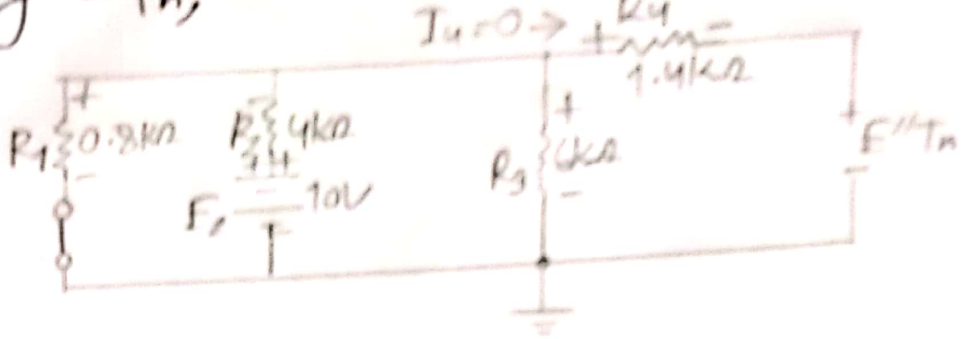


$$E'_{Th} = V_3$$

$$R_T' = R_2 \| R_3 = \frac{R_2 R_3}{R_2 + R_3} = \frac{(4 \cdot 6)}{4+6}\ \Omega = 2.4\text{k}\Omega$$

$$V_3 = \frac{R_T' E_1}{R_T' + R_1} \quad \frac{(24.6)}{2.4 + 0.8}\ V = 4.5V = E_{Th}'$$

Determining E_{Th}'',



$$E_{Th}'' = V_3$$

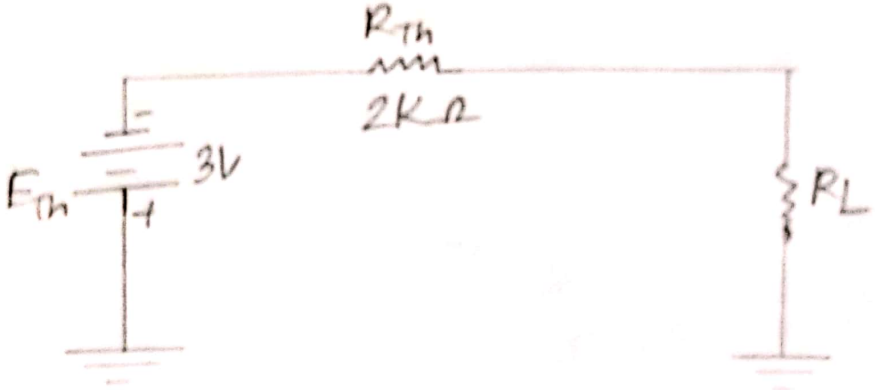
$$R_T' = R_1 \| R_3 = \frac{R_1 R_3}{R_1 + R_3} = \frac{(0.8 \cdot 6)}{0.8+6}\ \Omega = 0.706\text{K}\Omega$$

$$V_3 = \frac{R_T' \cdot E_2}{R_T' + R_2} = \frac{(0.706 \cdot 10)}{0.706 + 4} V = 1.5V = E_{Th}''$$

Since E_{Th}' and E_{Th}'' have opposite polarities,

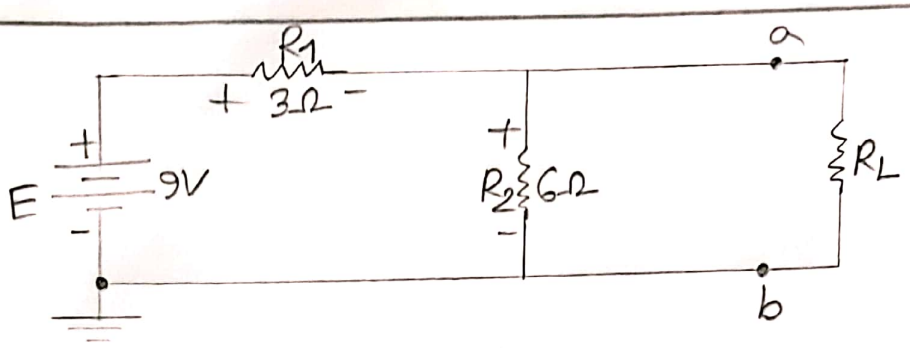
$$E_{Th} = E_{Th}' - E_{Th}'' = (4.5V - 1.5V) = 3V$$

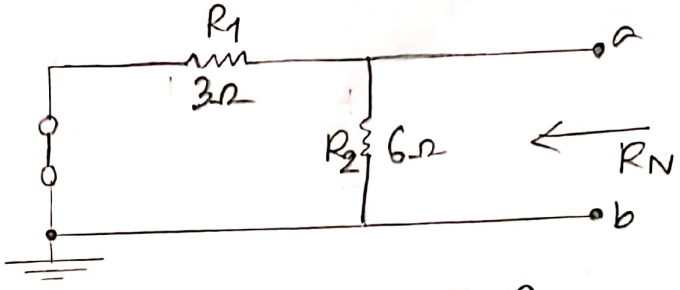
(polarity of E_{Th}')



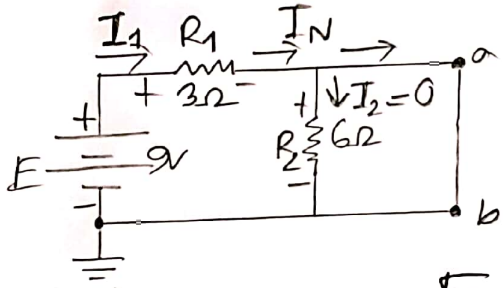
(Ans).

9.11



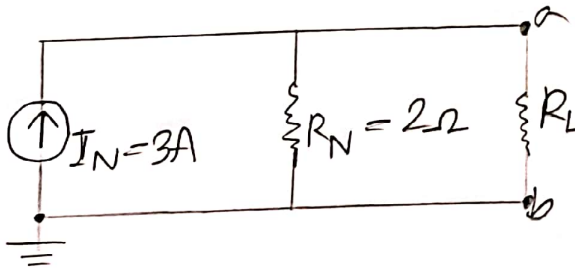


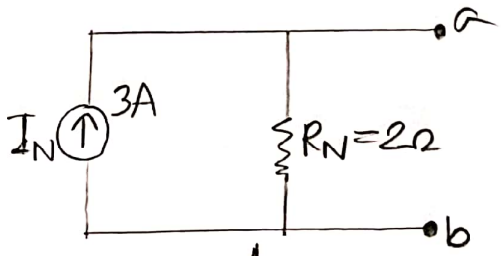
$$R_N = R_1 \| R_2 = \frac{R_1 R_2}{R_1 + R_2} = \frac{3.6}{3+6} = 2\,\Omega$$



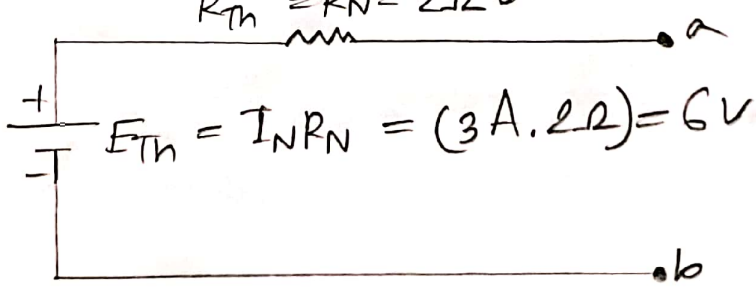
$$V_2 = I_2 R_2 = (0.6)\,V = 0V$$

Therefore, $I_N = \frac{E}{R_1} = \frac{9V}{3\Omega} = 3A.\uparrow$



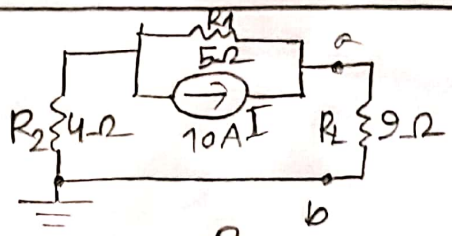


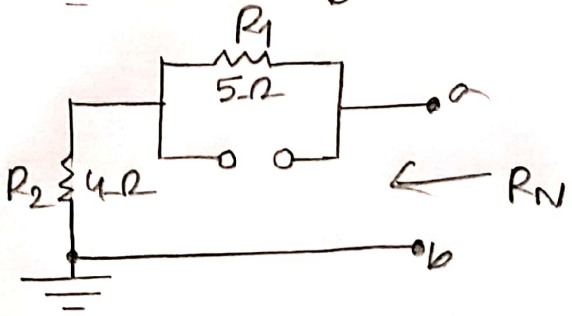
$R_{Th} = R_N = 2\,\Omega$



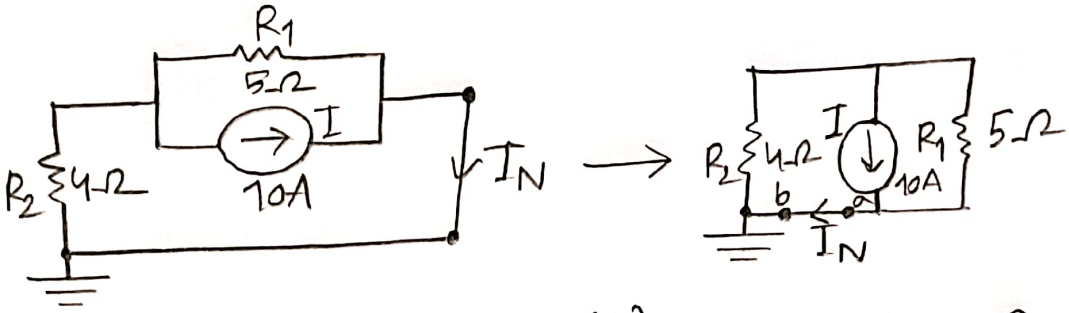
(Ans)

9.12

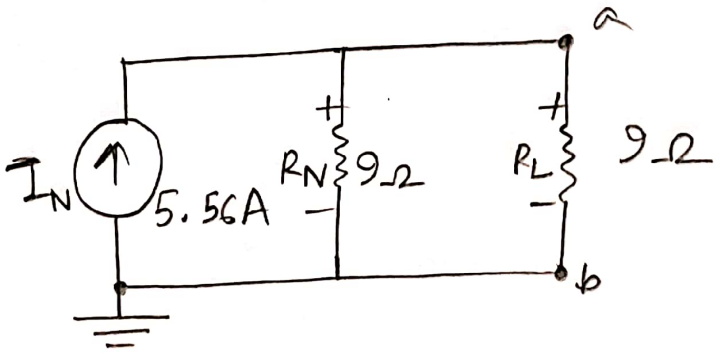




$$R_N = R_1 + R_2 = (5+4)\Omega = 9\Omega$$

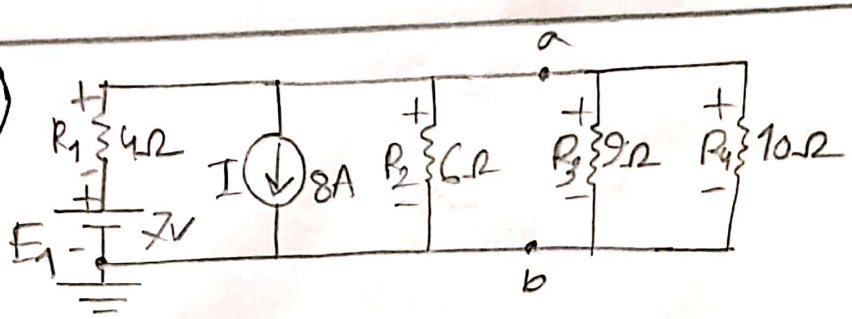


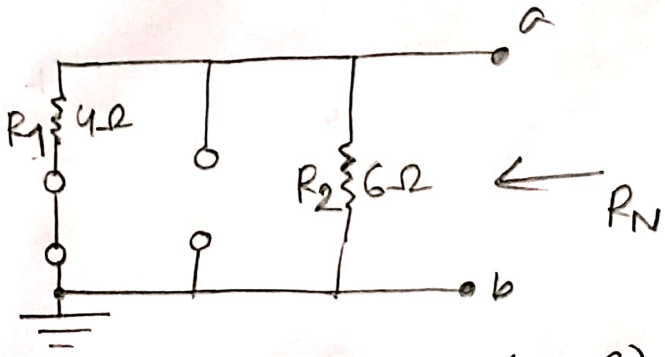
$$I_N = \frac{R_1 I}{R_1 + R_2} = \frac{(5.10)}{5+4} = 5.56A \uparrow$$



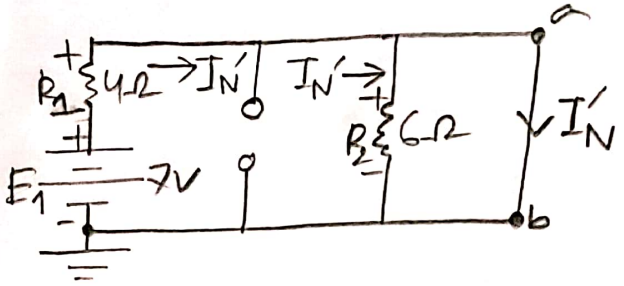
(Ans).

9.13

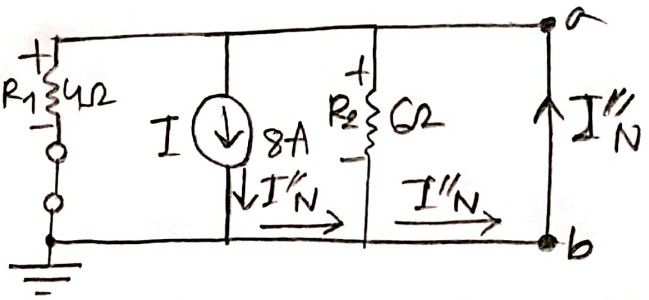




$$R_N = R_1 \| R_2 = \frac{R_1 R_2}{R_1 + R_2} = \frac{(4.6)}{4+6} = 2.4\,\Omega$$

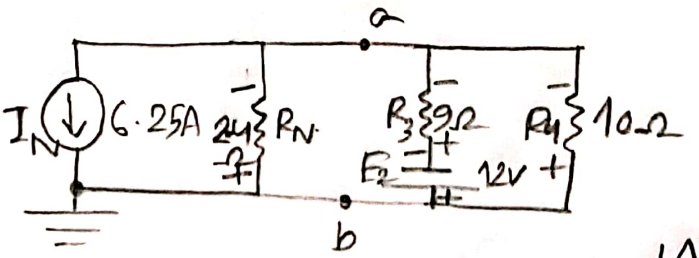


$$I_N' = \frac{E_1}{R_1} = \frac{7V}{4\,\Omega} = 1.75A \downarrow$$



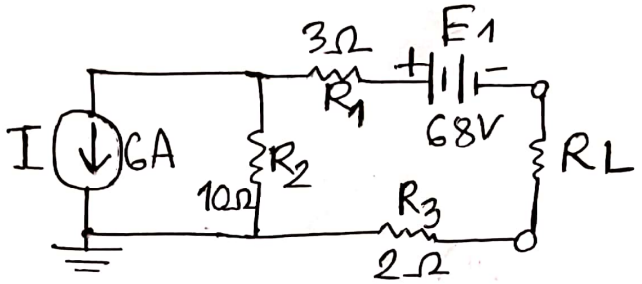
$$I_N'' = I = 8A \uparrow$$

$$\therefore I_N = I_N'' - I_N' = 8A - 1.75A = 6.25A \uparrow$$

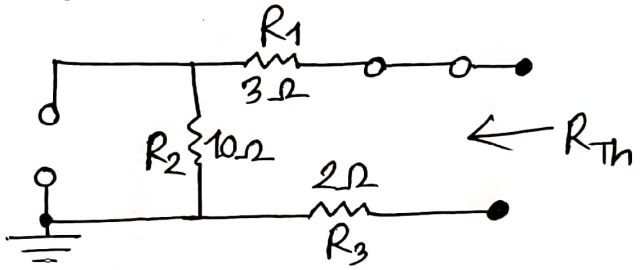


(Ans)

9.17



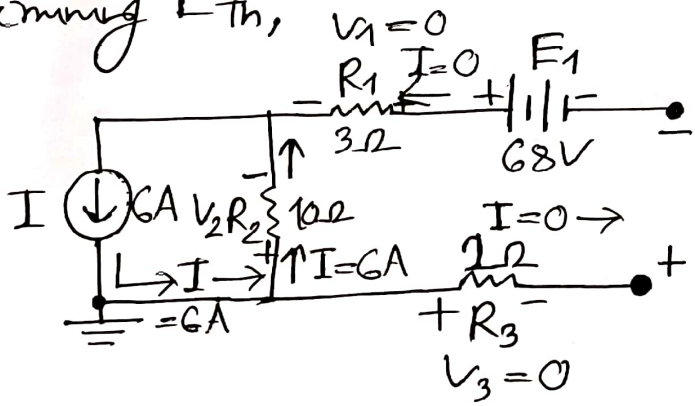
Determining R_{Th},



$R_{Th} = R_1 + R_2 + R_3 = (3 + 10 + 2)\Omega = 15\Omega$ (Ans).

$\therefore R_L = R_{Th} = 15\Omega$

Determining E_{Th},



Here, $V_1 = V_3 = 0$ and $V_2 = I_2 R_2 = IR_2 = (6.10)V$
$= 60V$

So,

$-V_2 - E + E_{th} = 0$

$\Rightarrow E_{th} = 60V + 68V = 128V$ (Ans).

$\therefore E_{th} = 128V$

$\therefore P_{L\,max} = \frac{E_{th}^2}{4R_{Th}} = \frac{(128)^2}{4.15} W = 273.07W$ (Ans)