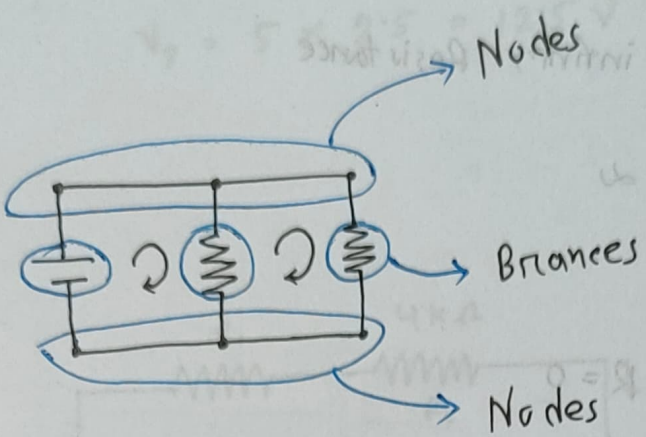
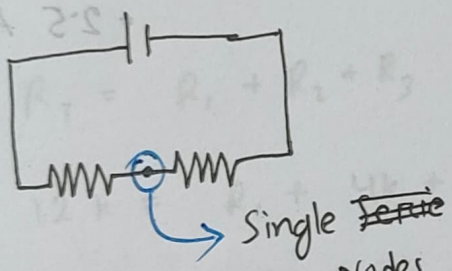
L-1 /26.01.2023/

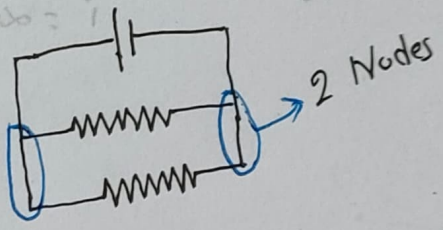


3 Brances

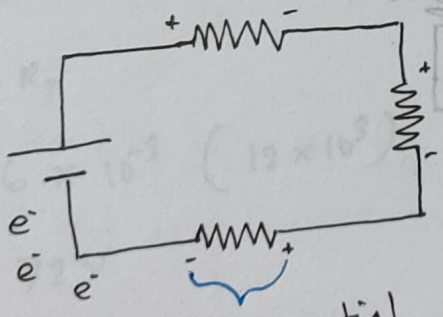
2 Nodes



seriese line



Parcallel

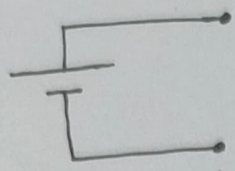


Protential Difference

$$i = \frac{q}{t}$$

$$i \propto \frac{1}{R} \Rightarrow i = \frac{V}{R}$$

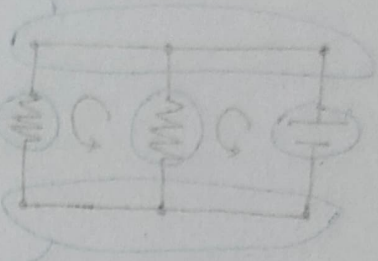
$$\Rightarrow V = iR$$

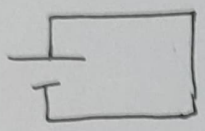


Open Circuit

infinity Resistance

$R = \infty$



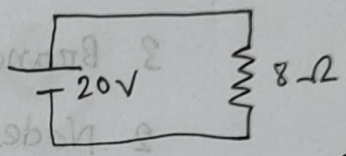


$R = 0$

$V = iR \qquad i = \frac{V}{R}$

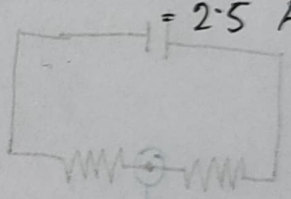
$V = i \cdot 0 \qquad i = \frac{V}{0}$

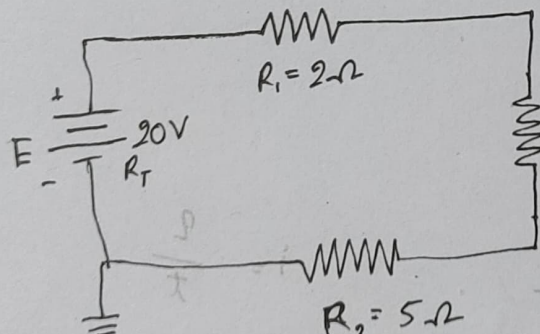
$= 0 \qquad i = \infty$



$I = \frac{V}{R} = \frac{20}{8}$

$= 2.5\ A$





$R_1 = 2\Omega \ ; \quad I = 2.5\ A$

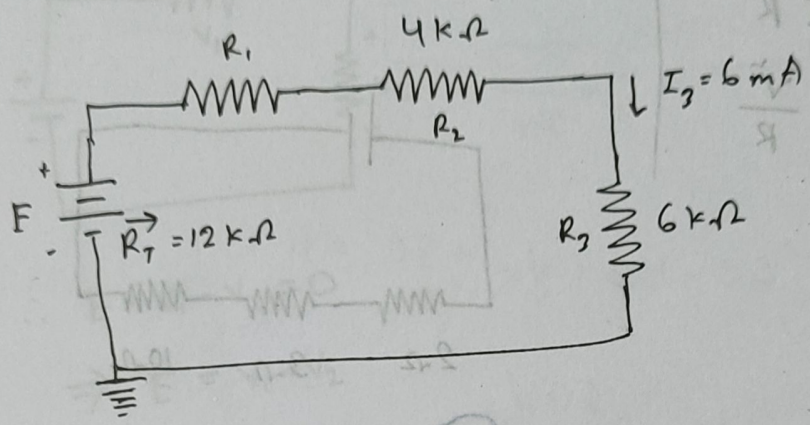
$V_1 = 2 \times 2.5 = 5\ V$

$R_2 = 1\Omega \ ; \quad I = 2.5\ A$

$V_2 = 1 \times 2.5 = 2.5\ V$

$R_3 = 5\,\Omega$; $I = 2.5\,A$

$V_3 = 5 \times 2.5 = 12.5\,V$



$R_T = R_1 + R_2 + R_3$

$12k = R_1 + 4k + 6k$

$R_1 = 2k\,\Omega$

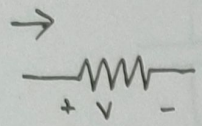
$V = IR$

$E = I R_T$

$= 6 \times 10^{-3} \left(12 \times 10^3\right)$

$= 72\,V$

L-2 / 02.02.2023



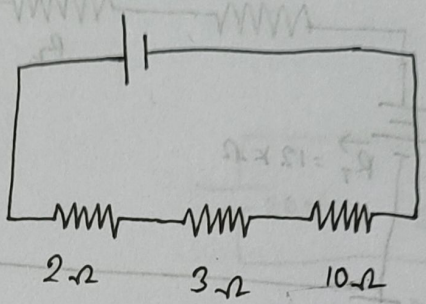
$P = VI$

$P = (IR)I = I^2R$

$P = V\left(\frac{V}{R}\right) = \frac{V^2}{R}$

$V = IR$

$I = \frac{V}{R}$



$V = IR$ → Same

$\therefore V \propto R$

Example : 5.7

a) $R_T = 1k + 2k + 3k$

$= 6k\Omega$

b) $36 = I_s(6k)$

$\therefore I_s = \frac{36}{6k} = 6mA$

c) $V_1 = 1k \times 6mA = 6V$

$V_2 = 3k \times 6mA = 18V$

$V_3 = 2k \times 6mA = 12V$

d) $P = 36 \times 6mA$

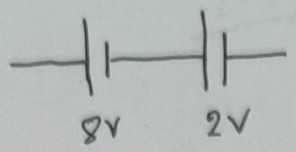
$= 216\ mW$

e) $P_1 = 6 \times 6mA = 36mW$

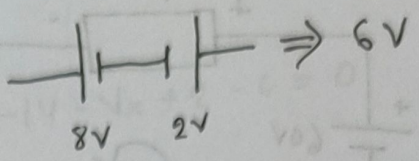
$P_2 = 18 \times 6mA = 108\ mW$

$P_3 = 12 \times 6mA = 72\ mW$

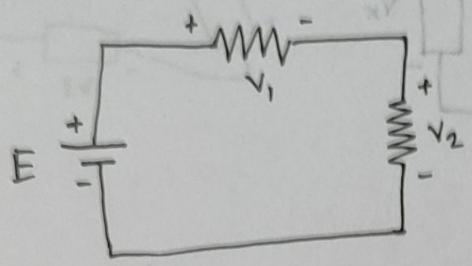
f) → 216 mW



$\Rightarrow 10V$



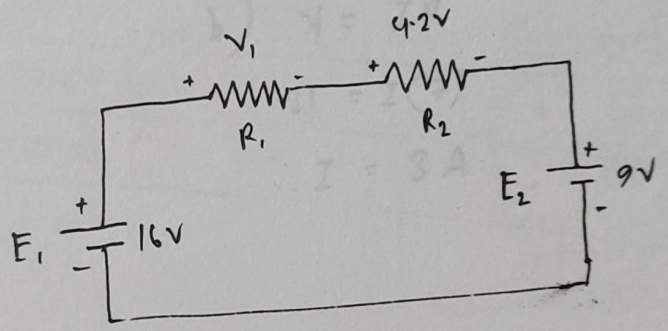
$\Rightarrow 6V$



$\therefore E - V_1 - V_2 = 0$

$\Rightarrow E = V_1 + V_2$

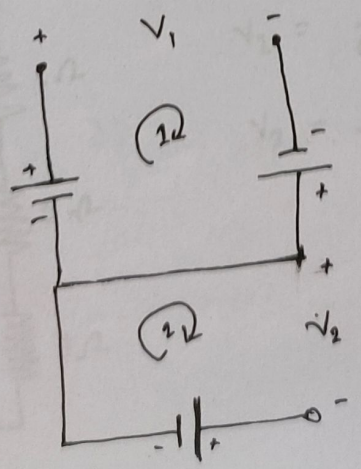
Example : 5·8



$\therefore 16 - V_1 - 4.2 - 9 = 0$

$\therefore V_1 = 2.8V$

Example : 5·10

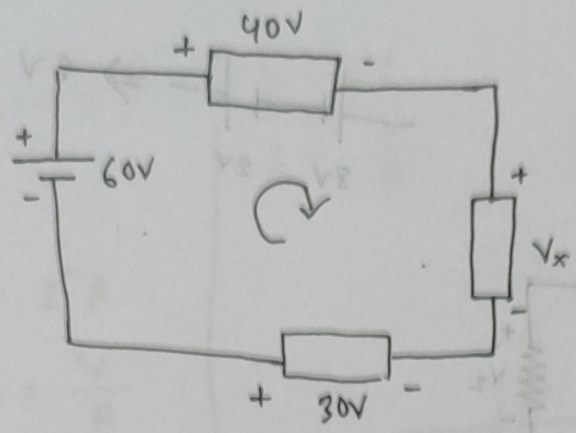


1 : $25 - V_1 + 15 = 0$

$\therefore V_1 = 40V$

2 : $-V_2 - 20 = 0$

$V_2 = -20V$



$$\therefore \quad 60 - 40 - V_x + 30 = 0$$

$$V_x = 50V$$

L-3 / 04.02.2023 /

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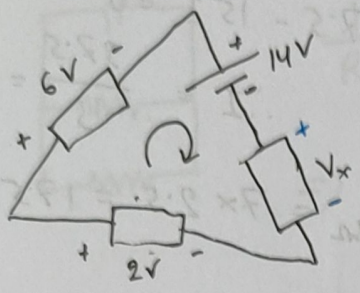
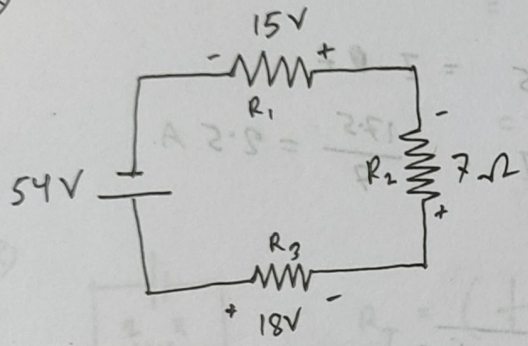


$\therefore -14 - V_x + 2 - 6 = 0$

$\therefore V_x = -18V$

∴ So, the polarity of V_x will be change



a) $-54 + 15 + V_2 + 18 = 0$

$\therefore V_2 = 21$

b) $V = IR$

$21 = I(7)$

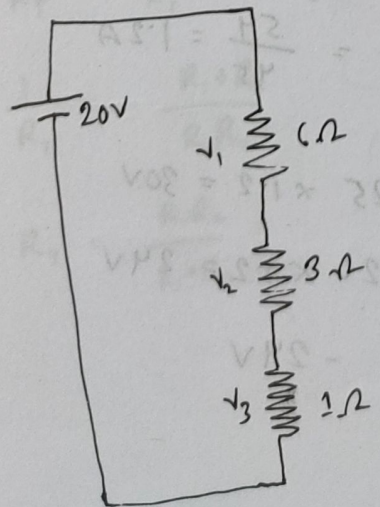
$\therefore I = 3A$

c) $15 = I_2 R_1$

$\therefore R_1 = \frac{15}{3} = 5\Omega$

$18 = I_2 R_3$

$\therefore R_3 = \frac{18}{3} = 6\Omega$

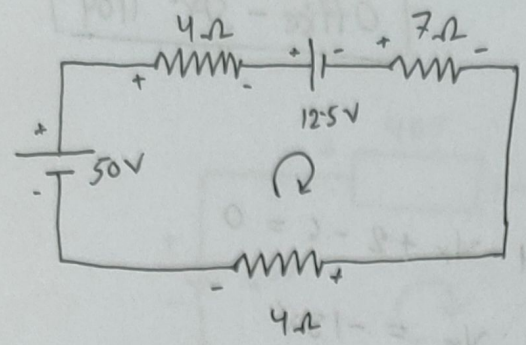


$V_1 = \frac{6}{6+3+1} \times 20 = 12V$

$V_2 = \frac{3}{6+3+1} \times 20 = 6V$

$V_3 = \frac{1}{6+3+1} \times 20 = 2V$

(*)



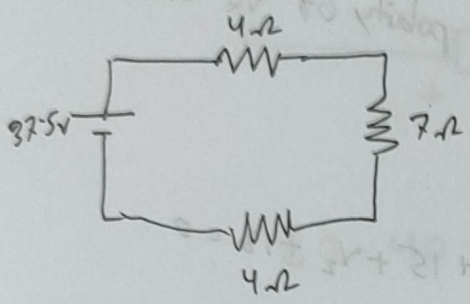
$\therefore 50 - 4I - 12.5 - 7I - 4I = 0$

$\therefore 37.5 - 15I = 0$

$\therefore I = \frac{37.5}{15} = 2.5\ A$

$\therefore V_{7\Omega} = 7 \times 2.5 = 17.5\ V$

(*)



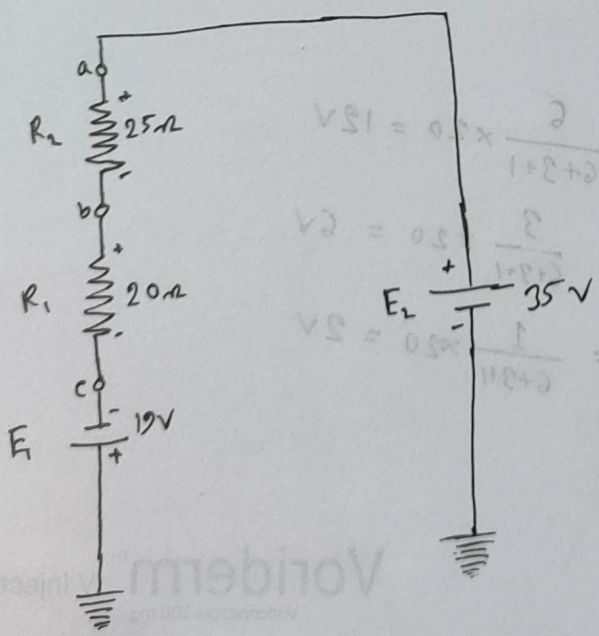
$V_{7\Omega} = \frac{7}{4+7+4} \times 37.5 = 17.5\ V$

$\therefore 17.5 = I \cdot 7$

$\therefore I = \frac{17.5}{7} = 2.5\ A$

	Enters through	Exist From	
Current	+	−	negative
Current	−	+	positive

(*)



$\therefore 35 = 25I + 20I - 19$

$\Rightarrow 54 = 45I$

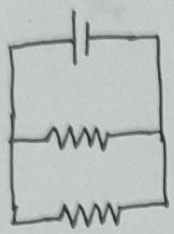
$\therefore I = \frac{54}{45} = 1.2A$

$\therefore V_{ab} = 25 \times 1.2 = 30V$

$V_{bc} = 20 \times 1.2 = 24V$

$V_{cb} = -24V$

Lecture-4 / 09.02.2023



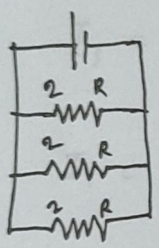
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\Rightarrow R_T = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1}$$

$$R_T = \left(\frac{1}{1} + \frac{1}{4} + \frac{1}{5}\right)^{-1}$$

$$= \left(\frac{20+5+4}{20}\right)^{-1}$$

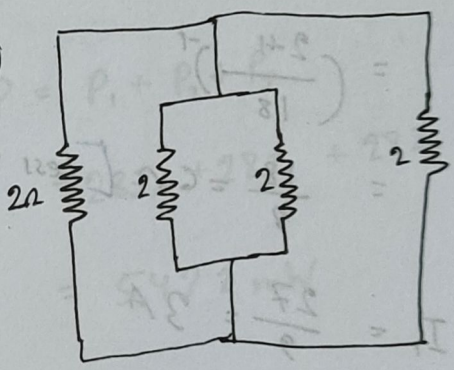
$$= \left(\frac{29}{20}\right)^{-1}$$



$$R_T = \left(\frac{1}{2} + \frac{1}{2}\right)^{-1}$$

$$= 1\ \Omega$$

$$\frac{1}{R_T} = \frac{R}{N}$$

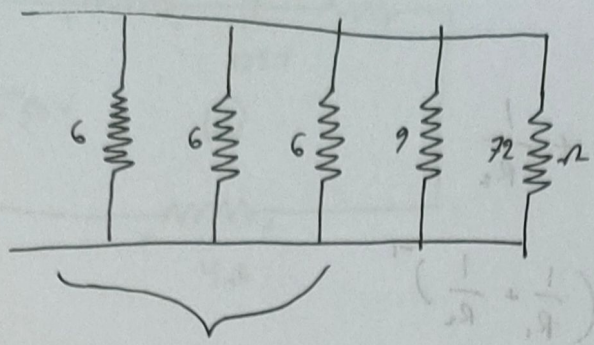


$$R_T = \frac{2}{4} = \frac{1}{2}\ \Omega$$

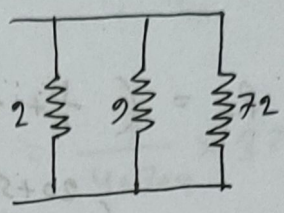
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_T} = \frac{R_1 + R_2}{R_1 R_2}$$

$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$



$\frac{6}{3} = 2\,\Omega$



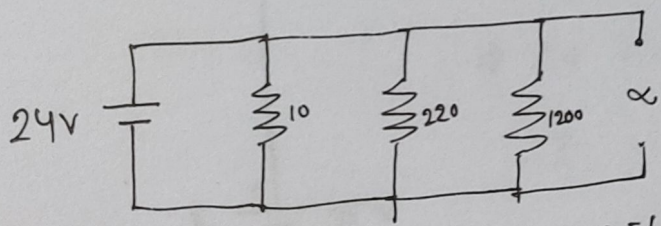
$$R_T = \left(\frac{1}{9} + \frac{1}{18}\right)^{-1} \qquad I_s = \frac{E}{R_T} = \frac{27}{6} = 4.5\,A$$

$$= \left(\frac{2+1}{18}\right)^{-1}$$

$$= \frac{18}{3} = 6\,\Omega \quad [\text{Less than minimum Resistance}]$$

$$\therefore I_1 = \frac{27}{9} = 3\,A$$

$$I_2 = \frac{27}{18} = 1.5\,A$$



$$R_T = \left(\frac{1}{10} + \frac{1}{220} + \frac{1}{1200} + \frac{1}{\infty}\right)^{-1}$$

↳ 0 can be ignore

$$= 9.49\,\Omega$$

$E = I_s R_T$

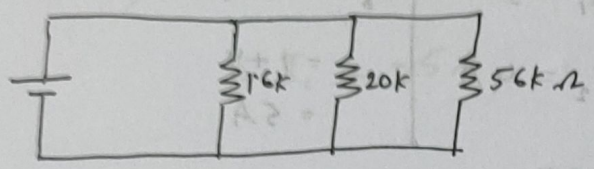
$\Rightarrow I_s = \frac{E}{R_T}$

$I_1 = \frac{24}{10} = 2.4\,A$

$I_2 = \frac{24}{220} = 0.12\,A$

$I_3 = \frac{24}{1.2k} = 20\,mA$

(*)



a) $R_T = \left(\frac{1}{1.6} + \frac{1}{20} + \frac{1}{56}\right)^{-1} = 1.4\,k\Omega$

b) $I_s = \frac{28}{1.4k} = 20\,mA$

$I_1 = \frac{28}{1.6k} = 17.5\,mA$

$I_2 = \frac{28}{20k} = 1.4\,mA$

$I_3 = \frac{28}{56k} = 0.5\,mA$

$\therefore P = P_1 + P_2 + P_3$

$= 28I_1 + 28I_2 + 28I_3$

$= 543.2\,mW$

L-5/11.02.2023

⊛ kirchhoff's current Law:

6.17

$I_1 + I_2 - I = 0$

$I_1 = 5 - 4$

$= 1\,A$

$I_3 = I_1 = 1\,A$

$I_4 = I_2 = 4\,A$

$I_5 = I_3 + I_4$

$= 1 + 4$

$= 5\,A$

6.18

From node a,

$I_1 + I_2 = I_3$

$\therefore I_3 = 4 + 3$

$= 7\,A$

From node b,

$I_3 = I_4 + I_5$

$I_5 = I_3 - I_4$

$= 7 - 1 = 6\,A$

6.19

a) $I_s = 8 + 10 + 2 = 20\,mA$

b) $E = V_1 = (2)(8) = 16\,V$

c) $V_3 = R_3 I_s$

$16 = R_3 (2)$

$\therefore R_3 = 8\,k\Omega$

d) $E = I_s R_T$

$R_T = \frac{16}{20} = 0.8\,k\Omega$

6·20/

Let's assume that I_1 is entering.

$$\therefore I_1 + 10 + 4 + 8 = 5 + 4 + 2 + 6$$

$$\Rightarrow I_1 + 22 = 17$$

$$\therefore I_1 = -5A$$

$\therefore I_1$ is existing with 5A current.

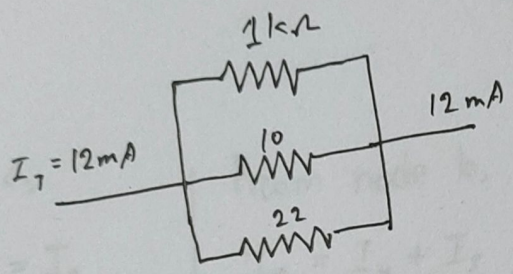
L-6 / 16.02.2023 /

⊛ Current deride Rule!

$$I \propto \frac{1}{R}$$

$$\Rightarrow I_x = I_T \frac{R_T}{R_x}$$

6.22/

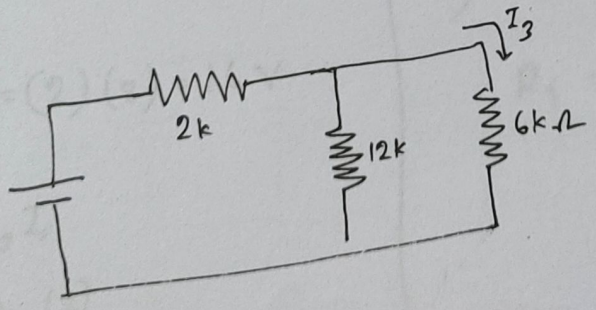


$$R_T = \left(\frac{1}{1} + \frac{1}{10} + \frac{1}{22}\right)^{-1}$$

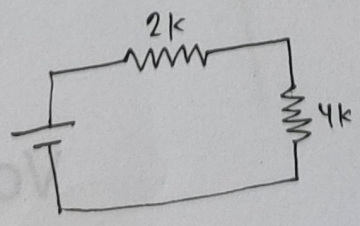
$$= 873\ \Omega$$

$$I_1 = \frac{I_T R_T}{R_1} = \frac{12\times10^{-3}\times873}{1000} = 10.48\ mA$$

⊛



$$\left(\frac{1}{6} + \frac{1}{12}\right)^{-1} = 4k$$



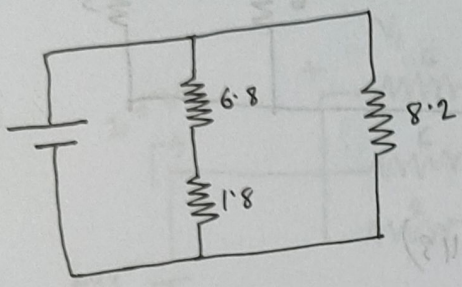
$$\therefore I_T = \frac{54}{6} = 9mA$$

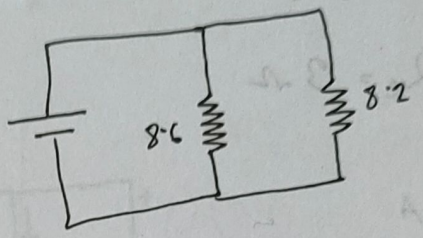
$$I_3 = \frac{I_T R_T}{R_3}$$

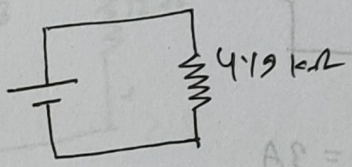
$$= \frac{9(4)}{6} = 6mA$$

7.2/

$$\left(\frac{1}{2} + \frac{1}{18}\right)^{-1} = 1.8$$







$\therefore V = IR$

$$I = \frac{V}{R} = \frac{12}{4.19} = 2.86mA$$

$$I_4 = \frac{I_T R_T}{R_4} = \frac{(2.86)(4.19)}{(8.2)} \quad [\text{From } 2^{nd} \text{ circuit}]$$

$$= 1.46\ mA$$

$$V_2 = 1.8 \times 1.4$$

$$= 2.52\ V$$

7.4/

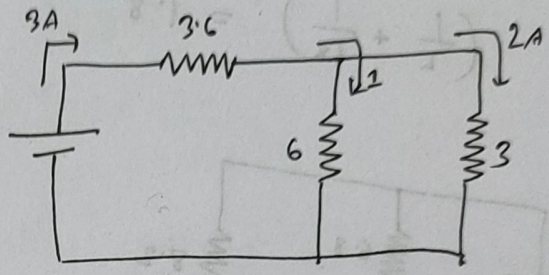
$$R_A = \left(\frac{1}{6} + \frac{1}{9}\right)^{-1} = 3.6\ \Omega$$

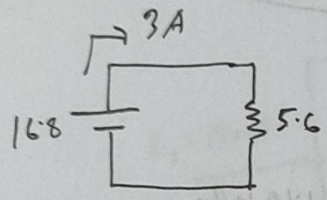
$$R_B = 4 + (6 \| 3)$$

$$= 4 + \left(\frac{1}{6} + \frac{1}{3}\right)^{-1}$$

$$= 6\ \Omega$$

$$R_C = 3\ \Omega$$





$$= 3.6 + (6 \| 3)$$

$$= 3.6 + \left(\frac{1}{6} + \frac{1}{3}\right)^{-1}$$

$$= 5.6\ \Omega$$

$$\Rightarrow I = \frac{16.8}{5.6} = 3A$$

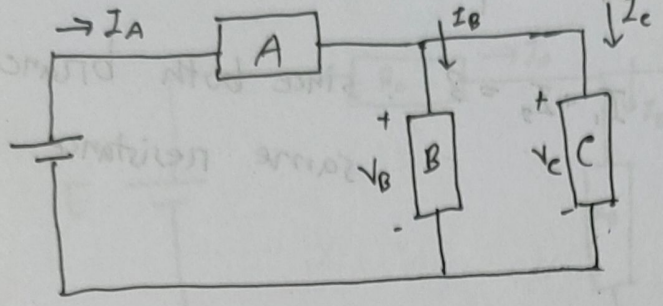
$$I_3 = \frac{I_T R_T}{R_3}$$

$$= \frac{3(2)}{(3)}$$

$$= 2A$$

Ans

L-7/18.02.2023/

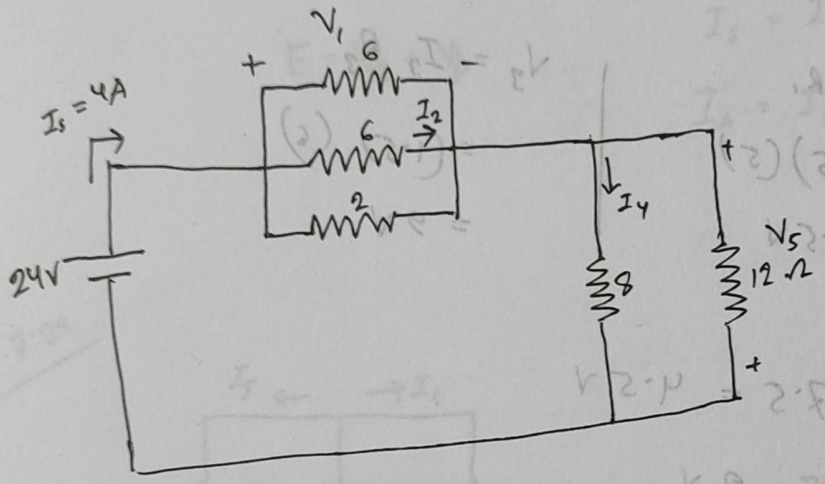


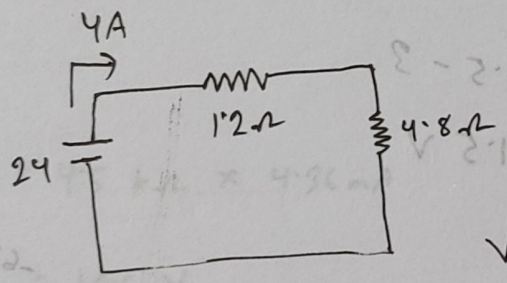
$I_s = I_A$

$I_A = I_B + I_C$

$V_B = V_C$

$E = V_A + V_B$



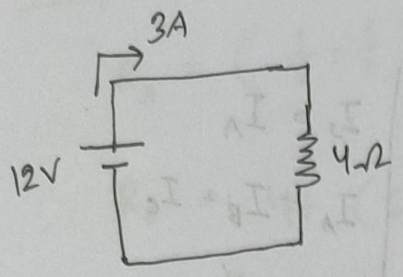


$$V_5 = \frac{4 \cdot 8}{6} \times 24 = 19 \cdot 2V$$

$$I_s = \frac{24}{6} = 4A$$

$$\therefore I_2 = \frac{I_T R_T'}{R_2} = \frac{4(1 \cdot 2)}{6} = 0 \cdot 8A$$

$$\therefore I_4 = \frac{V}{R} = \frac{19 \cdot 2}{8} = 2 \cdot 4A$$



$$I_3 = \frac{12}{4} = 3A$$

$I_1 + I_3 = 3$: since both branches have same resistance.

$$I_1 = I_3$$

$$I_1 = 1.5\,A$$

$$V_1 = I_1 R_1$$
$$= (1.5)(5)$$
$$= 7.5\,V$$

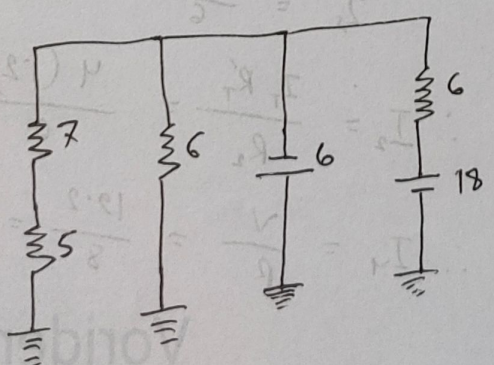
$$V_3 = I_3 R_3$$
$$= (1.5)(6)$$
$$= 9\,V$$

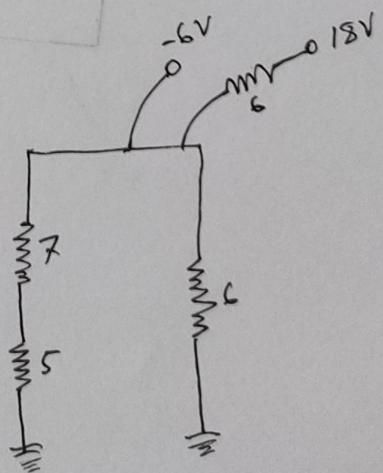
$$\therefore V_a = 12 - 7.5 = 4.5\,V$$

$$\therefore V_b = 12 - 9 = 3\,V$$

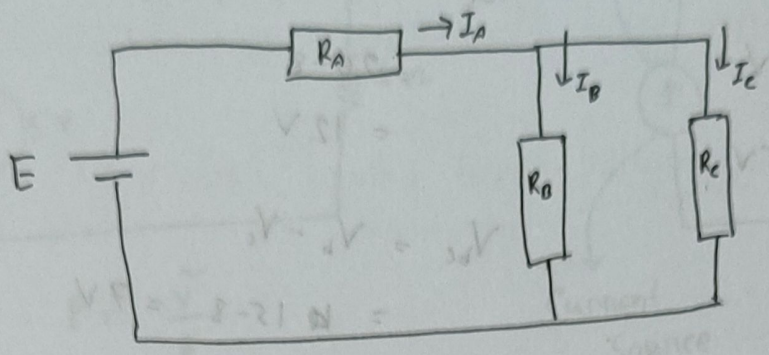
$$\therefore V_{ab} = V_a - V_b$$
$$= 4.5 - 3$$
$$= 1.5\,V$$

Figure- 7.22





L-8 / 23.02.2023 /



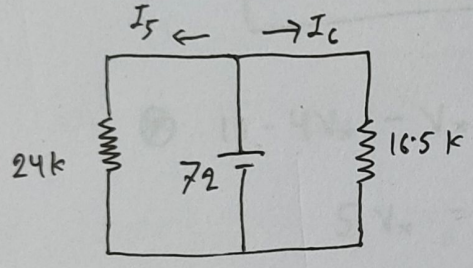
$E = V_A + V_b$

$I_s = I_A$

$I_A = I_B + I_C$

⊛

figure: 7.22



$I_5 = \frac{72}{24k} = 3mA$

$I_C = \frac{72}{16.5k} = 4.36\ mA$

$I_s = 7.36\ mA$

$V_z = 4.5\ k\Omega \times 4.36\ mA$

$= 19.6\ V$

7.27/

$V_a = 20V$

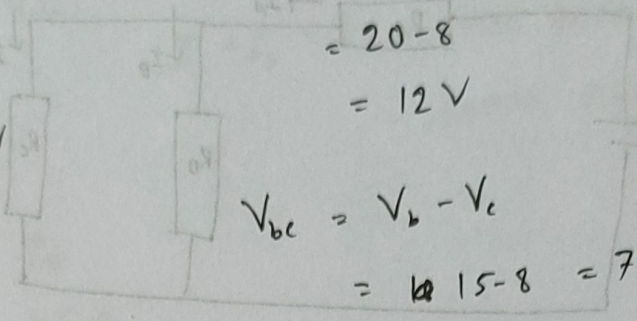
$V_c = 8V$

$V_b = 15V$

$V_{ac} = V_a - V_c$

$= 20 - 8$

$= 12V$

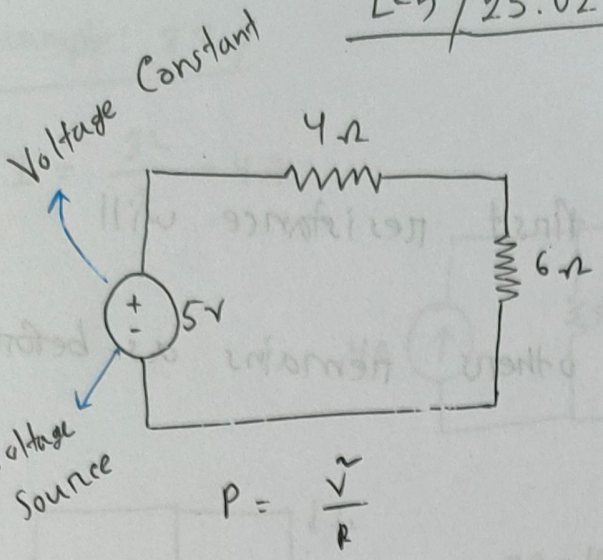


$V_{bc} = V_b - V_c$

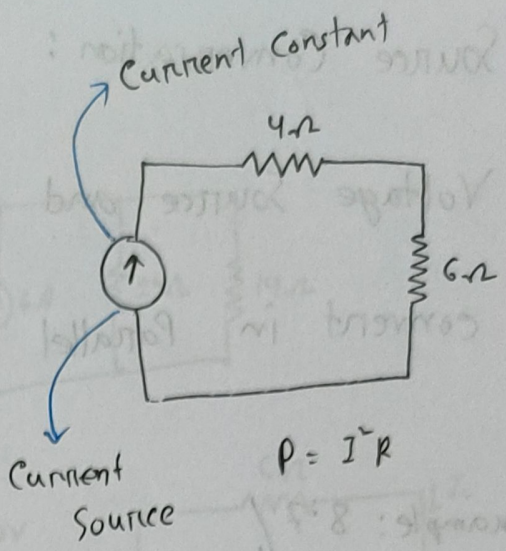
$= 15 - 8 = 7V$

$$I_2 = \frac{V_{bc}}{R_2} = \frac{7}{4} = 1.75\ A$$

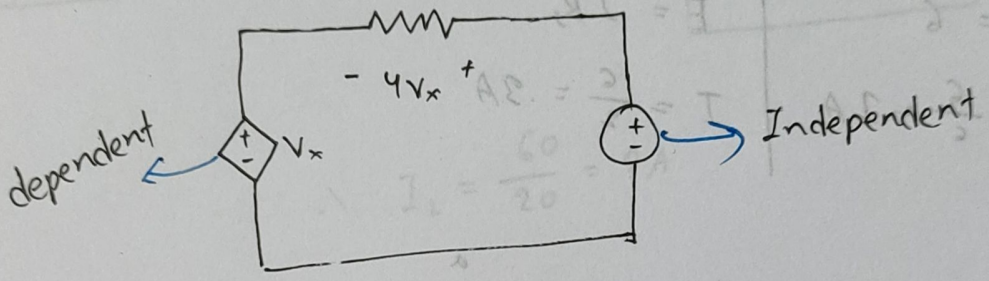
L-9 / 25.02.2023 /



$P = \frac{V^2}{R}$



$P = I^2R$

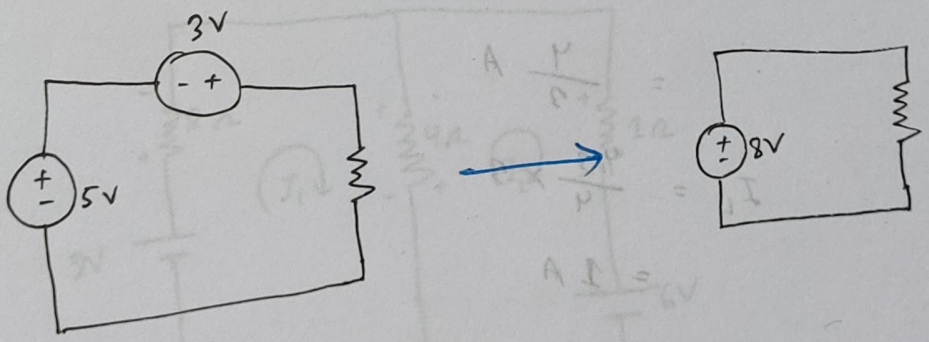


(*) $10 - 4V_x - V_x = 0$

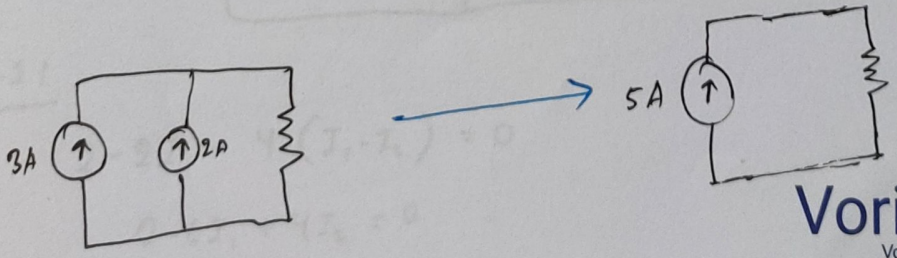
$5V_x = 10$

$V_x = 2$

(*)



(*)



Source Conversation:

Voltage Source and the first resistance will convert in Parallel and others remains as before.

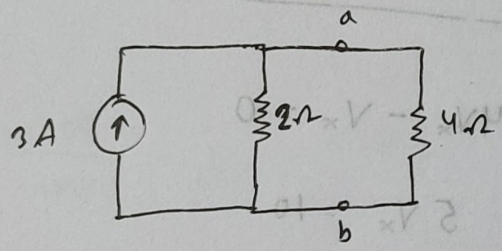
Example: 8.7

$R_T = 6$

$I_L = \frac{6}{6} = 1A$

$E = IR$,

$I = \frac{6}{2} = 3A$



$$R_T = \left(\frac{1}{2} + \frac{1}{4}\right)^{-1}$$

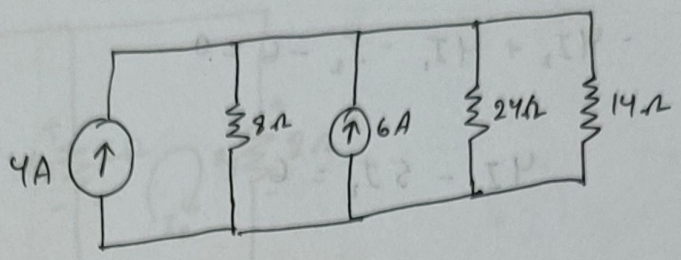
$$= \frac{4}{3} A$$

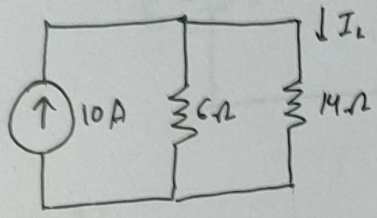
$$I_L = \frac{4/3}{4} \times 3$$

$$= 1A$$

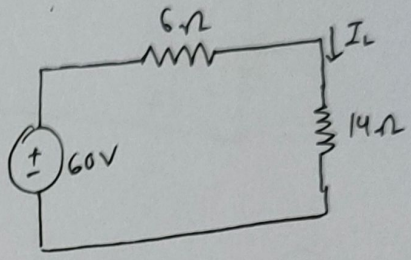
Example: 8 /

$$I = \frac{32}{8} = 4A$$



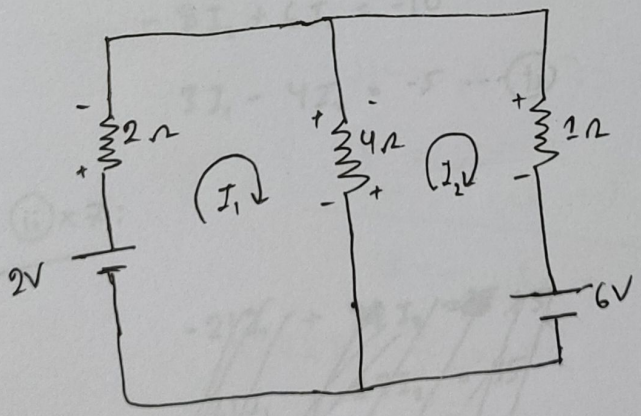


$E = IR = 10 \cdot 6 = 60V$



$$\therefore I_L = \frac{60}{20} = 3A$$

- Voltage Source cannot be in Parallel.
- Current Source cannot be in Seriese.



Loop-1!

$$2 - 2I_1 - 4(I_1 - I_2) = 0$$

$$2 - 6I_1 + 4I_2 = 0$$

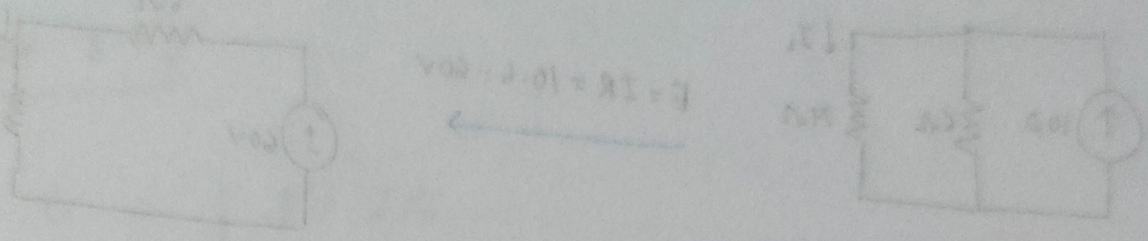
$$3I_1 - 2I_2 = 1$$

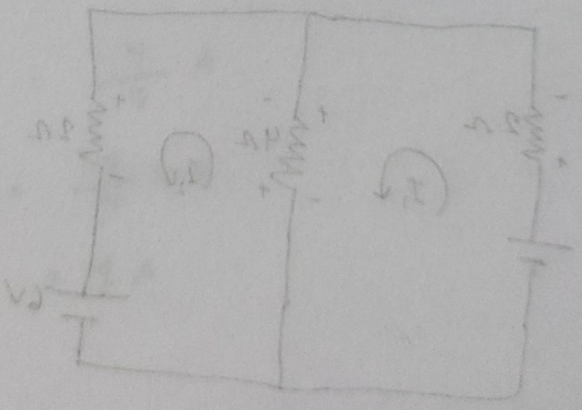
Loop-2:

$$-4(I_2 - I_1) - 1I_2 - 6V = 0$$

$$-4I_2 + 4I_1 - I_2 - 6 = 0$$

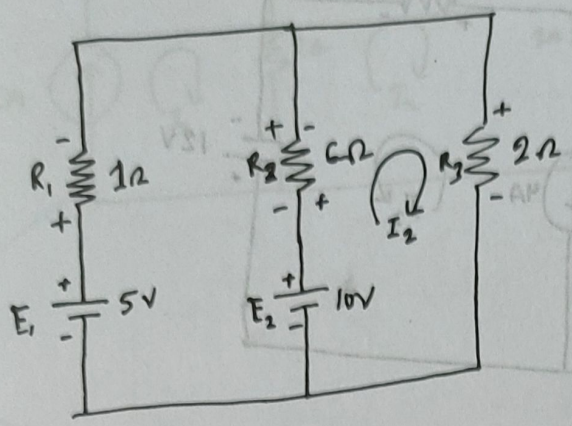
$$4I_1 - 5I_2 = 6$$





L-10 | 02.03.2023 |

8.31 |



Loop-1:

$$5 - I_1 - 6(I_1 - I_2) - 10 = 0$$

$$-5 - I_1 - 6I_1 + 6I_2 = 0$$

$$-7I_1 + 6I_2 = 5 \quad \cdots (i)$$

Loop-2:

$$10 - 6(I_2 - I_1) - 2I_2 = 0$$

$$10 - 6I_2 + 6I_1 - 2I_2 = 0$$

$$-8I_2 + 6I_1 = -10$$

$$3I_1 - 4I_2 = -5 \quad \cdots (ii)$$

(i) × 3 + (ii) × 7 :

$$-21I_1 + 18I_2 = 15$$

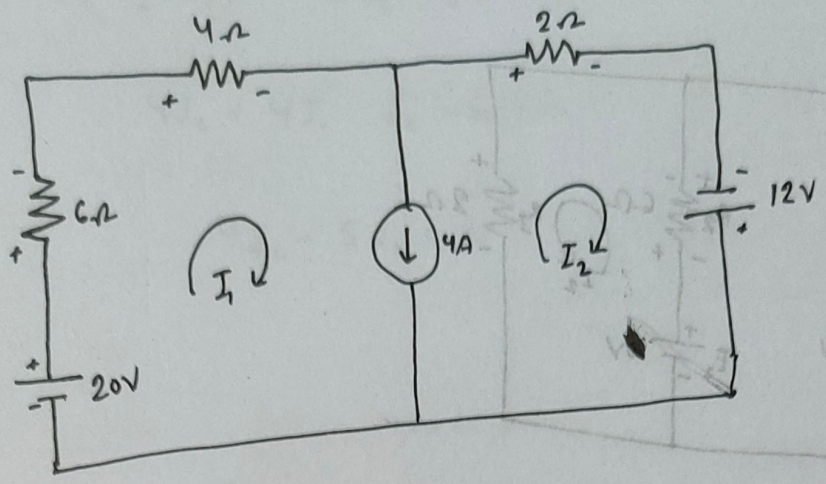
$$21I_1 - 28I_2 = -35$$

$$-10I_2 = -20$$

$$\therefore I_2 = 2\ A$$

$$\therefore I_1 = \frac{-5+8}{3} = 1\ A$$

8.33/



Without (4A):

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

$$-10I_1 - 2I_2 = -32$$

$$-5I_1 - I_2 = -16 \quad \cdots (i)$$

$$I_1 = I_2 + 4$$

$$I_1 - I_2 = 4 \quad \cdots (ii)$$

$$-5I_1 - I_2 = -16$$

$$I_1 - I_2 = 4$$

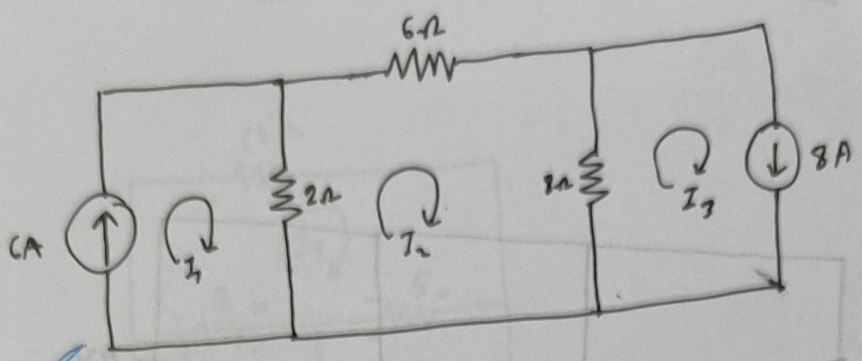
(-) (+) (+)

$$-6I_1 = -20$$

$$I_1 = \frac{20}{6} = 3.33\ A$$

$$I_2 = 3.33 - 4 = -0.67\ A$$

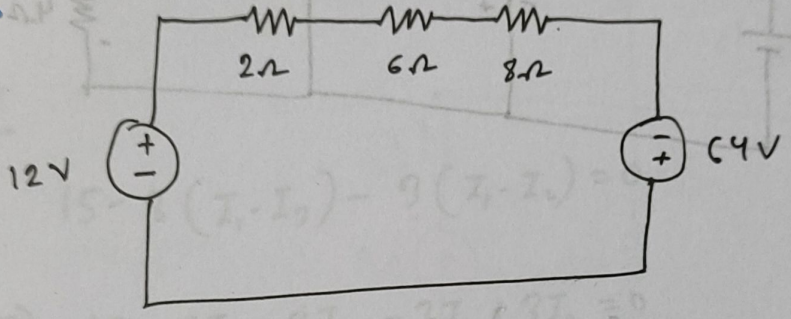
8.35/



$I_2 = 4.75A$

$I_1 = 6A$

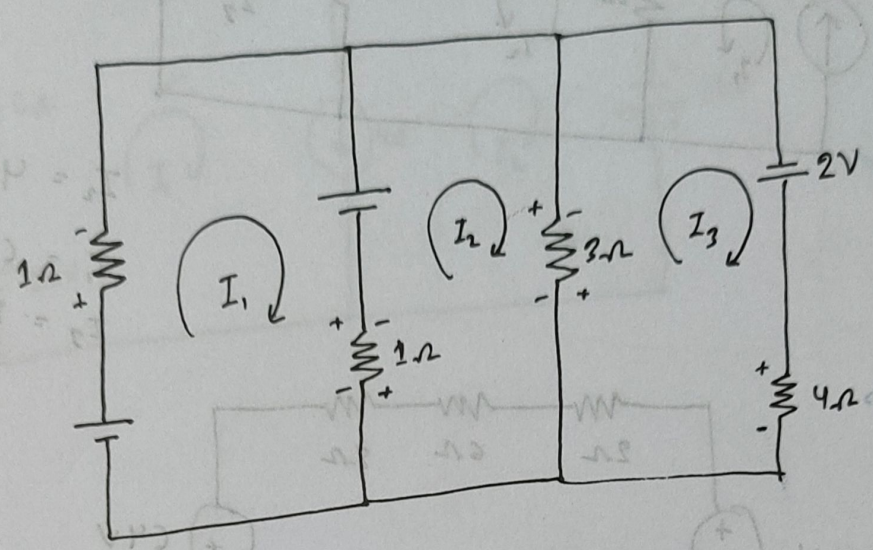
$I_3 = 8A$



$$I = \frac{76}{16} = 4.75\ A$$

L-11 / 04.03.2023 /

8.41 /



Mesh-1:

$$2 - I_1 - 4 - (I_1 - I_2) = 0$$

$$\Rightarrow \quad -2I_1 + I_2 = 2$$

Mesh-2:

$$4 - 3(I_2 - I_3) - (I_2 - I_1) - 2I_2 = 0$$

$$\Rightarrow \quad I_1 - 6I_2 + 3I_3 = -4$$

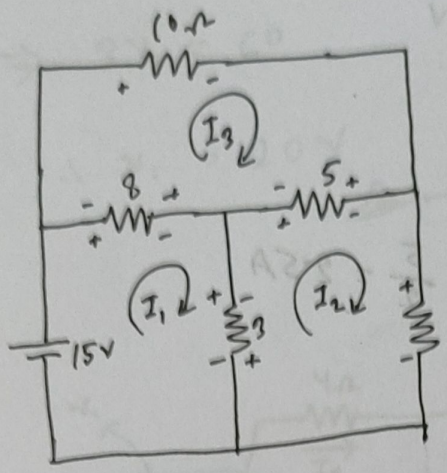
Mesh-3:

$$2 - 4I_3 - 3(I_3 - I_2) = 0$$

$$\Rightarrow \quad 3I_2 - 7I_3 = -2$$

∴ Now we cramer Rules for solving this equation.

L-12 / 09.03.2023 /



∴ Mesh-1:

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

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

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

Mesh-2:

$$-3(I_2 - I_1) - 5(I_2 - I_3) - 2I_2 = 0$$

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

$$\therefore 3I_1 - 10I_2 + 5I_3 = 0 \quad \cdots (ii)$$

Mesh-3:

$$-10I_3 - 8(I_3 - I_1) - 5(I_3 - I_2) = 0$$

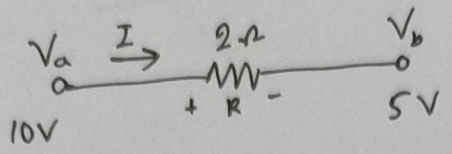
$$\Rightarrow -10I_3 - 8I_3 + 8I_1 - 5I_3 + 5I_2 = 0$$

$$\therefore 8I_1 + 5I_2 - 23I_3 = 0 \quad \cdots (iii)$$

$I_1 = 2.63\ A$

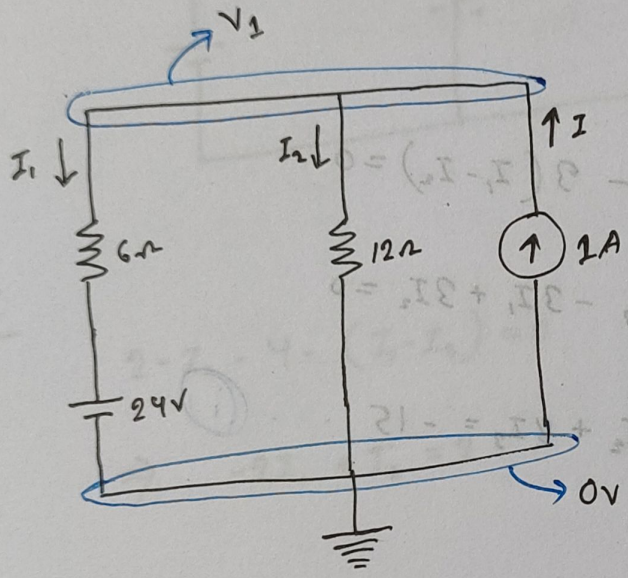
$I_2 = 1.40\ A$

$I_3 = 1.22\ A$



$\therefore V_{ab} = 10 - 5 = 5\ V$

$\therefore I = \frac{V_{ab}}{R} = \frac{5}{2} = 2.5A$



Here,

$V_{6\Omega} = V_1 - 24$

$\therefore I_1 = \frac{V_1 - 24}{6}$

$\therefore I_2 = \frac{V_1 - 0}{12} = \frac{V_1}{12}$

$\therefore$ In node - V_1 :

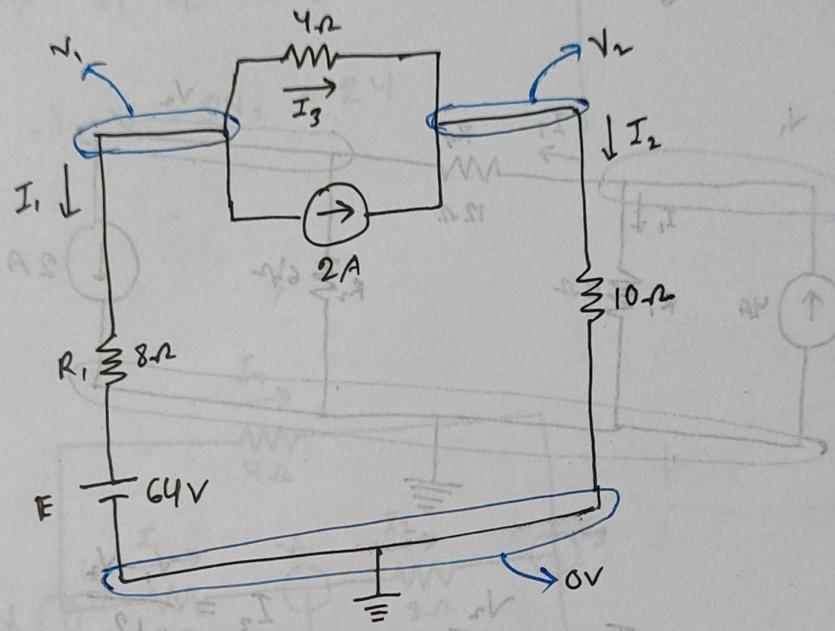
$I = I_1 + I_2$

$1 = \frac{V_1 - 24}{6} + \frac{V_1}{12}$

$\Rightarrow 12 = 2V_1 - 48 + V_1$

$\Rightarrow 3V_1 = 60$

$\therefore V_1 = 20V$



$I_1 = \frac{V_1 - 64}{8}$ $\quad I_2 = \frac{V_2}{10}$ $\quad I_3 = \frac{V_1 - V_2}{4}$

Node-1:

$I_1 + I_3 + 2 = 0$

$\Rightarrow \frac{V_1 - 64}{8} + \frac{V_1 - V_2}{4} + 2 = 0$

$\Rightarrow V_1 - 64 + 2V_1 - 2V_2 + 16 = 0$

$\therefore 3V_1 - 2V_2 = 48 \quad \ldots (i)$

Node-2:

$I_3 + 2 = I_2$

$\frac{V_1 - V_2}{4} + 2 = \frac{V_2}{10}$

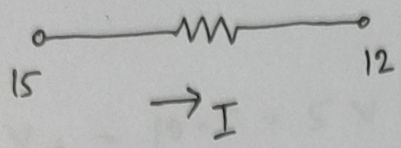
$\frac{V_1 - V_2 + 8}{4} = \frac{V_2}{10}$

$10V_1 - 10V_2 + 80 = 4V_2$

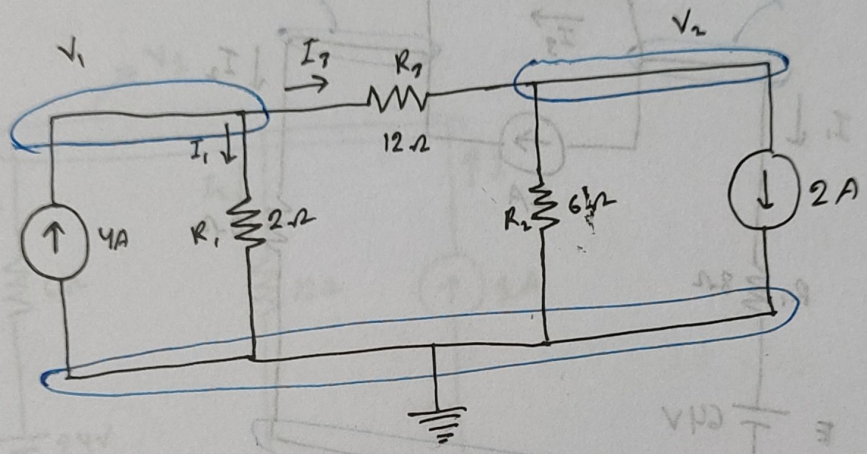
$\therefore 10V_1 - 14V_2 = -80 \quad \ldots (ii)$

(i) × 10 − (ii) × 3 then substitute.

L-13 / 11.03.2023 /



$$I = \frac{3}{6} = 0.5\ A$$



$$I_1 = \frac{V_1}{2} \qquad I_2 = \frac{V_2}{6} \qquad I_3 = \frac{V_1 - V_2}{12}$$

at node-1:

$$4 = I_1 + I_3$$

$$\Rightarrow 4 = \frac{V_1}{2} + \frac{V_1 - V_2}{12}$$

$$\Rightarrow V_1 - V_2 + 6V_1 = 48$$

$$\therefore 7V_1 - V_2 = 48$$

at node-2:

$$I_3 = I_2 + 2$$

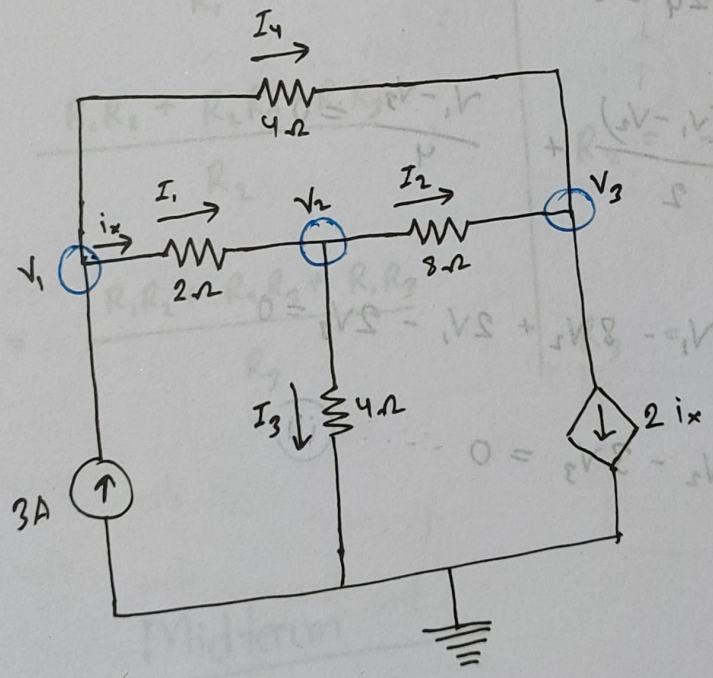
$$\Rightarrow \frac{V_1 - V_2}{12} = \frac{V_2}{6} + 2$$

$$\Rightarrow V_1 - V_2 = 2V_2 + 24$$

$$\therefore V_1 - 3V_2 = 24$$

$V_1 = 6\ V$

$V_2 = -6\ V$



$$I_1 = \frac{V_1 - V_2}{2}$$

$$I_2 = \frac{V_2 - V_3}{8}$$

$$I_3 = \frac{V_2}{4}$$

$$I_4 = \frac{V_1 - V_3}{4}$$

$$i_x = \frac{V_1 - V_2}{2}$$

Node-1:

$$3 = I_1 + I_4$$

$$\Rightarrow 3 = \frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{4}$$

$$\Rightarrow 12 = 2V_1 - 2V_2 + V_1 - V_3$$

$$\therefore 3V_1 - 2V_2 - V_3 = 12 \quad \cdots (i)$$

Node-2:

$$I_1 = I_2 + I_3$$

$$\Rightarrow \frac{V_1 - V_2}{2} = \frac{V_2 - V_3}{8} + \frac{V_2}{4}$$

$$\Rightarrow 4V_1 - 4V_2 = V_2 - V_3 + 2V_2$$

$$\therefore 4V_1 - 7V_2 + V_3 = 0 \quad \cdots (ii)$$

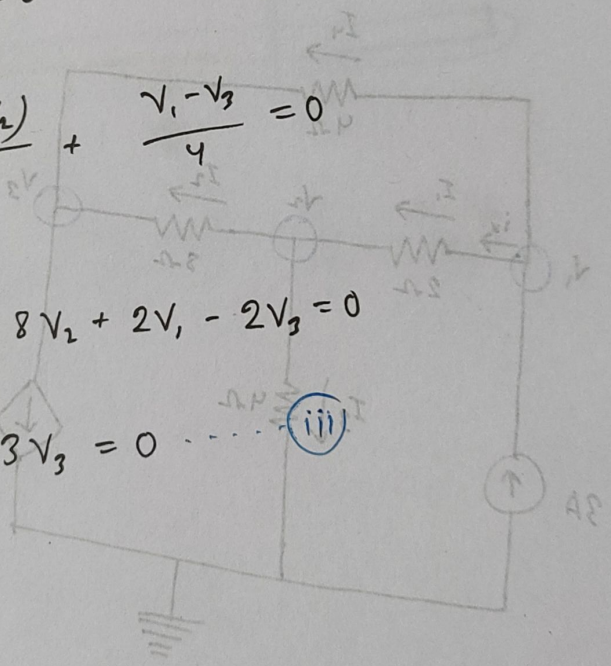
Node-3:

$$I_2 + 2i_x + I_4 = 0$$

$$\Rightarrow \frac{V_2 - V_3}{8} + \frac{2(V_1 - V_2)}{2} + \frac{V_1 - V_3}{4} = 0$$

$$\Rightarrow V_2 - V_3 + 8V_1 - 8V_2 + 2V_1 - 2V_3 = 0$$

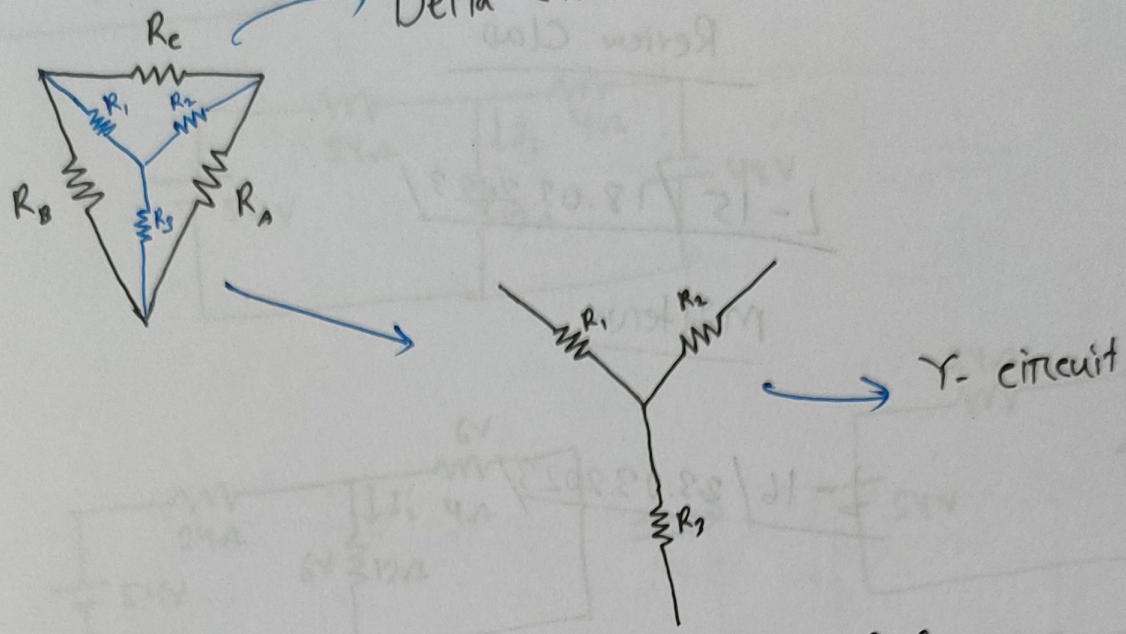
$$\therefore 10V_1 - 7V_2 - 3V_3 = 0 \quad \cdots (iii)$$



$$\therefore V_1 = -168\ V$$

$$V_2 = -132\ V$$

$$V_3 = -252\ V$$



Here,

$$R_A = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_1}$$

$$R_B = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_2}$$

$$R_C = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_3}$$

$$R_1 = \frac{R_BR_C}{R_A + R_B + R_C}$$

$$R_2 = \frac{R_AR_C}{R_A + R_B + R_C}$$

$$R_3 = \frac{R_AR_B}{R_A + R_B + R_C}$$

Midterm

1. Quiz-1
2. Quiz-2
3. Node Analysis
4. Mesh Analysis