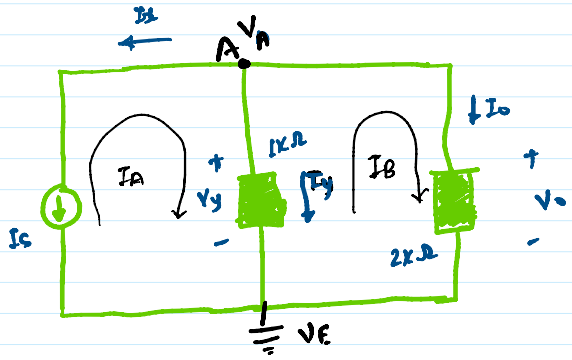
Assignment 2

12 September 2022 13:02

① Soln :-

(a)



No. of elements, E = 3

No. of nodes, N = 2

No. of loops = E - N + 1 = 2.

(b) No. of independent KCL equations = N - 1 = 1

No. of independent KVL equations = E - N + 1 = 2

(c) KCL Constraints :

Node A : $I_{Is} + I_y + I_o = 0 \Rightarrow I_y + I_o = -I_{Is}$

Element Constraints:

$I_{Is} = I_s = 1mA$, $I_y = \frac{V_A}{R}$, $I_o = \frac{V_A}{2R}$; $R = 1k\Omega$

Nodal Equation

Node A: $I_y + I_o = -I_{Is}$

$\Rightarrow \frac{V_A}{R} + \frac{V_A}{2R} = -I_s$

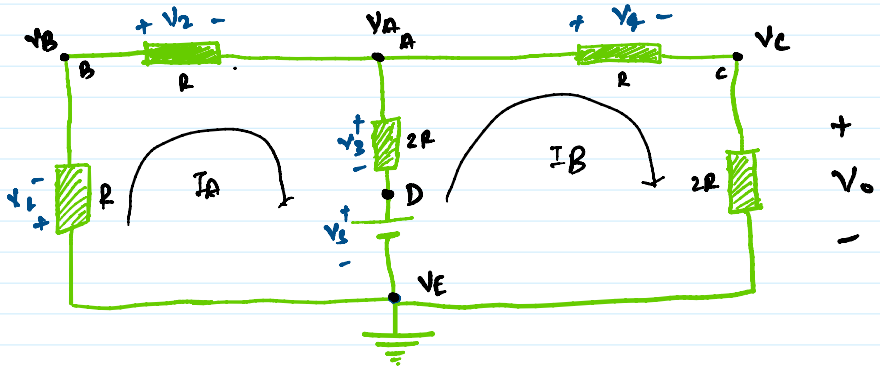
$\Rightarrow \frac{3V_A}{2R} = -I_s$

$\Rightarrow V_A = \frac{-1mA \times 2 \times 1000}{3} = -\frac{2}{3}V$

- $V_y = V_A = -\frac{2}{3}V$
- $V_o = V_A = -\frac{2}{3}V$
- $I_{Is} = I_s = 1mA$
- $I_o = \frac{V_A}{2R} = \frac{-2}{3 \times 2 \times 1000} = -\frac{1}{3000}A = -0.33mA$
- $I_y = \frac{V_A}{R} = -0.67mA$

② Sol^{n} :-

R = 1000 Ω



(a) No. of Nodes = 5 ; No. of elements = 6

No. of loops = E - N + 1 = 6 - 5 + 1 = 2.

(b) No. of independent KCL equations = N - 1 = 4

No. of independent KVL equations = E - N + 1 = 2

(c) KVL Constraints

Mesh A : $-V_1 - V_2 - V_3 - V_5 = 0$

$\Rightarrow V_1 + V_2 + V_3 = -V_5$

Mesh B : $V_5 + V_3 - V_4 - V_o = 0$

$\Rightarrow V_3 - V_4 - V_o = -V_5$

Element Constraints

$V_1 = I_A \cdot R$; $V_2 = I_A \cdot R$; $V_3 = (I_A - I_B) \cdot 2R$; $V_4 = I_B \cdot R$

$V_o = I_B \cdot 2R$

Mesh - Current equations

Mesh A : $V_1 + V_2 + V_3 = -V_5$

$\Rightarrow I_A \cdot R + I_A R + 2(I_A - I_B) R = -V_5$

$\Rightarrow 4 I_A R - 2 I_B R = -V_5$ ... (i)

Mesh B: $V_3 - V_4 - V_o = -V_s$

$\Rightarrow 2R(I_A - I_B) - I_B \cdot R - 2I_B R = -V_s$ — (iii)

$\Rightarrow 2I_A R - 5I_B R = -V_s$

$$\begin{bmatrix} 4R & -2R \\ 2R & -5R \end{bmatrix} \begin{bmatrix} I_A \\ I_B \end{bmatrix} = \begin{bmatrix} -V_s \\ -V_s \end{bmatrix}$$

$$I_A = \frac{\begin{vmatrix} -V_s & -2R \\ -V_s & -5R \end{vmatrix}}{\begin{vmatrix} 4R & -2R \\ 2R & -5R \end{vmatrix}} = \frac{\begin{vmatrix} -4 & -2000 \\ -4 & -5000 \end{vmatrix}}{\begin{vmatrix} 4000 & -2000 \\ 2000 & -5000 \end{vmatrix}} = \frac{20000 - 8000}{-20000000 + 4000000}$$

$$= \frac{12000}{-16000000} = \frac{-3}{4}\ mA$$

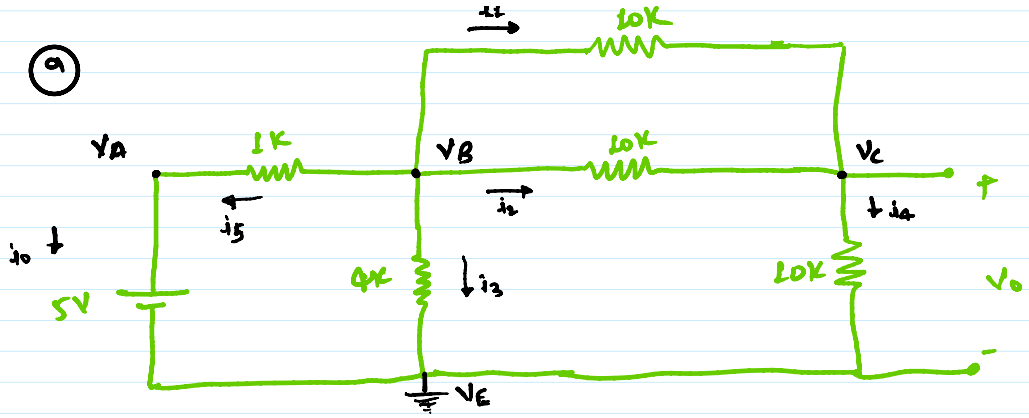
$$I_B = \frac{\begin{vmatrix} 4R & -V_s \\ 2R & -V_s \end{vmatrix}}{\begin{vmatrix} 4R & -2R \\ 2R & -5R \end{vmatrix}} = \frac{\begin{vmatrix} 4000 & -4 \\ 2000 & -4 \end{vmatrix}}{-16000000} = \frac{-16000 + 8000}{-16000,000}$$

$$= \frac{1}{2}\ mA$$

- $V_o = I_B \times 2R = \frac{1}{2} \times 10^{-3} \times 2 \times 1000 = 1\ V$
- $I_o = I_B = 0.5\ mA$

③ 30V:

(3) Soln:- (a)



No. of Nodes = 4

No. of KVL equations = N-1 = 4-1 = 3

KCL Constraints

Node A : $i_o - i_5 = 0$

Node B : $i_1 + i_2 + i_3 + i_5 = 0$

Node C : $i_4 - i_2 - i_1 = 0$

Element Constraints

$i_5 = \frac{V_B - V_A}{R}$; $i_1 = \frac{V_B - V_C}{10R}$; $i_2 = \frac{V_B - V_C}{10R}$; $i_3 = \frac{V_B}{4R}$; $i_4 = \frac{V_C}{10R}$

where $R = 1\,K\Omega$. ; $V_A = 5V$

Node-Voltage Equations

Node B : $i_1 + i_2 + i_3 + i_5 = 0$

$\Rightarrow \frac{V_B - V_C}{10R} + \frac{V_B - V_C}{10R} + \frac{V_B}{4R} + \frac{V_B - V_A}{R} = 0$

$\Rightarrow 2V_B - 2V_C + 2V_B - 2V_C + 5V_B + 20V_B - 20V_A = 0$

$\Rightarrow -20V_A + 29V_B - 4V_C = 0$

$\Rightarrow -20 \times 5 + 29V_B - 4V_C = 0$

$\Rightarrow 29V_B - 4V_C = 100$ — ii)

Node C : $i_4 - i_2 - i_1 = 0$

$\Rightarrow \frac{V_C}{10R} - \frac{V_B - V_C}{10R} - \frac{V_B - V_C}{10R} = 0$

$\Rightarrow V_C - V_B + V_C - V_B + V_C = 0$

$\Rightarrow \quad -2V_B + 3V_C = 0 \qquad -(iii)$

from (i) and (iii)

$$29V_B - 4V_C = 100$$

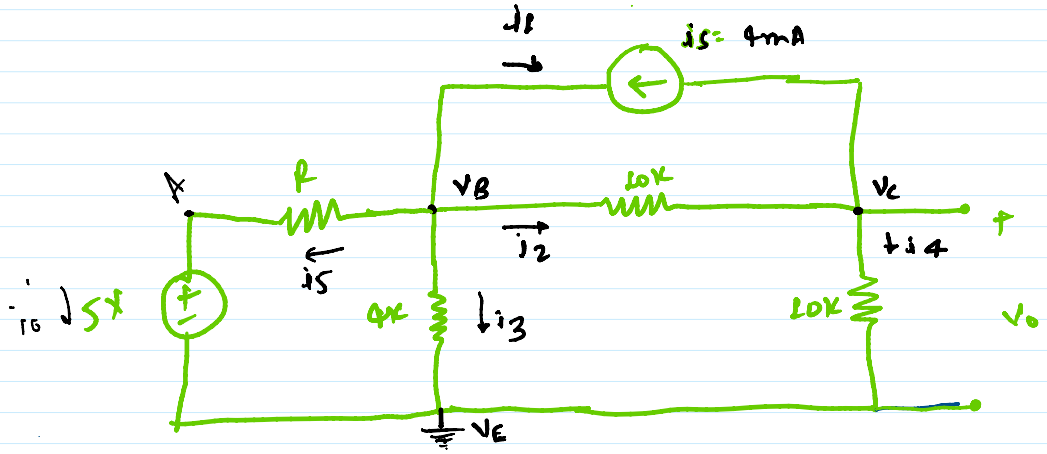
$$\Rightarrow 29 \cdot \frac{3V_C}{2} - 4V_C = 100$$

$$\Rightarrow \frac{79V_C}{2} = 100 \quad \Rightarrow \quad V_C = \frac{200}{79} V$$

So, $V_B = \frac{3V_C}{2} = \frac{3}{2} \times \frac{200}{79} = \frac{300}{79} V.$

- $V_o = V_C = \frac{200}{79} V = 2.53V$

(b)



KCL Constraints

Node A : $i_o - i_5 = 0$

Node B : $i_1 + i_2 + i_3 + i_5 = 0$

Node C : $i_4 - i_2 - i_1 = 0$

Element Constraints

$i_5 = \frac{V_B - V_A}{R}$; $i_1 = -i_5$; $i_2 = \frac{V_B - V_C}{10R}$; $i_3 = \frac{V_B}{4R}$; $i_4 = \frac{V_C}{10R}$

where $R = 1K\Omega$. ; $V_A = 5V$

Node-Voltage Equations

Node B : $i_1 + i_2 + i_3 + i_5 = 0$

$$\Rightarrow \frac{V_B - V_C}{} + \frac{V_B}{} + \frac{V_B - V_A}{} = i_5$$

$$\Rightarrow \quad \frac{V_B - V_C}{10R} + \frac{V_B}{4R} + \frac{V_B - V_A}{R} = i_s$$

$$\Rightarrow \quad 2V_B - 2V_C + 5V_B + 20V_B - 20V_A = i_s \cdot 20R$$

$$\Rightarrow \quad -20V_A + 27V_B - 2V_C = 20 i_s R$$

$$\Rightarrow \quad -20.5 + 27V_B - 2V_C = 4 \times 10^{-3} \times 20 \times 1000$$

$$\Rightarrow \quad 27V_B - 2V_C = 180 \qquad - (i)$$

Node C:

$$i_4 - i_2 - i_1 = 0$$

$$\Rightarrow \quad \frac{V_C}{10R} - \frac{V_B - V_C}{10R} = -i_s$$

$$\Rightarrow \quad -V_B + 2V_C = -i_s \cdot 10R$$

$$\Rightarrow \quad -V_B + 2V_C = -4 \times 10^{-3} \times 10 \times 1000 = -40$$

$$\Rightarrow \quad -V_B + 2V_C = -40 \qquad - (ii)$$

adding (i) and (ii)

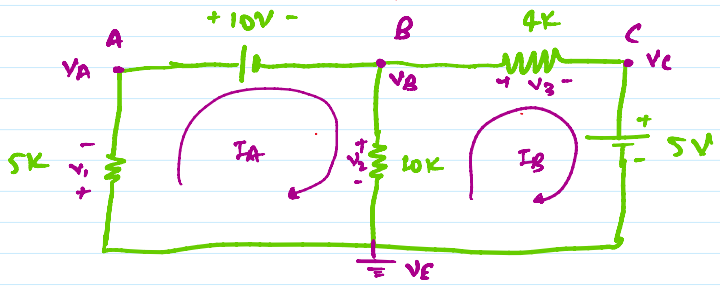
$$26V_B = 140$$

$$V_B = \frac{140}{26} = 5.38 \text{ V}$$

$$V_C = \frac{V_B - 40}{2} = -17.30 \text{ V}$$

- $V_o = V_C = -17.30 \text{V}$

(4) (i) (a)



No. of elements = 5

No. of nodes = 4

No. of ML Eqn = 5 - 4 + 1 = 2

KVL Constraints

Mesh A: $-V_1 - V_{S_1} - V_2 = 0$

$\Rightarrow -V_1 - V_2 = V_{S_1}$

Mesh B: $V_2 - V_3 - V_{S_2} = 0 \Rightarrow V_2 - V_3 = V_{S_2}$

Element Constraints

$V_{S_1} = 10V$; $V_{S_2} = 5V$; $V_1 = 5R \cdot I_A$; $V_2 = 10R(I_A - I_B)$; $V_3 = 4R \cdot I_B$

Mesh - Current Equations

Mesh A: $-V_1 - V_2 = V_{S_1}$

$\Rightarrow -5R I_A - 10R(I_A - I_B) = 10$

$\Rightarrow -5R I_A - 10R I_A + 10R I_B = 10$

$\Rightarrow -15R I_A + 10R I_B = 10$

$\Rightarrow -3R I_A + 2R I_B = 2$ -- (i)

Mesh B: $V_2 - V_3 = V_{S_2}$

$\Rightarrow 10R(I_A - I_B) - 4R I_B = 5$

$\Rightarrow 10R \cdot I_A - 14R \cdot I_B = 5$ --- (ii)

$$\begin{bmatrix} -3R & 2R \\ 10R & -14R \end{bmatrix} \begin{bmatrix} I_A \\ I_B \end{bmatrix} = \begin{bmatrix} 2 \\ 5 \end{bmatrix}$$

$$I_A = \frac{\begin{vmatrix} 2 & 2R \\ 5 & -14R \end{vmatrix}}{\begin{vmatrix} -3R & 2R \\ 10R & -14R \end{vmatrix}} = \frac{\begin{vmatrix} 2 & 2000 \\ 5 & -14000 \end{vmatrix}}{\begin{vmatrix} -3000 & 2000 \\ 10000 & -14000 \end{vmatrix}} = \frac{-28000 - 10000}{(42 - 20) \times 10^6}$$

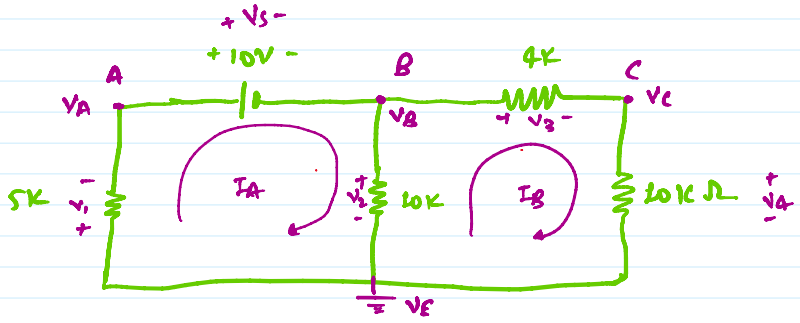
$$= \frac{-38000}{22 \times 10^6} = -1.72 \text{ mA}$$

$$I_B = \frac{\begin{vmatrix} -3k & 2 \\ 10k & 5 \end{vmatrix}}{\begin{vmatrix} -3k & 2k \\ 10k & -19k \end{vmatrix}} = \frac{\begin{vmatrix} -3000 & 2 \\ 10000 & 5 \end{vmatrix}}{22 \times 10^6} = \frac{-15000 - 20000}{22 \times 10^6}$$

$$= -1.59 \text{ mA}$$

- $I_o = I_A - I_B = -1.72 - (-1.59) = -0.13 \text{ mA}$

(b)



No. of elements = 5

No. of nodes = 4

No. of MC Eqn = 5 - 4 + 1 = 2

KVL Constraints

Mesh A: $-V_1 - V_{S_1} - V_2 = 0$

$\Rightarrow -V_1 - V_2 = V_S$

Mesh B: $V_2 - V_3 - V_4 = 0$

Element Constraints

$V_{S1} = 10V$; $V_1 = 5k \cdot I_A$; $V_2 = 10k(I_A - I_B)$; $V_3 = 4k \cdot I_B$; $V_4 = I_B \cdot 10k$

Mesh - Current equations

Mesh A: $-V_1 - V_2 = V_S$

$\Rightarrow -5k\, I_A - 10k I_A + 10k I_B = V_S$

$\Rightarrow -15k \cdot I_A + 10k \cdot I_B = 10$

$\Rightarrow -3k\, I_A + 2k\, I_B = 2$ ---- (i)

Mesh B: $V_2 - V_3 - V_4 = 0$

$$\Rightarrow \quad 10R(I_A - I_B) - 4R I_B - I_B \cdot 10R = 0$$

$$\Rightarrow \quad 10R \cdot I_A - 24R I_B = 0 \qquad \text{- (ii)}$$

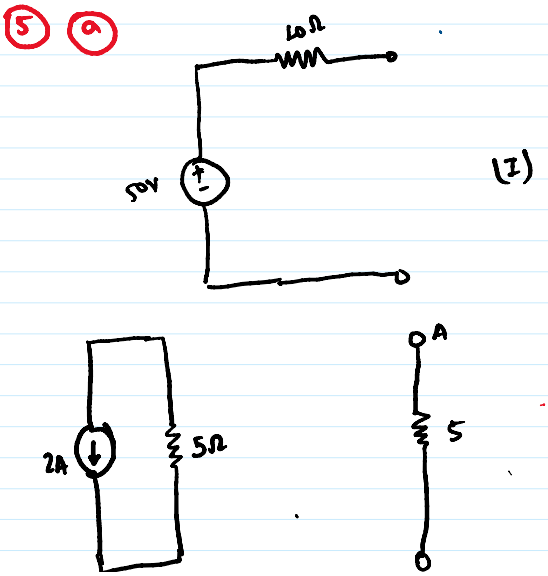
$$\begin{bmatrix} -3R & 2R \\ 10R & -24R \end{bmatrix} \begin{bmatrix} I_A \\ I_B \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$

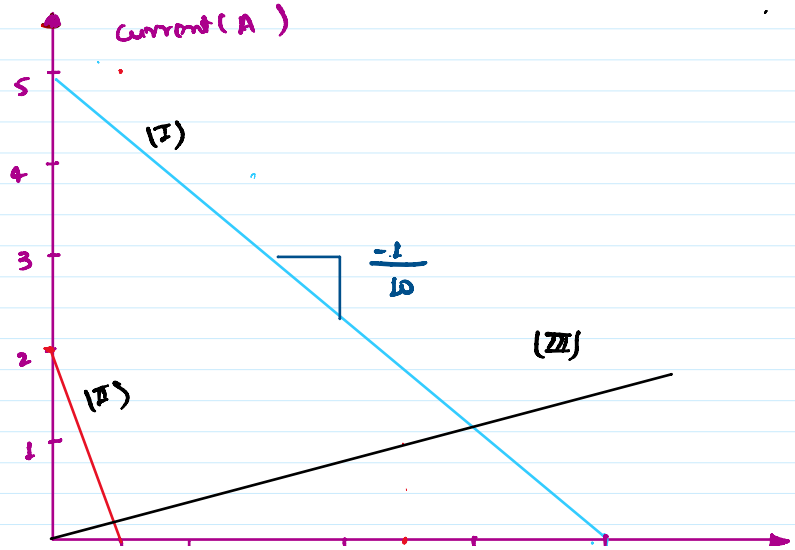
$$I_A = \frac{\begin{vmatrix} 2 & 2R \\ 0 & -24R \end{vmatrix}}{\begin{vmatrix} -3R & 2R \\ 10R & -24R \end{vmatrix}} = \frac{-48R}{72R^2 - 20R^2} = \frac{-48}{52R} = \frac{-48}{52}\ mA$$

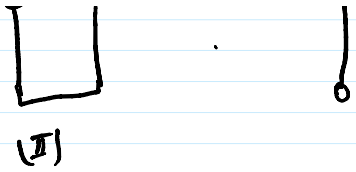
$$I_B = \frac{\begin{vmatrix} -3R & 2 \\ 10R & 0 \end{vmatrix}}{\begin{vmatrix} -3R & 2R \\ 10R & -24R \end{vmatrix}} = \frac{-20R}{52R^2} = \frac{-20}{52}\ mA$$

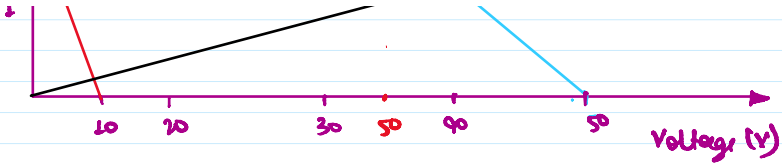
- $I_0 = I_A - I_B = -\frac{48+20}{52}\ mA = \frac{-28}{52}\ mA = -0.538\ mA$

(5) (a)

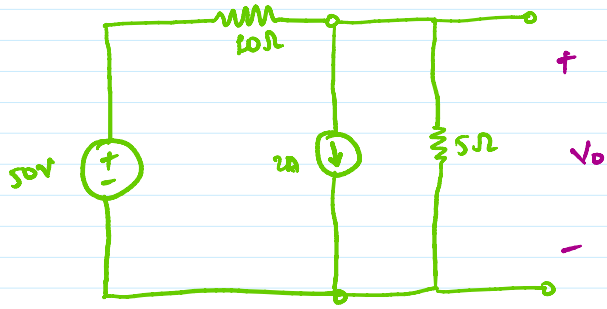


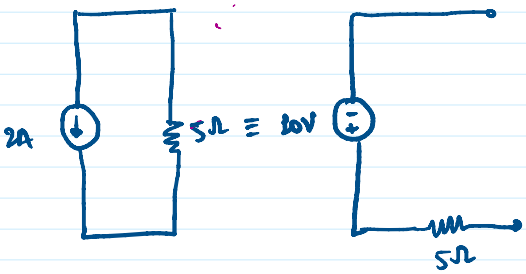


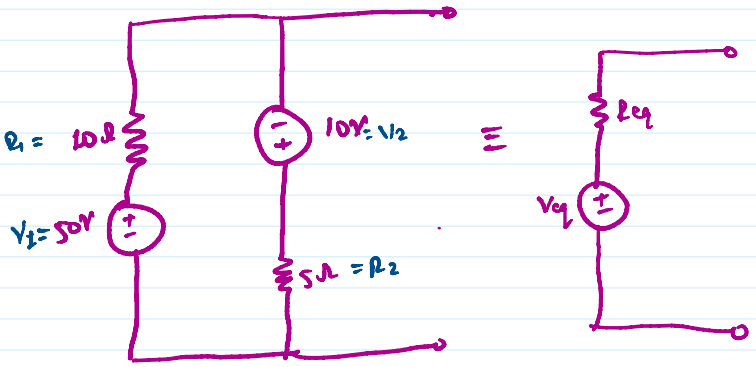




(b)







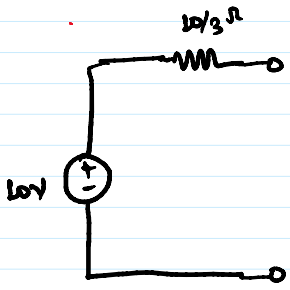
$$V_{eq} = \frac{V_1 R_2 + V_2 R_1}{R_1 + R_2}$$

$$= \frac{50 \cdot 5 + (-10) \cdot 10}{10+5}$$

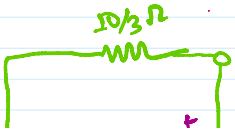
$$= \frac{250 - 100}{15} = 10V$$

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{5 \times 10}{15} = \frac{10}{3}\,\Omega$$

- Equivalent practical voltage source circuit :-

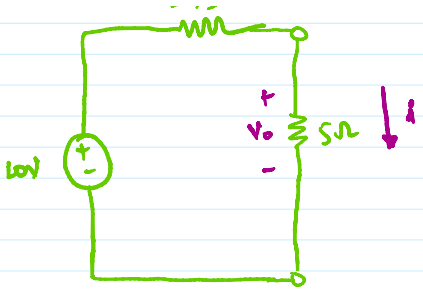


(c)



$$V_o = \frac{5}{5+10} \times 10$$

(c)



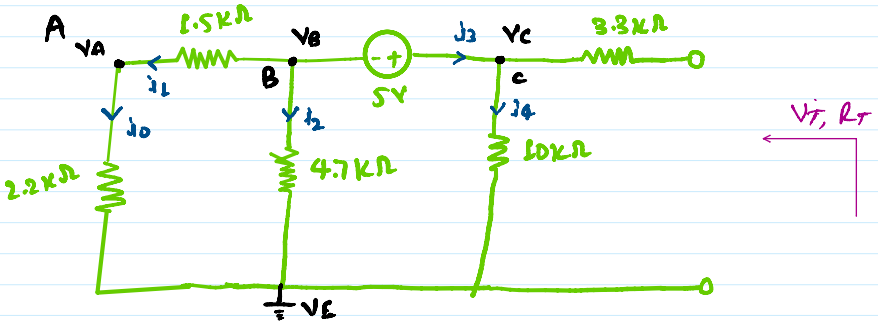
$$V_o = \frac{5}{5+\frac{10}{3}} \times 10$$

$$= \frac{15^3}{25} \times 10^2 = 6\ V$$

$$i = \frac{V_o}{R_1} = \frac{6}{5} = 1.2\ A$$

power: $V_o i_o = (6 \times 1.2)\ W = 7.2\ W$

(6) (a)



No. of nodes = 4

No. of KVL eqn = 3

KCL Constraint

Node A: $i_o - i_1 = 0$

Node B: $i_1 + i_2 + i_3 = 0$

Node C: $i_4 - i_3 = 0 \Rightarrow i_3 = i_4$

Element Constraints

$$i_o = \frac{V_A}{2200}\ ;\quad i_1 = \frac{V_B - V_A}{1500}\ ;\quad i_4 = \frac{V_C}{10000}\ ;\quad V_C - V_B = 5\ V\ ;\quad i_2 = \frac{V_B}{4700}$$

Node-Voltage equations:

Node A: $i_o - i_1 = 0$

$$\Rightarrow \frac{V_A}{2200} - \frac{V_B - V_A}{1500} = 0$$

$$\Rightarrow 15 V_A = 22 V_B - 22 V_A$$

$$\Rightarrow \boxed{37 V_A - 22 V_B = 0}$$

and $\boxed{-V_B + V_C = 5}$

Node B: $i_1 + i_2 + i_3 = 0$

$$\frac{V_B - V_A}{1500} + \frac{V_B}{4700} + \frac{V_C}{10000} = 0$$

$$\frac{V_B - V_A}{15} + \frac{V_B}{47} + \frac{V_C}{100} = 0$$

$$4700 V_B - 4700 V_A + 1500 V_B + 705 V_C = 0$$

$$\Rightarrow \boxed{-940 V_A + 1240 V_B + 141 V_C = 0}$$

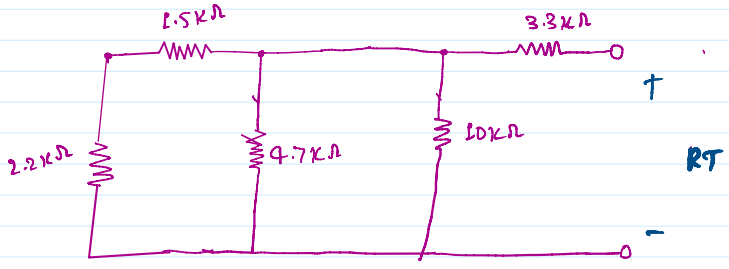
$$\begin{bmatrix} 37 & -22 & 0 \\ 0 & -1 & 1 \\ -940 & 1240 & 101 \end{bmatrix} \begin{bmatrix} V_A \\ V_B \\ V_C \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \\ 0 \end{bmatrix}$$

$$V_A = \frac{\begin{vmatrix} 0 & -22 & 0 \\ 5 & -1 & 1 \\ 0 & 1240 & 101 \end{vmatrix}}{\begin{vmatrix} 37 & -22 & 0 \\ 0 & -1 & 1 \\ -940 & 1240 & 101 \end{vmatrix}} = \frac{77550}{-152085} = -0.509\ V$$

$$V_B = \frac{\begin{vmatrix} 37 & 0 & 0 \\ 0 & 5 & 1 \\ -940 & 0 & 101 \end{vmatrix}}{\begin{vmatrix} 37 & -22 & 0 \\ 0 & -1 & 1 \\ -940 & 1240 & 101 \end{vmatrix}} = \frac{130425}{-152085} = -0.8575\ V$$

$$V_C = V_B + 5 = -0.8575 + 5 = 4.142\ V$$

- $V_T = V_C = 4.142\ V$



$$R_T = \left((1.5K + 2.2K) \,||\, 4.7K \,||\, 10K \right) + 3.3K$$

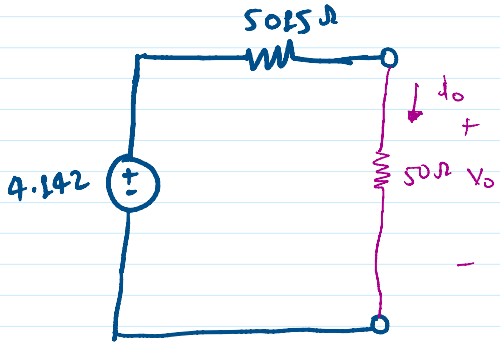
$$= \left(3700 \,||\, 4700 \,||\, 10000 \right) + 3.3K$$

$$= \left[\left(\frac{3700 \cdot 4700}{3700 + 4700} \right) \,||\, 10000 \right] + 3300$$

$= (2070.23 \,||\, 10000) + 3300$

$= 1715.15 + 3300 \approx 5015\ \Omega$

(b)



$i_o = \frac{4.142}{5015 + 50} = 0.817\ mA$

$V_o = i_o \cdot R = 50\, i_o$

$= 50 \times 0.817\ mA$

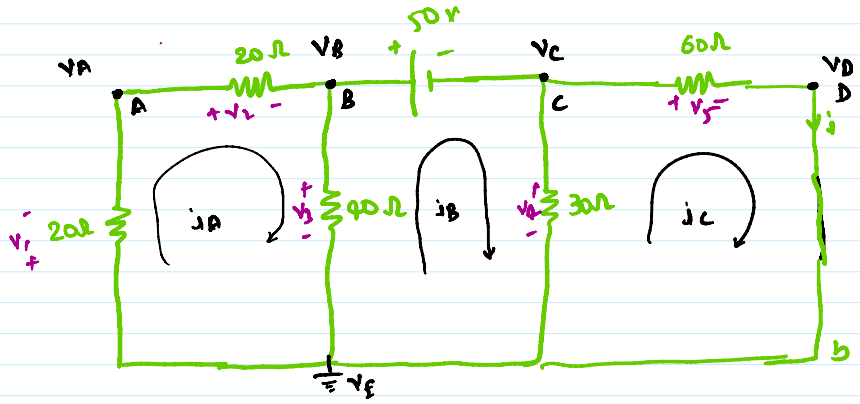
$= 40.8\ mV$

Power: $V_o I_o = 40.8 \times 0.817\ \mu W$

$= 33.33\ \mu W$

$i_o = 0.817\ mA$; $V_o = 40.8\ mV$; Power: $33.33\ \mu W$

(7) (a)



Total No. of Elements, E = 6

Total No. of nodes, N = 5

Total No. of independent mesh equation = 6 − 5 + 1 = 2.

(b)

KVL Constraints

Mesh A: $-V_1 - V_2 - V_3 = 0 \Rightarrow V_1 + V_2 + V_3 = 0$

Mesh B: $V_3 - V_5 - V_4 = 0 \Rightarrow V_3 - V_0 = V_5$

Mesh C: $V_4 - V_5 = 0$

Element Constraints

$V_1 = 20 \cdot i_A$; $V_2 = 20 \cdot i_A$; $V_3 = (i_A - i_B) \cdot 40$; $V_4 = (i_B - i_C) \cdot 30$; $V_5 = i_C \cdot 60$

Mesh - Current Equation

Mesh A: $V_1 + V_2 + V_3 = 0$

$\Rightarrow 20\, i_A + 20\, i_A + 40 i_A - 40 i_B = 0$

$\Rightarrow 80 i_A - 40 i_B = 0$

$\Rightarrow 2 i_A - i_B = 0$ — (ii)

Mesh B: $V_3 - V_0 = V_5$

$\Rightarrow 40 (i_A - i_B) - 30 \cdot (i_B - i_C) = 50$

$\Rightarrow 40 i_A - 70 i_B + 30 i_C = 50$

$\Rightarrow 4 i_A - 7 i_B + 3 i_C = 5$ — (iii)

Mesh C: $V_4 - V_5 = 0 \Rightarrow (i_B - i_C) \cdot 30 - 60 i_C = 0$

$\Rightarrow 30 i_B - 90 i_C = 0$

$\Rightarrow i_B - 3 i_C = 0$ — (iii)

adding (i) and (iii)

$2 i_A - 3 i_C = 0$ -- (iv)

from (iii) and (ii)

$4 i_A - 7(3 i_C) + 3 i_C = 5$

$\Rightarrow 4 i_A - 18 i_C = 5$ -- (v)

Two independent eqn are (iv) and (v)

from (iv) and (v)

$4iA - 18iC = 5$

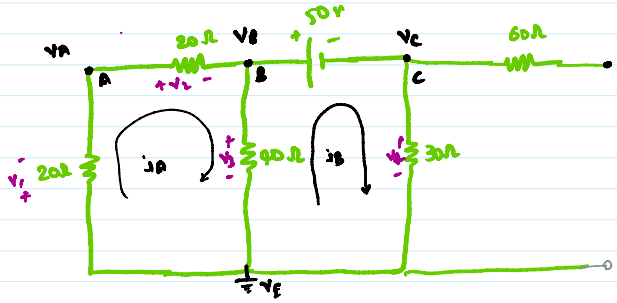
$\Rightarrow 2\cdot(3iC) - 18iC = 5$

$\Rightarrow -12iC = 5$

$\Rightarrow iC = \frac{-5}{12}$ A

$\therefore iN = iC = -5/12$ A

(c)



Total. No of Elements = 5

Total No. of Nodes = 4

Total No. of independent mesh-current equation = 5-4+1 = 2

KVL Constraints

Mesh A: $-V_1 - V_2 - V_3 = 0 \Rightarrow V_1 + V_2 + V_3 = 0$

Mesh B: $V_3 - V_5 - V_4 = 0 \Rightarrow V_3 - V_4 = V_5$

Element Constraints

$V_1 = 20\,iA$; $V_2 = 20\,iA$; $V_3 = 40(iA - iB)$

$V_4 = 30\,iB$

Mesh-Current Equations

Mesh A: $V_1 + V_2 + V_3 = 0$

$\Rightarrow 20\,iA + 20\,iA + 40\,iA - 40\,iB = 0$

$\Rightarrow 80\,iA - 40\,iB = 0$

$\Rightarrow 2\,iA - iB = 0$ — (i)

Mesh B: $V_3 - V_4 = V_5$

$\Rightarrow 40\,iA - 40\,iB - 30\,iB = 50$

$\Rightarrow 40iA - 70\,iB = 50$

$\Rightarrow 4iA - 7iB = 5$ — (ii)

Putting (i) in (ii)

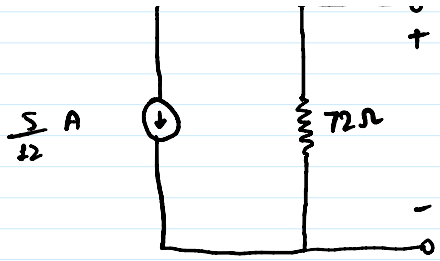
$2iB - 7iB = 5$

$iB = -1A$

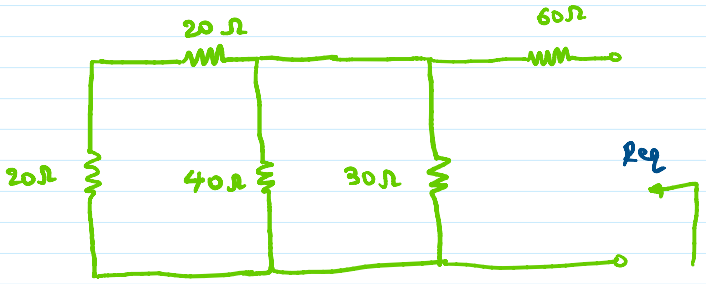
$V_T = V_C = 30 \cdot iB = -30$ V

(d)

$R_T = \frac{V_T}{iN} = \frac{-30}{-5/12} = 6 \times 12 = 72\Omega$



(e)



look-back method

$$R_{eq} = [(20+20) \,||\, 40 \,||\, 30] + 60$$

$$= [40 \,||\, 40 \,||\, 30] + 60$$

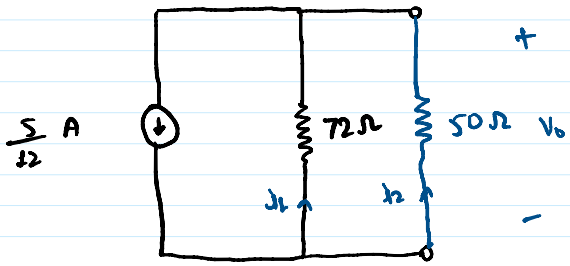
$$= \left[\frac{1600}{80} \,||\, 30\right] + 60$$

$$= (20 \,||\, 30) + 60$$

$$= \frac{20.30}{50}^{2} + 60 = 72\ \Omega$$

$R_{eq} = R_T = 72\ \Omega$

(d)



$$i_2 = \frac{72^{6}}{72+50} \times \frac{5}{12}$$

$$i_2 = \frac{30}{72+50} = \frac{30}{122}\ A$$

$i_2 = \frac{30}{122}\ A$

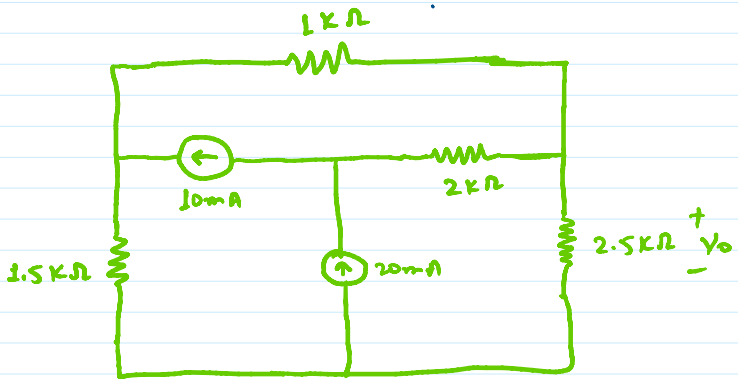
$V_o = -i_2 \cdot 50 = \frac{-30}{122} \cdot 50 = -12.29\ V$

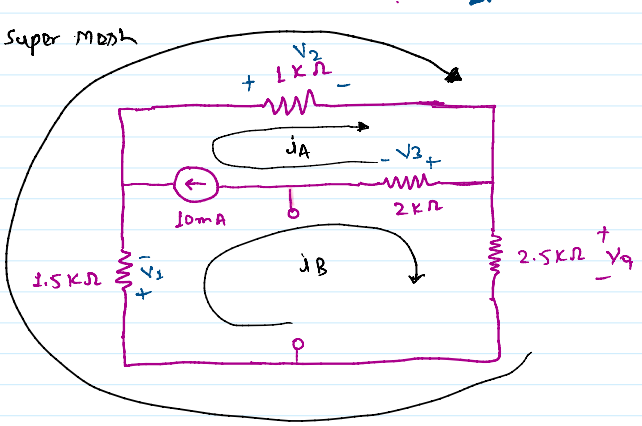
$V_2 = -12.29\ V$

Power $= |V_o \cdot I_2| = 3.023$ Watt

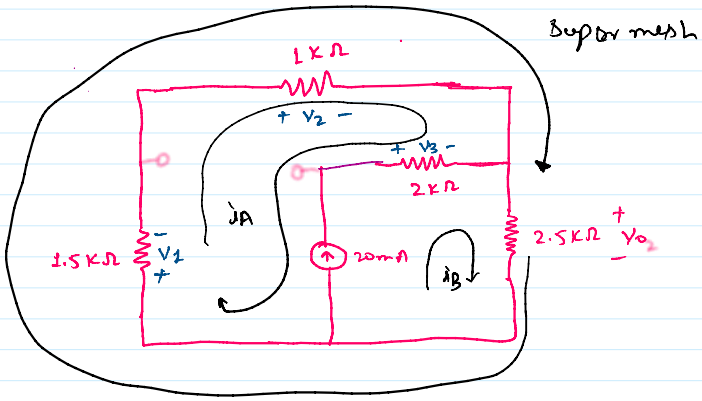
P = 3.023W

(8)





(I)



(II)

KVL Constraints

Super Mesh : $-V_1 - V_2 - V_{o1} = 0$

$V_1 + V_2 + V_{o1} = 0$

Element Constraints

$i_A - i_B = 10mA$; $V_1 = 1500\, i_B$

$V_2 = 1000 i_A$; $V_{o1} = 2500\, i_B$

Mesh-Current Equation

$V_1 + V_2 + V_{o1} = 0$

$\Rightarrow 1500 i_B + 1000 i_A + 2500 i_B = 0$

$\Rightarrow 1000 i_A + 4000 i_B = 0$

$\Rightarrow i_A + 4 i_B = 0$ - (i)

KVL Constraints

Super Mesh : $-V_1 - V_2 - V_{o2} = 0$

$V_1 + V_2 + V_{o2} = 0$

Element Constraints

$i_B - i_A = 20mA$; $V_1 = 1500\, i_A$;

$V_2 = 1000 i_A$; $V_{o2} = 2500\, i_B$

Mesh-Current Equation

$V_1 + V_2 + V_{o2} = 0$

$\Rightarrow 1500 i_A + 1000 i_A + 2500 i_B = 0$

$\Rightarrow i_A + i_B = 0$ - (ii)

also, $i_B - i_A = 20mA$ - (iii)

also, $i_A - i_B = 10mA$ -(ii)

from (i) and (ii)

$i_B = -2mA$; $i_A = 8mA$

$V_{o1} = 2500\, i_B$

$= 2500 \times -2mA$

$V_{o1} = -5V$

from (i) and (ii)

$i_A = -10mA$; $i_B = 10mA$

$V_{o2} = 2500\, i_B$

$= 10 \times 2.5 = 25V$

$V_{o2} = 25V$

- By superposition principle, we can say.

Voltage across 2.5 kΩ resistor, $V_o = V_{o1} + V_{o2}$

$= 20V$