

Nodal

يكون عندي مقاومات و Current Source يطبق (ا) مجموع التيارات الداخلة

Applying KCL

$$\sum I_i = () V - V_j - V_k \dots$$

Self conduct Mutual Mutual
المقاومة افعال متبادلة

$$\sum I_{in} = \sum I_{out} \quad (1 \text{ و } 2)$$

$$I = \frac{V}{R} \quad (2)$$

Supernode

Independent

يكون عندي Voltage Source بين 2 Node

KCL على كل الدائرة وحول
 $I = \frac{V}{R}$

(1) رجل $I \cdot V_S = 0$ و يوجد بين

لديهم تكون بين 2 nonreference node

Mesh:

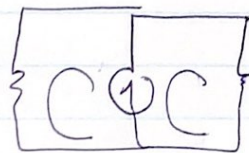
لديهم mesh عندي رجل KVL

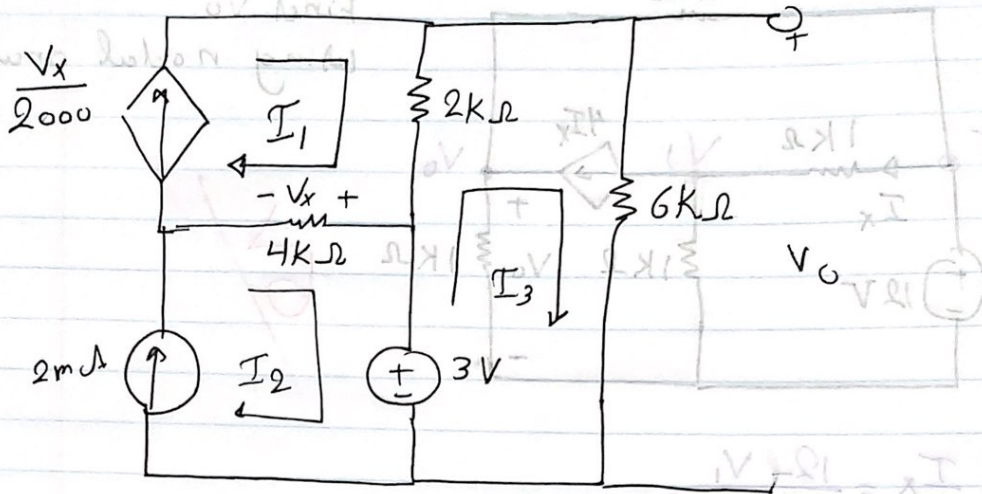
+V (⊕) ↑ التيار طالع
-V (⊕) ↓ التيار زرع المش داخل

$$\pm V = (SR) I_{mesh} - (MR) I$$

Super mesh

يكون عندي Current Source بين 2 mesh





using mesh analysis Find I_2, V_o, I_3, I_1

$$I_2 = 2 \text{ mA}$$

$$V_x = 4000(I_1 - I_2)$$

$$V_x = 4000 I_1 - 8 I_2$$

$$I_1 = \frac{V_x}{2000}$$

$$I_1 = \frac{4000 I_1}{2000} - \frac{8}{2000}$$

$$-I_1 = -4 \times 10^{-3}$$

$$I_1 = 4 \text{ mA}$$

To find I_3

mesh 3

$$3 = 8000 I_3 - 2000 I_1$$

$$3 = 8000 I_3 - 2000 \times 4 \times 10^{-3}$$

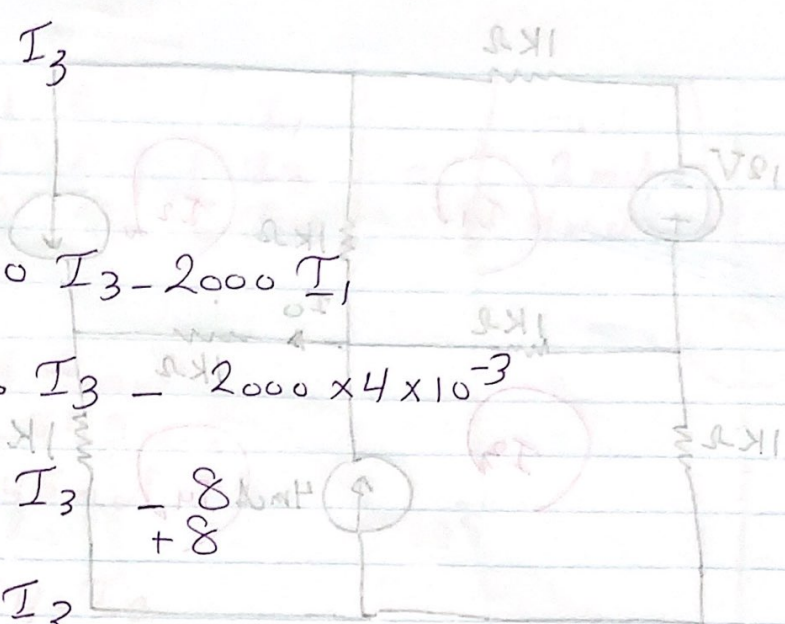
$$3 + 8 = 8000 I_3 - 8$$

$$11 = 8000 I_3$$

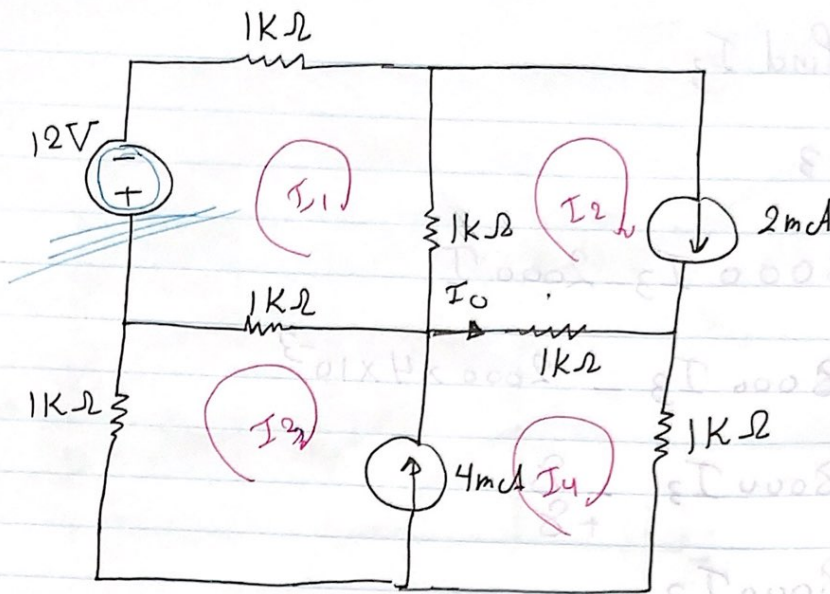
$$I_3 = 1.375 \text{ mA}$$

$$V_0 = 6 I_3$$

$$= 8.25 \text{ V}$$



sub circuit



Find I_0 a) 1.45 b) -0.55 c) -2.55 d) -4.2

$$I_2 = 2 \text{ mA}$$

$$12 + 1kI_1 + 1k(I_1 - I_2) + 1k(I_1 - I_3) = 0$$

Substitute $I_2 = 2 \text{ mA}$

$$12 + 3kI_1 - 2 - 1kI_3 = 0$$

$$3I_1 - I_3 = -0.01 \rightarrow \text{①}$$

Supermesh

$$1kI_3 + 1k(I_3 - I_1) + 1k(I_4 - I_2) + 1kI_4$$

$$2I_3 - I_1 + 2I_4 = 2 \text{ mA}$$

$$I_4 - I_3 = 4 \text{ mA}$$

$$\begin{bmatrix} 3 & -1 & 0 \\ -1 & 2 & 2 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} -0.1 \\ 2 \text{ mA} \\ 4 \text{ mA} \end{bmatrix}$$

$$I_1 = -4.18 \text{ mA}$$

$$I_3 = -2.545 \text{ mA}$$

$$I_4 = 1.45 \text{ mA}$$

$$I_0 = I_4 - I_2$$

$$= 1.45 \text{ mA} - 2 \text{ mA}$$

$$I_0 = -0.55 \text{ mA}$$

Find V_x using mesh analysis

$$I_1 - I_2 = 0.1$$

$$I_1 = I_2 + 0.1$$

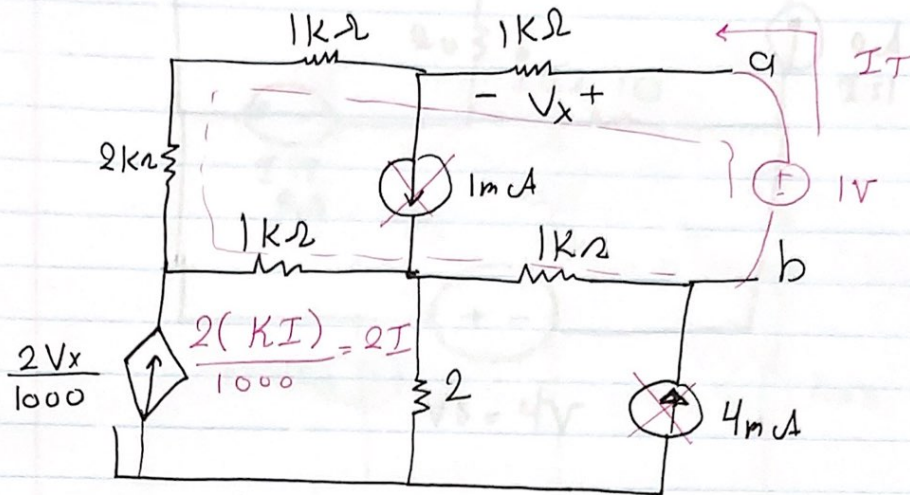
$$I_2 - I_3 = 2$$

$$I_2 - I_1 = 4$$

$$I_2 - I_3 = 2$$

$$I_2 - I_1 = 4$$

Find Thevenin's equivalent circuit



dep + ind sources

$$V_x = I \cdot 1k$$

Connect 1V

KVL

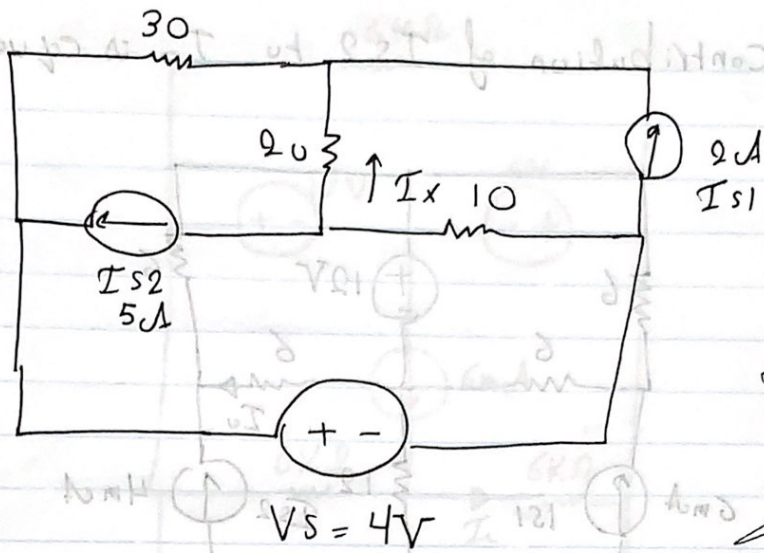
$$-1 + 1kI + 1kI + 2kI + (3I)1k + 1k(I) = 0$$

$$1 = 8kI$$

$$I = \frac{1}{8k}$$

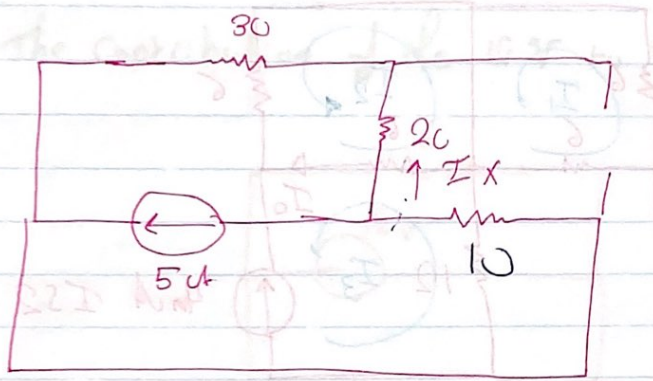
$$R_{th} = \frac{1}{\frac{1}{8k}} = 8k\Omega$$

$$V_{th} = -8V$$



Flucka
AbuZayed

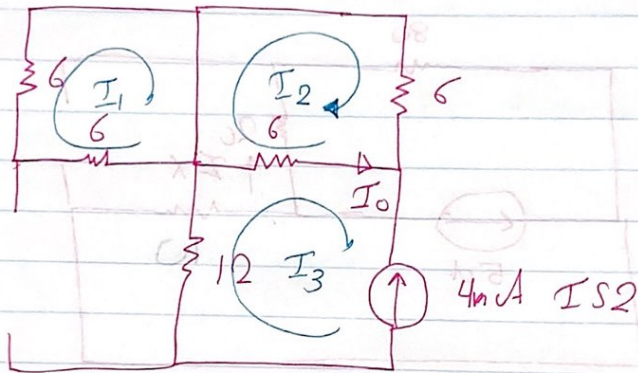
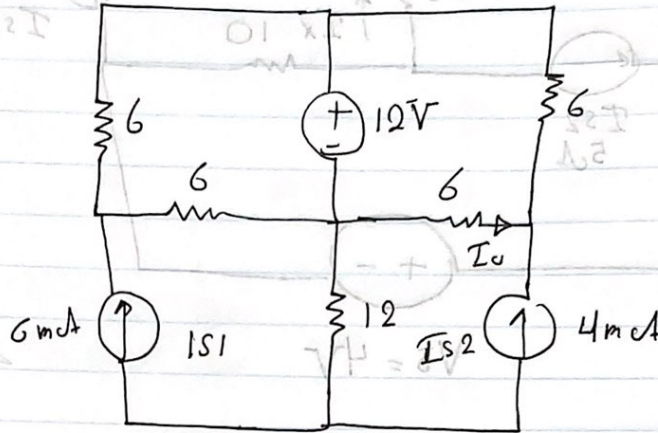
Contribution I_{s2} to I_x



Current divider Rule

$$= \frac{5 \times 10}{20 + 30 + 10} = -0.833 \text{ A}$$

The contribution of I_{S2} to I_0 is equal



$$I_3 = -4 \text{ mA}$$

$$I_3 = -4 \text{ mA}$$

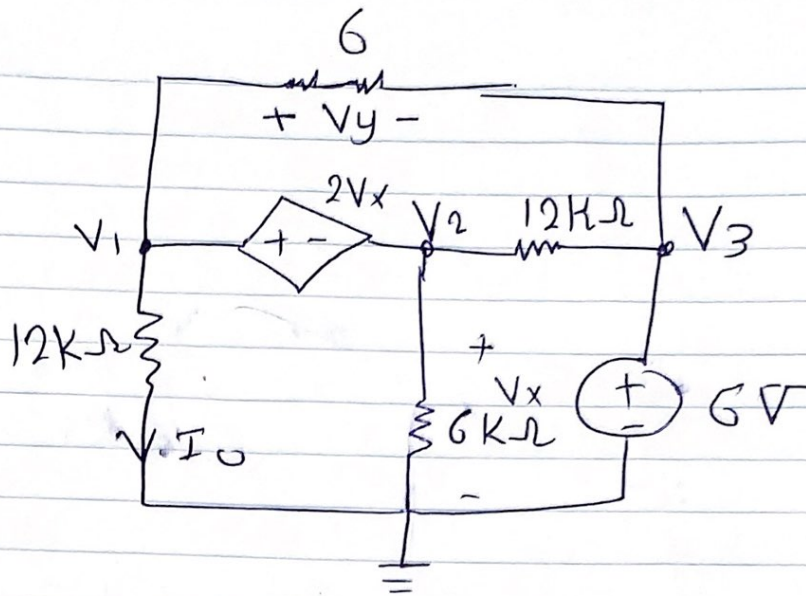
$$I_0 = I_3 - I_2$$

$$= -4 - I_2 = -4 + 2 = -2 \text{ mA}$$

$$\text{mesh 1 } 12 I_1 = 0$$

$$\text{mesh 2 } 12 I_2 - 6 I_3 = 0$$

$$12 I_2 + 24 = 0 \quad 12 I_2 = -24 \quad I_2 = -2$$



Supernode

$$V_1 - V_2 = 2V_x$$

$$V_x = V_2$$

$$V_1 - V_2 = 2V_2$$

$$V_1 = 3V_2$$

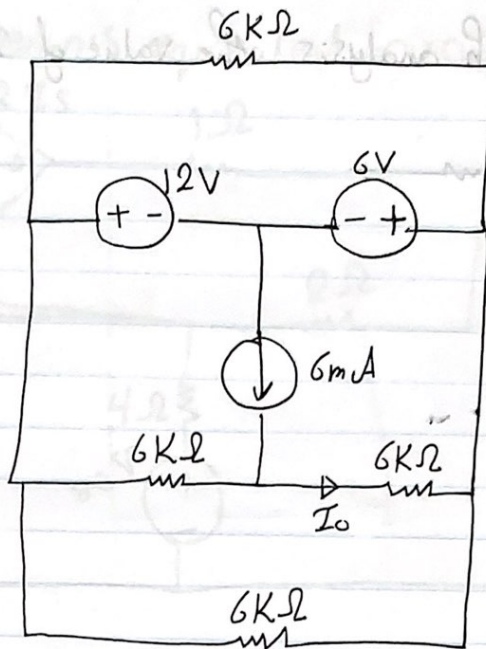
$$\left(\frac{1}{6} + \frac{1}{12}\right)V_1 + \left(\frac{1}{12} + \frac{1}{6}\right)V_2 - \frac{1}{12k}V_3 - \frac{1}{6}V_3 = 0$$

$$0.25V_1 + 0.25V_2 - 1.5 \times 10^{-3} = 0$$

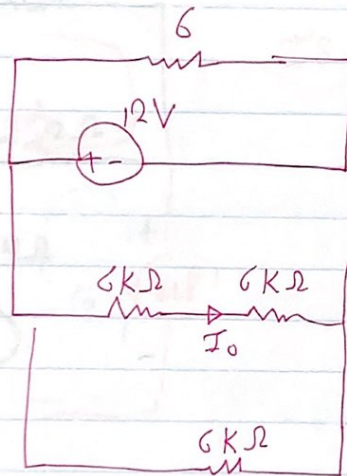
$$0.25 \times 10^{-3}V_1 + 0.25 \times 10^{-3}V_2 = 1.5 \times 10^{-3}$$

$$0.75 \times 10^{-3}V_2 + 0.25 \times 10^{-3}V_2 = 1.5 \times 10^{-3}$$

$$1 \times 10^{-3}V_2 = 1.5 \times 10^{-3} \quad V = 1.5V$$

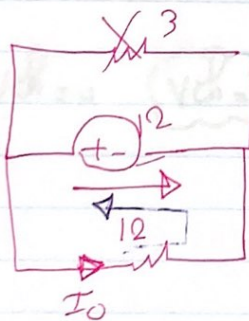


The Contribution of the 12V to I_0 .



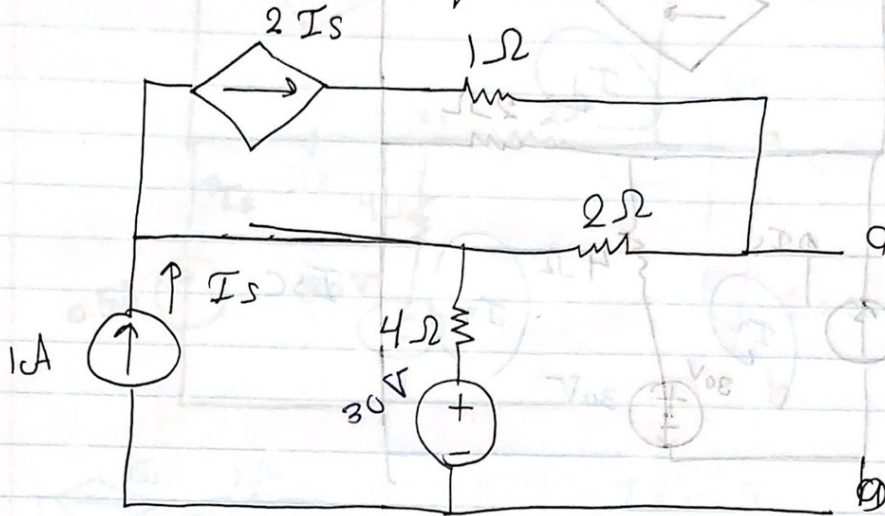
$$6 \parallel 6 = 3$$

$$I_0 = \frac{V}{R} = \frac{12}{12} = 1 \text{ A}$$

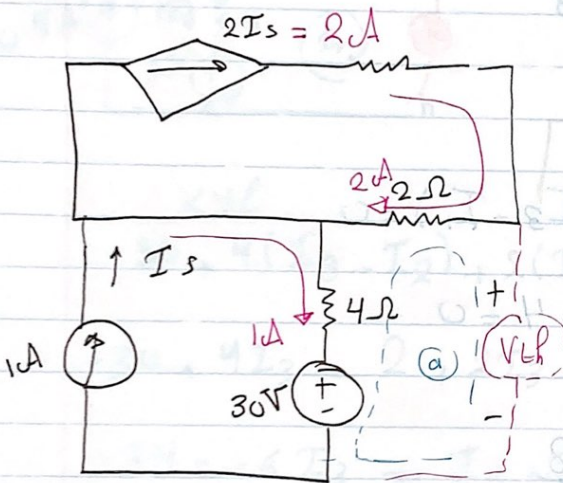


Kill $6V$ source

Find Thevenin's equivalent circuit a, b



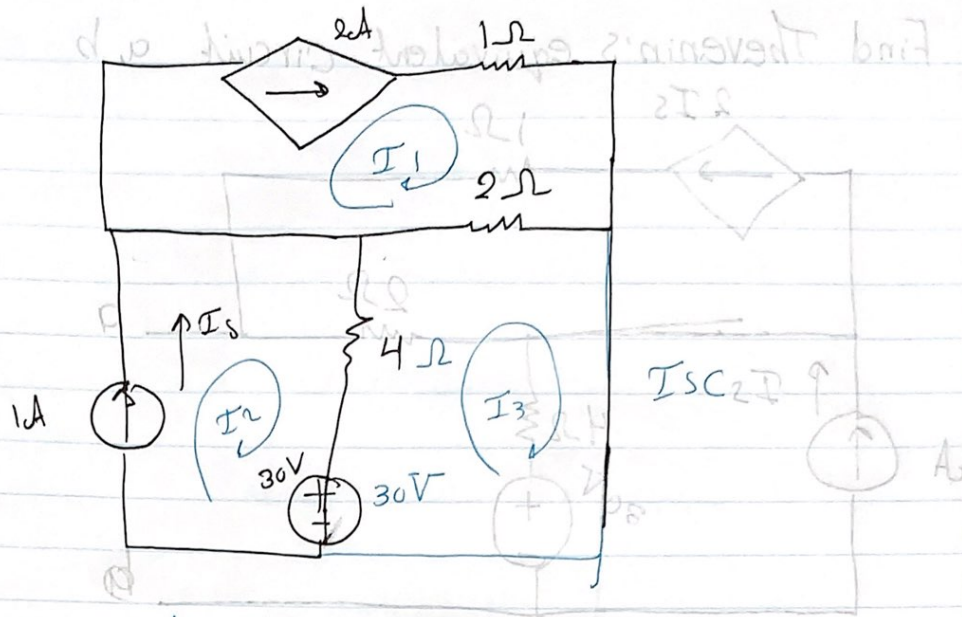
s1) $R_{th} = \frac{V_{th}}{I_{sc}}$



$R_{th} = \frac{V_{th}}{I_{sc}}$
 $I_s = 1A$

KVL

$-30 - 4 - 4 + V_{th} = 0$ $V_{th} = 38$



$$I_1 = 2A$$

$$I_2 = 1A \quad I_{SC} = -I_3$$

at mesh 3

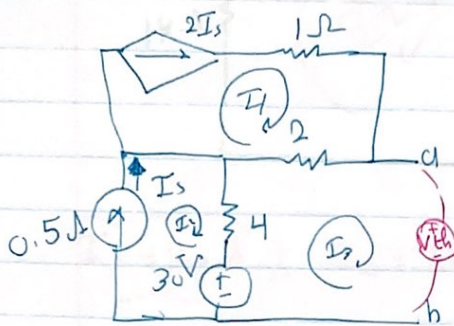
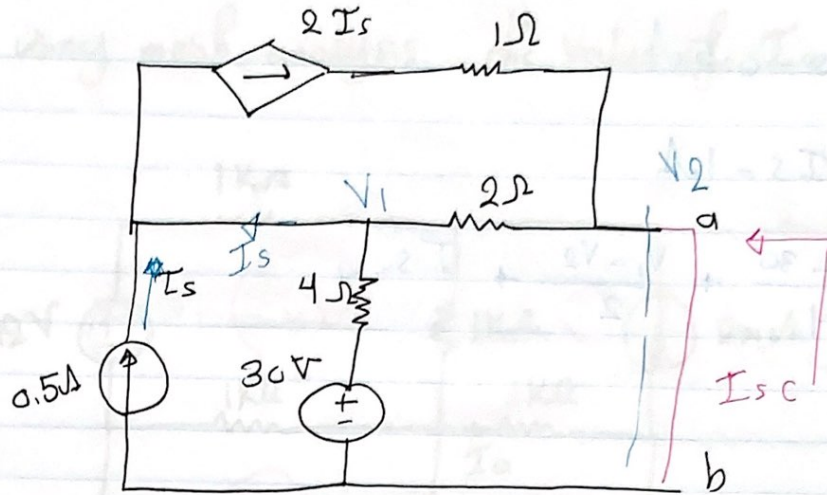
$$-30 + 4(I_3 - I_2) + 2(I_3 - I_1) = 0$$

$$-30 + 4I_3 - 4 + 2I_3 - 4 = 0$$

$$-38 = -6I_3 \quad I_3 = -\frac{38}{6}$$

$$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{38}{\frac{38}{6}} = 6\Omega$$

$$V_{th} = 38V \quad R_{th} = 6\Omega$$



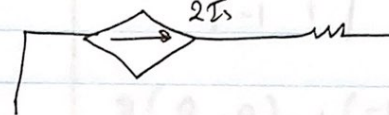
$$I_s = 0.5$$

$$I_1 = 1$$

$$I_2 = 0.5$$

-30

$$I_3 = -I_{sc} \Rightarrow I_{sc} = -I_3$$



KVL

$$-30 + 4(I_3 - I_2) + 2(I_3 - I_1) = 0$$

$$-30 + 4I_3 - 2 + 2I_3 - 2I_1 = 0$$

$$-34 = -6I_3 \Rightarrow I_3 = \frac{34}{6} \Rightarrow I_{sc} = -\frac{34}{6}$$

$$V_{th} \Rightarrow -30 + 4I_2 - 2I_1 + V_{th} = 0$$

$$-30 - 2 - 2 + V_{th} = 0$$

$$+34 = V_{th}$$

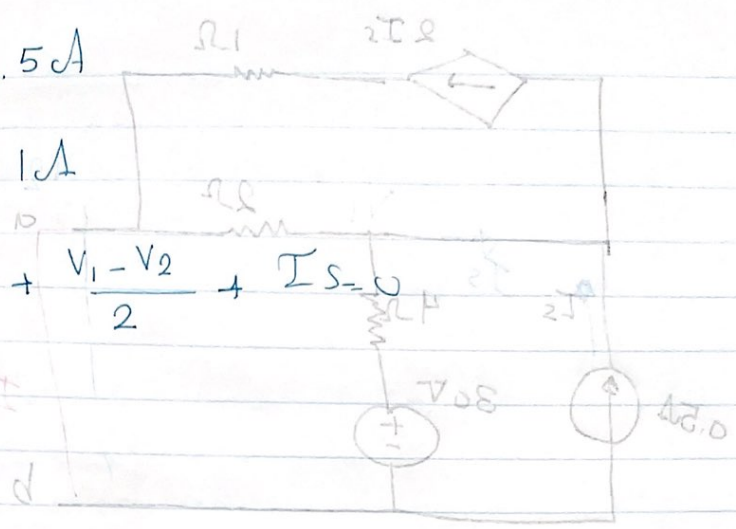
$$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{34}{\frac{34}{6}} = 6\Omega$$

$$V_{th} = 34V$$

$$I_s = 0.5 \text{ A}$$

$$2I_s = 1 \text{ A}$$

$$\frac{V_1 - 30}{4} + \frac{V_1 - V_2}{2} + I_s = 0$$



$$I_2 = 0.5$$

$$I_1 = 1$$

$$I_3 = 0.5$$

$$I_2 = 0.5 \text{ A}$$



$$0 = (I_1 - I_2)R + 2(I_2 - I_1)H + 30 + 4(I_2 - I_1) = 0$$

$$0 = 4I_2 - 2I_1 + 2I_2 - 4I_1 + 30 + 4I_2 - 4I_1 = 0$$

$$-3I_1 + 10I_2 = -30 \Rightarrow I_1 = \frac{10I_2 + 30}{3}$$

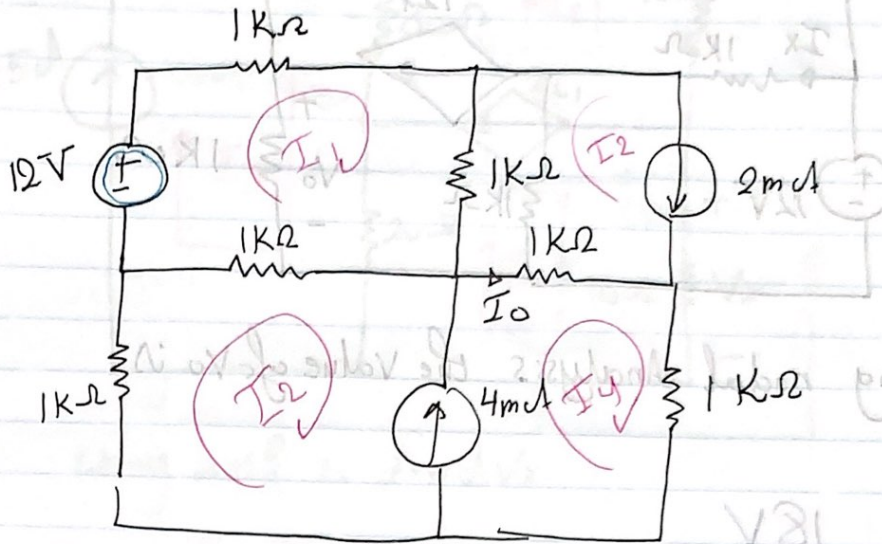
$$V_2 = 30 + 2I_2 = 30 + 2(0.5) = 31 \text{ V}$$

$$-30 = 2I_2 - 30 \Rightarrow I_2 = 0$$

$$I_2 = 0 \Rightarrow V_2 = 30 \text{ V}$$

$$+34 \text{ V} = 30 + 4I_2$$

Using mesh analysis the value of I_0 is equal



$I_1 = 2\text{mA}$ $I_0 = I_4 - I_2$

Mesh 1

$$-12 + 3kI_1 - 2 - 1kI_3 = 0$$

$$0.014 = 3I_1 - I_2$$

$$I_4 - I_3 = 4\text{mA}$$

$$3I_3 - I_1 + 2I_4 = 2\text{mA}$$

$$\begin{bmatrix} 3 & -1 & 0 \\ -1 & 2 & 2 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} 0.014 \\ 2\text{mA} \\ 4\text{mA} \end{bmatrix}$$

$I_0 = I_4 - I_2 = 1.63 \times 10^{-3} \text{A}$

$$\Delta = 3 \begin{vmatrix} 2 & 2 \\ -1 & 1 \end{vmatrix} + 1 \begin{vmatrix} -1 & 0 \\ -1 & 1 \end{vmatrix} + 0$$

$$3(2+2) + 1(-1)$$

$$12 - 1 = 11$$

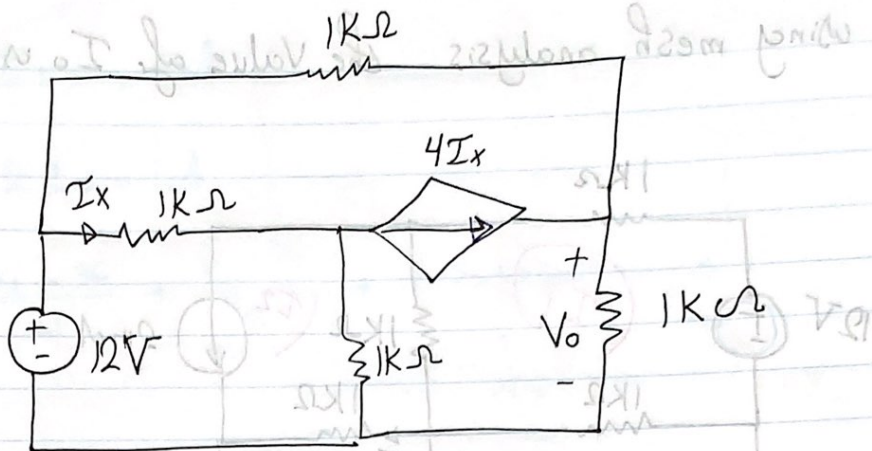
$$\Delta_3 = \begin{vmatrix} 3 & -1 & 0.014 \\ -1 & 2 & 2\text{mA} \\ 0 & -1 & 4\text{mA} \end{vmatrix}$$

$$3 \begin{pmatrix} 2 & 2 \times 10^{-3} \\ -1 & 4 \times 10^{-3} \end{pmatrix} + 1 \begin{pmatrix} -1 & 0.014 \\ -1 & 4 \times 10^{-3} \end{pmatrix}$$

$$3(0.01) + 0.01$$

$$= 0.04$$

$$I_4 = \frac{0.04}{11} = 3.63 \times 10^{-3}$$



Using nodal analysis the value of V_o is

18V

$$\begin{vmatrix} 0 & 1 & 0 \\ 1 & 1 & -1 \\ 1 & 1 & -1 \end{vmatrix} = \Delta$$

$$\Delta = 1(1-1) + 1(1-1) = 0$$

$$11 = 1 - 1 = 0$$

$$\begin{vmatrix} 1 & 0 & 0 \\ 1 & 1 & -1 \\ 1 & 1 & -1 \end{vmatrix} = \Delta_1$$

$$\begin{vmatrix} 1 & 0 & 0 \\ 1 & 1 & -1 \\ 1 & 1 & -1 \end{vmatrix} = \Delta_2$$

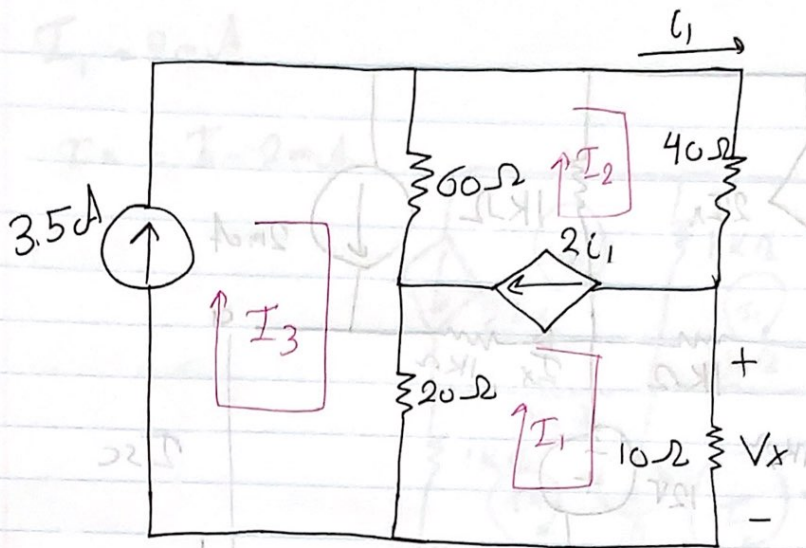
$$\Delta_2 = 1(1-1) + 1(1-1) = 0$$

$$11 = 1 - 1 = 0$$

$$V_o = \frac{\Delta_1}{\Delta} = \frac{0}{0} = 18V$$

$$\begin{vmatrix} 1 & 0 & 0 \\ 1 & 1 & -1 \\ 1 & 1 & -1 \end{vmatrix} = \Delta_3$$

$$\Delta_3 = 1(1-1) + 1(1-1) = 0$$



Using mesh to find V_x

$$2i_1 = I_2 - I_1$$

$$i_1 = I_2$$

$$I_3 = 3.5$$

$$I_2 = -I_1$$

Supermesh 1 & 2

$$0 = 30I_1 - 80I_3 + 10I_2$$

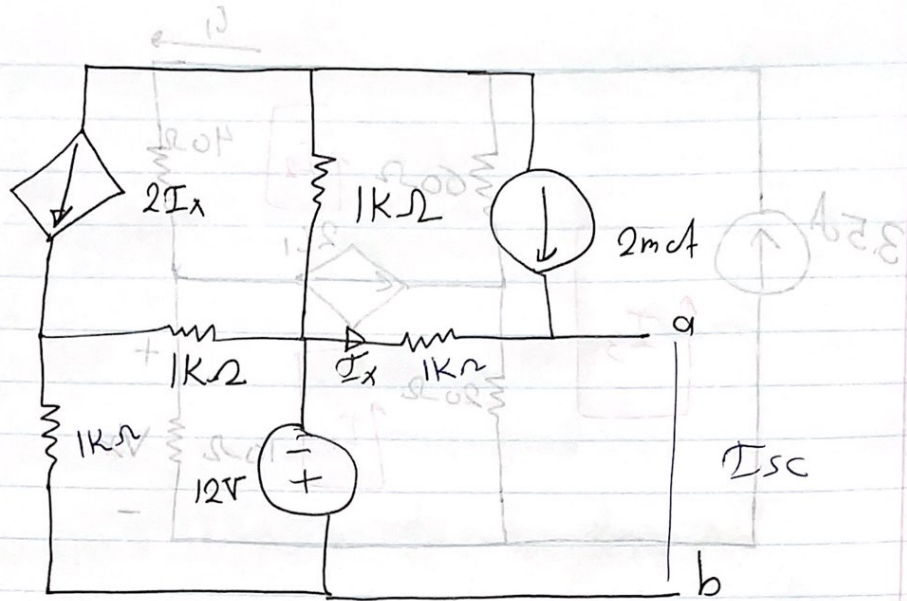
$$= 30I_1 - 280 + 100I_2$$

$$280 = 30I_1 - 100I_2$$

$$\frac{280}{-70} = \frac{-70I_1}{-70}$$

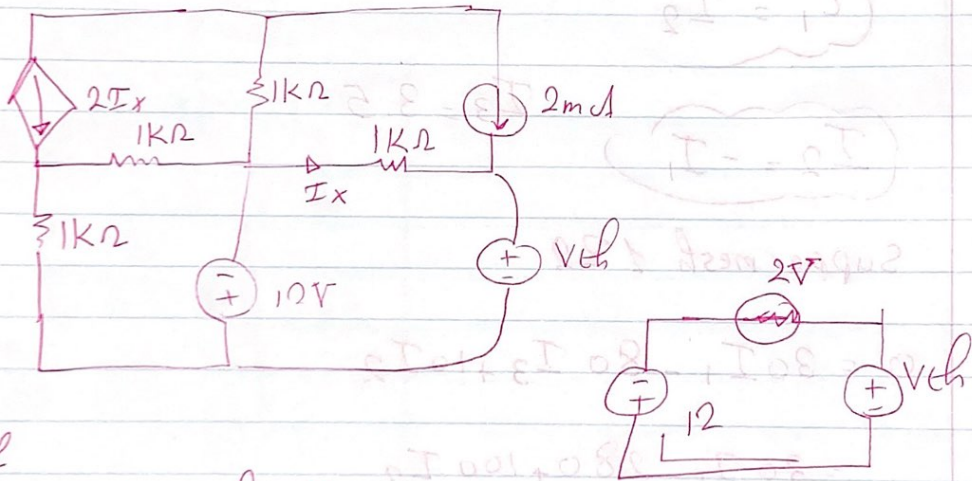
$$-4 = I_1$$

$$V_x = IR = -40V$$



$V_{th} = 3.29$

Source transformation



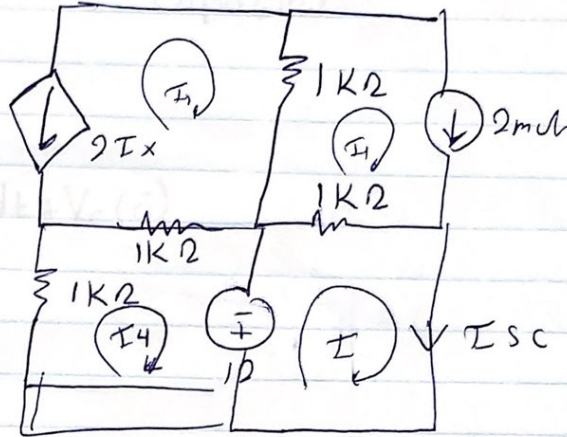
KVL
 $12V - 2V + V_{th} = 0$

$V_{th} = -10V$

T

$$I_1 = 2 \text{ mA}$$

$$I_x = I - 2 \text{ mA}$$



$$V_L(t) = 10 + 1k(I - 2 \text{ mA}) = 0$$

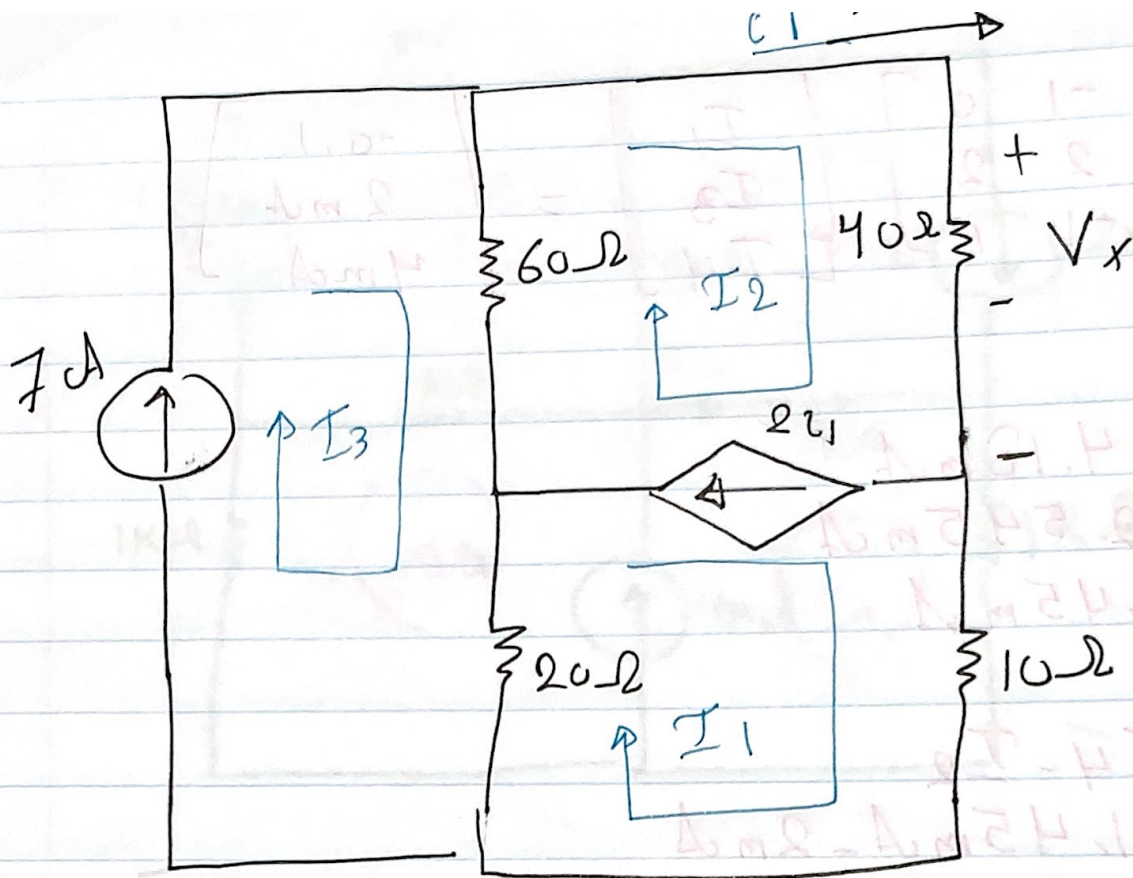
$$10 + 1kI - 2 = 0$$

$$10 + 1kI = 0$$

$$I = -10$$

$$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{-10}{-10} = 1k\Omega$$

(Non-homogeneous)



Find V_x using mesh analysis