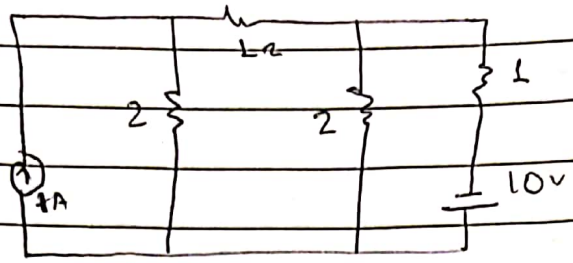
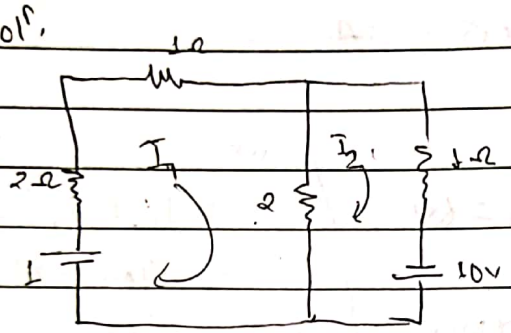
Tutorial - 2.

1) Using mesh analysis, obtain the current through the 10 V batteries for the circuit shown in fig.



=> Sol^n.



In mesh I

$$2I_1 + I_1 + 2(I_1 - I_2) = 2$$

$$3I_1 + 2I_1 - 2I_2 = 2$$

$$5I_1 - 2I_2 = 2 \quad \text{--- (i)}$$

In mesh II

$$I_2 + 2(I_2 - I_1) = 10$$

$$3I_2 - 2I_1 = 10 \quad \text{--- (ii)}$$

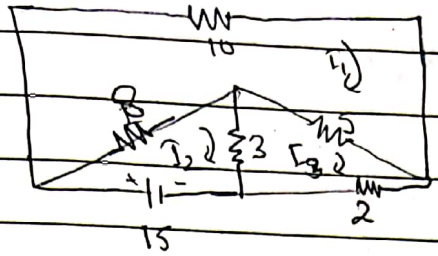
Solving (i) & (ii)

$$I_1 = 2.36\,A$$

$$I_2 = 4.9\,A$$

Current through 10V battery is 4.9A

2) What is the power loss in the 10Ω resistor in the network shown. Use mesh method.



In mesh I

$$10I_1 + 5(I_1 - I_3) + 8(I_1 - I_2) = 0$$
$$10I_1 + 5I_1 - 5I_3 + 8I_1 - 8I_2 = 0$$
$$23I_1 - 5I_3 - 8I_2 = 0 \quad \text{---(i)}$$

In mesh II

$$8(I_2 - I_1) + 3(I_2 - I_3) = 15$$
$$8I_2 - 8I_1 + 3I_2 - 3I_3 = 15$$
$$-8I_1 + 11I_2 - 3I_3 = 15 \quad \text{---(ii)}$$

In mesh III

$$5(I_3 - I_1) + 2I_3 + 3(I_3 - I_2) = 0$$
$$5I_3 - 5I_1 + 2I_3 + 3(I_3 - I_2) = 0$$
$$-5I_1 - 3I_2 + 10I_3 = 0 \quad \text{---(iii)}$$

Solve eqn (i), (ii) & (iii) we get

$I_1 = 1.23A$

$I_2 = 2.63A$

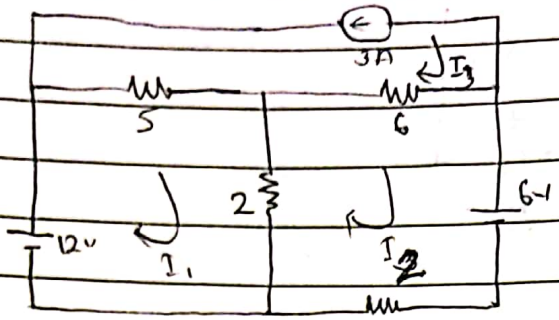
$I_3 = 1.39A$

Power loss at 10Ω is $I_1^2 \times R$

$= 1.23^2 \times 10$

$= 15.129$ W.

3) Determine the current through resistor using mesh method.



=> 3A

$I_3 = -3A$

In mesh I

$5(I_1 - I_3) + 2(I_1 - I_2) = 12$

$5I_1 + 15 + 2I_1 - 2I_2 = 12$

$7I_1 - 2I_2 = -3$ ——— (i)

In mesh II

$2(I_2 - I_1) + I_2 + 6(I_2 - I_3) = -6$

$2I_2 - 2I_1 + I_2 + 6I_2 + 18 = -6$

$-2I_1 + 9I_2 = -24$ ——— (ii)

Now eqn (i) & (ii) we get.

$I_1 = -1.27A$

$I_2 = -2.91A$

$I_3 = -3A$

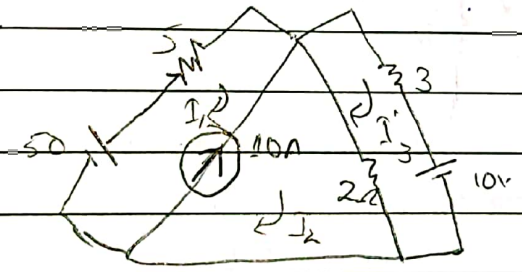
current through 5Ω = $I_1 - I_3$ = $-1.27 + 3$
= 1.73A

Current through 2Ω = $I_1 - I_2$ = $-1.27 + 2.95$
= 1.68A

Current through 6Ω = $I_2 - I_3$ = $-2.95 + 3$
= 0.05A

Current through 1Ω = I_2 = -2.95 A
= 2.95A (B → A)

4) Using Mesh analysis find current flow through 50V source.



$I_2 - I_1 = 10$

$-I_1 + I_2 = 10$ —(i)

Applying KVL in super mesh

$5I_1 + 2(I_2 - I_3) = 50$

$5I_1 + 2I_2 - 2I_3 = 50$ —(ii)

In mesh III

$3I_3 + 2(I_3 - I_2) = -10$

$3I_3 + 2I_3 - 2I_2 = -10$

$-2I_2 + 5 \cdot I_3 = -10$ —(iii)

solving

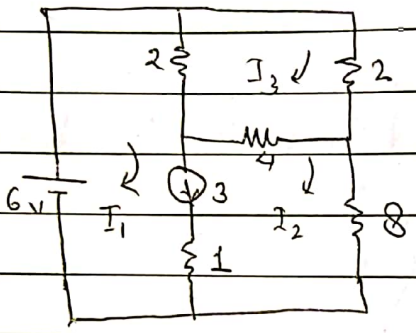
$I_1 = 5.48$

$I_2 = 15.48$

$I_3 = 4.19$

current through 50 V is 5.48 A.

(8) Use mesh analysis to determine i_1, i_2, i_3 in fig



⇒ soln,

$I_1 - I_2 = 3$ — (i)

Applying KVL on super mesh

$2(I_1 - I_3) + 4(I_2 - I_3) + 8I_2 = 6$

$2I_1 - 2I_3 + 4I_2 - 4I_3 + 8I_2 = 6$

$2I_1 + 12I_2 - 6I_3 = 6$ — (ii)

In mesh III

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

$2I_3 + 4I_3 - 4I_2 + 2I_3 - 2I_1 = 0$

$-2I_1 - 4I_2 + 9I_3 = 0$ — (iii)

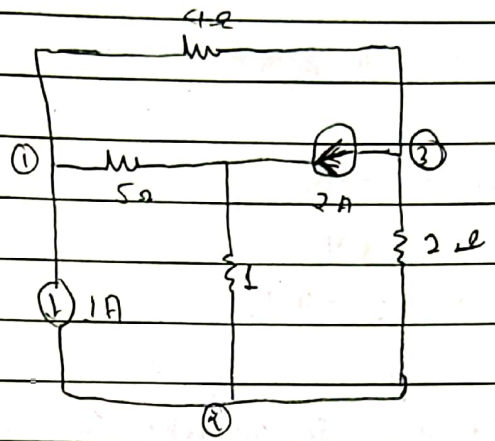
Solving the eqn. we get

$I_1 = 3.4\,A$

$I_2 = 0.4\,A$

$I_3 = 0.93\,A$

(10) Q. Find the current & voltage drop through 5 Ω resistor



⇒ Eqn.

Appling KVL on node (1)

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

$$-1 = \left(\frac{1}{3} + \frac{1}{4}\right) V_1 - \frac{1}{5} V_2 - \frac{1}{4} V_3$$

$$-1 = 0.45 V_1 - \frac{1}{5} V_2 - \frac{1}{4} V_3$$

$$-1 = 0.45 V_1 - 0.2 V_2 - 0.25 V_3 \quad \text{---(i)}$$

Appling KVL on node (2)

$$2 = \frac{V_2 - V_1}{5} + \frac{V_2 - V_1}{1}$$

$$2 = \left(\frac{-1}{5}\right) V_1 + \left(\frac{1}{6} + 1\right) V_2$$

$$2 = -0.2 V_1 + 1.2 V_2 \quad \text{---(ii)}$$

Applying KVL on node (iii)

$$\frac{V_4 - V_3}{2} = 2 + \frac{V_3 - V_1}{4}$$

$$\frac{0 - V_3}{2} = 2 + \frac{V_3}{4} - \frac{V_1}{4}$$

$$-2 = -\frac{V_1}{4} + \left(\frac{1}{2} + \frac{1}{4}\right) V_3$$

$$-2 = -0.25 V_1 + 0.75 V_3 \quad \text{(iii)}$$

Solving (i), (ii) & (iii)

$V_1 = -4V$,

$V_2 = 1V$

$V_3 = -4V$.

Current through 5Ω resistor $= \frac{V_2 - V_1}{5} = \frac{1 - (-4)}{5}$

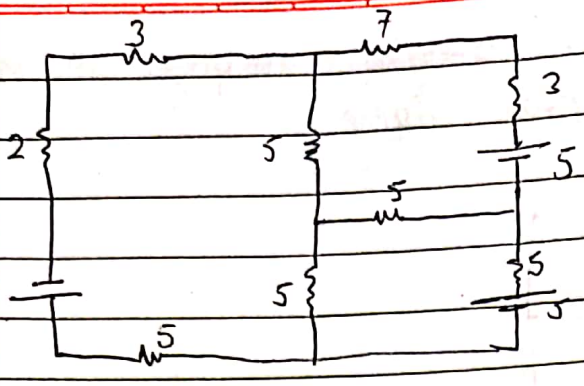
$= 1A$

Voltage drop through 5 resistor $= V_2 - V_1$

$= 1 - (-4)$

$= 5V$.

Q(5)



⇒ Soln,

Mesh I

$$-10 + 2I_1 + 3I_1 + 5(I_1 - I_2) + 5(I_1 - I_3) + 5I_1 = 0$$

$$\Rightarrow 2I_1 + 3I_1 + 5I_1 - 5I_2 + 5I_1 - 5I_3 + 5I_1 = 10$$

$$\Rightarrow 20I_1 - 5I_2 - 5I_3 = 10 \quad \text{---(1)}$$

Mesh II

$$-5 + 5I_2 - 5I_3 + 5I_2 - 5I_1 + 7I_2 + 3I_2 = 0$$

$$\Rightarrow 5I_2 + 5I_2 + 7I_2 + 3I_2 - 5I_3 - 5I_1 = 5$$

$$\Rightarrow -5I_1 + 20I_2 - 5I_3 = 5 \quad \text{---(2)}$$

Mesh III

$$-5 + 5I_3 - 5I_1 + 5I_3 - 5I_2 + 5I_1 = 0$$

$$5I_3 + 5I_3 + 5I_3 - 5I_1 - 5I_2 = 5$$

$$-5I_1 - 5I_2 + 15I_3 = 5 \quad \text{---(3)}$$

Solving (i), (ii) & (iii)

$I_1 = 0.88\,A$

$I_2 = 0.68\,A$

$I_3 = 0.85\,A$

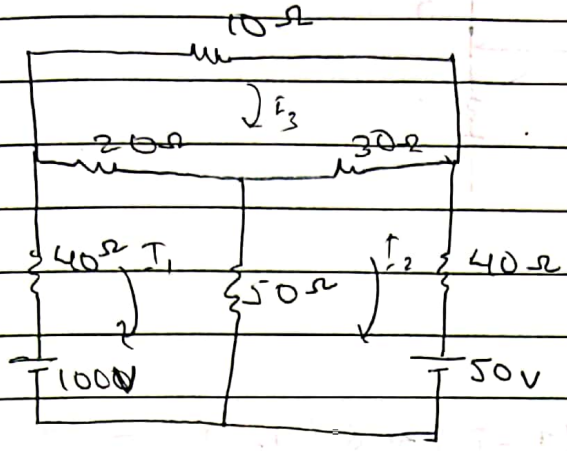
$P_{10} = I_1 V = 8.8\,W$

$P_5 = I_2 V = 3.4\,W$

$P_5 = I_3 V = 4.15\,W$

Q. Determine the current in 10Ω by applying Maxwell's loop-current method in given figure.

Sol":



In mesh (I)

$$100 - 40I_1 - 20[I_1 - I_3] - 50(I_1 - I_2) = 0$$
$$100 - 40I_1 - 20I_1 + 20I_3 - 50I_1 + 50I_2 = 0$$
$$100 - 110I_1 + 20I_3 + 50I_2 = 0 \quad \text{(i)}$$

In mesh (III)

$$-I_2 - (I_2 - I_3)30 - 20(I_2 - I_1) = 0$$
$$-10I_2 - 30I_2 + 30I_3 - 20I_2 + 20I_1 = 0$$
$$20I_1 - 60I_2 + 30I_3 = 0 \quad \text{(iii)}$$

In mesh II

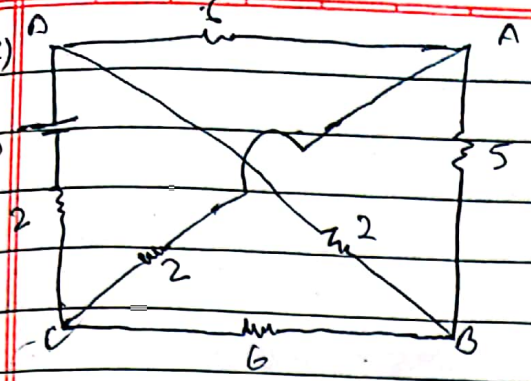
$$-50 - 50(I_2 - I_1) - 30(I_2 - I_3) - 40I_2 = 0$$
$$-50 - 50I_2 + 50I_1 - 30I_2 + 30I_3 - 40I_2 = 0 \quad \text{(ii)}$$
$$80I_1 = 120I_2$$

Solving eqn (i) (ii) & (iii) we get

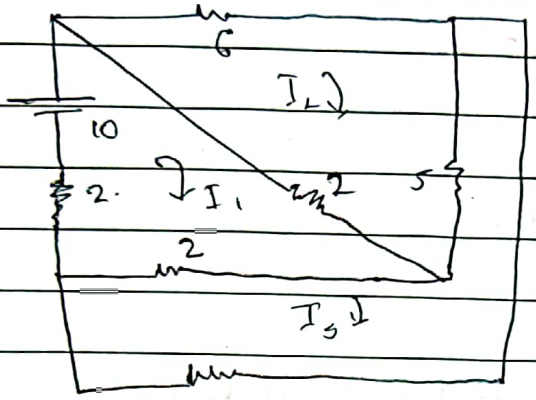
$I_1 = 1.034$ A
$I_2 = 0.1150$ A
$I_3 = 0.4023$ A

Current through 10Ω = $I_3 = 0.4025$ Amp.

(Q.7)



=> Soln



Mesh I

$$-6I_1 - 5(I_1 - I_3) - 2(I_1 - I_2) = 0$$

$$-6I_1 - 5I_1 + 5I_3 - 2I_1 + 2I_2 = 0$$

$$-13I_1 + 2I_2 + 5I_3 = 0 \quad \text{(i)}$$

Mesh II

$$10 - 2(I_2 - I_1) - 6(I_2 - I_3) - 2I_2 = 0$$

$$10 - 2I_2 + 2I_1 - 6I_2 + 6I_3 - 2I_2 = 0$$

$$10 - 10I_2 + 2I_1 + 6I_3 = 0$$

$$2I_1 - 10I_2 + 6I_3 = -10 \quad \text{(ii)}$$

Mesh III

$$-2I_3 - 6(I_3 - I_2) - 5(I_3 - I_1) = 0$$

$$-2I_3 - 6I_3 + 6I_2 - 5I_3 + 5I_1 = 0$$

$$-13I_3 + 6I_2 + 5I_1 = 0$$

$$5I_1 + 6I_2 - 13I_3 = 0 \quad \text{(iii)}$$

solving eqn (i) (ii) & (iii)

$I_1 = 0.7$ A

$I_2 = 1.8$ A

$I_3 = 1.1$ A

voltage across AB

current $= I_2 - I_3$

$= 0.4$ Amp

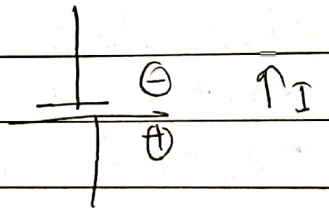
$V = IR$

$= 0.4 \times 2 \quad = 0.8.$

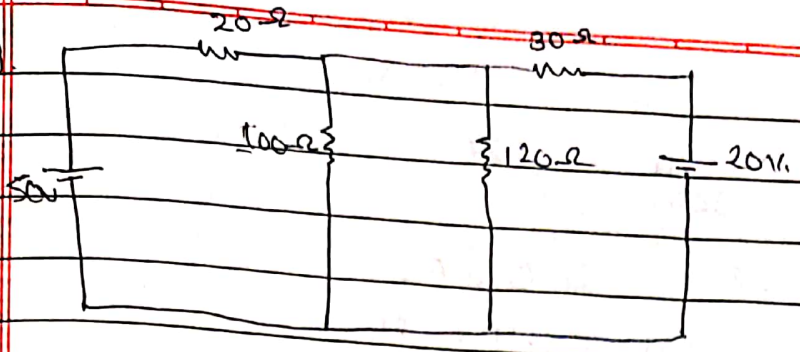
$= 2V$

since the direction of current is clockwise

polarity



Q.9



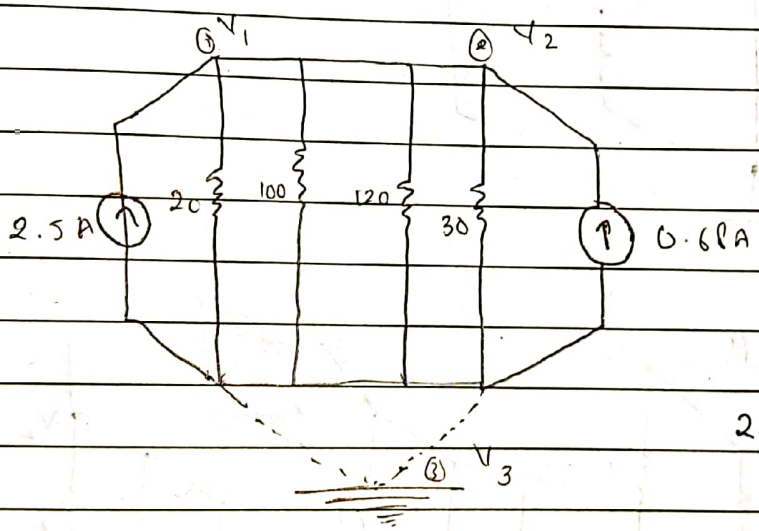
The voltage source is transformable to current source

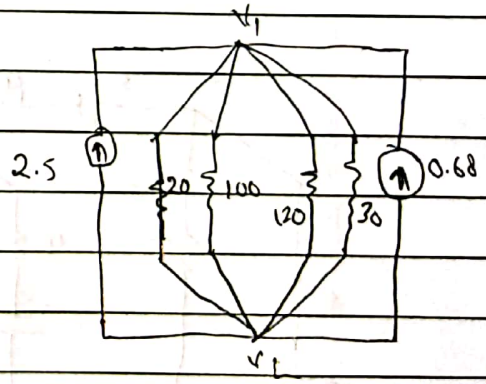
$V = IR$

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

50V V.S $\longrightarrow$ 2.5 Amp C.S.

20V V.S $\longrightarrow$ 0.68 Amp C.S.





At node (1)

$\Sigma I_{(incoming)} = \Sigma I_{(outgoing)}$

$$2.5 + 0.68 = \left(\frac{V_1 - V_2}{20}\right) + \left(\frac{V_1 - V_2}{100}\right) + \left(\frac{V_1 - V_2}{120}\right) + \left(\frac{V_1 - V_2}{30}\right)$$

$V_2 = 0$

$$3.18 = \left(\frac{1}{20} + \frac{1}{100} + \frac{1}{120} + \frac{1}{30}\right) V_1$$

$$V_1 = 3.18 \times \frac{600}{61}$$

$$V_1 = 31.27 \text{ V}$$

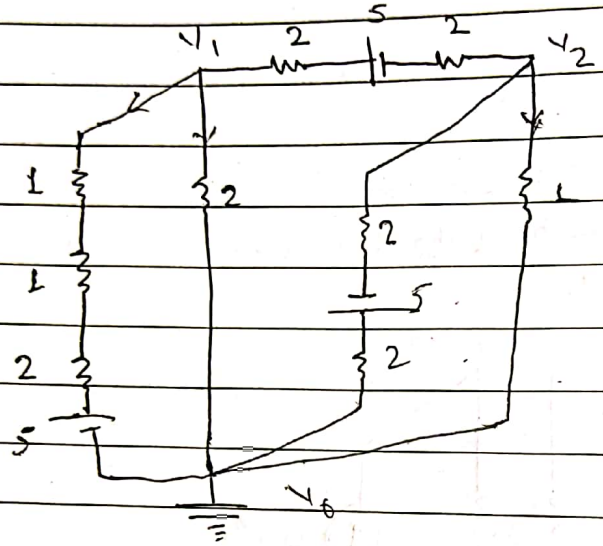
Current through 100Ω resistor is

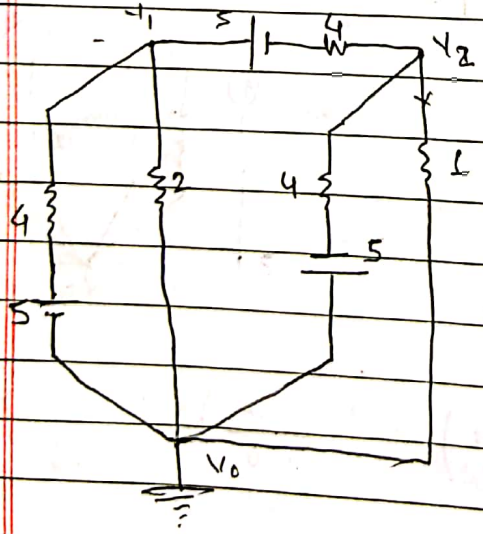
$$I = \frac{V_1 - V_2}{100} = \frac{3.27}{100}$$

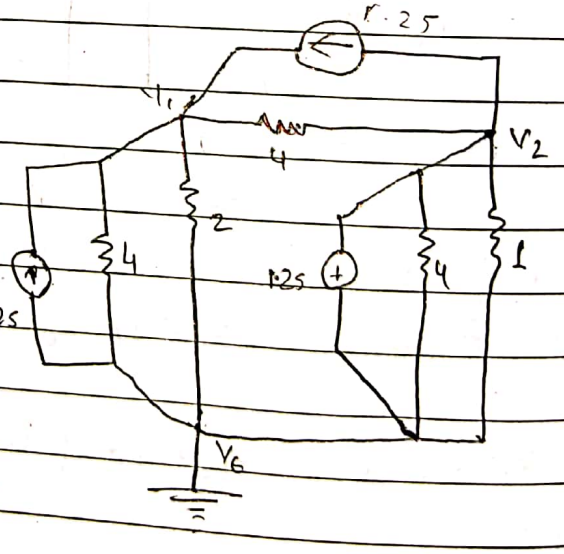
$$= 0.31 \text{ Amp}$$

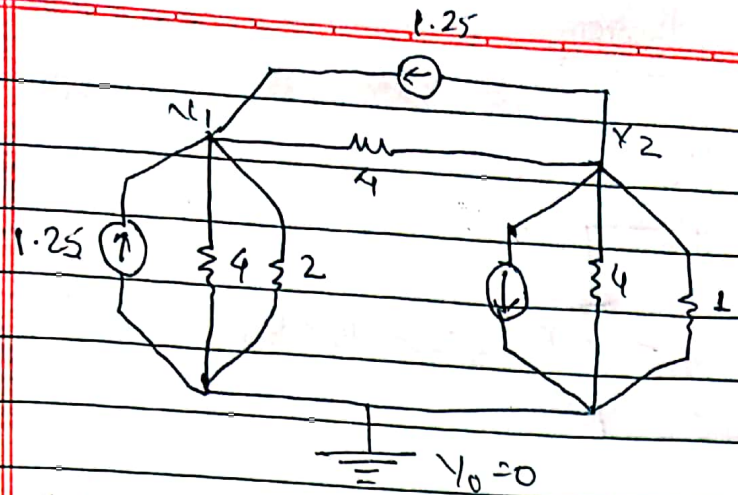
i.e. 3.11 m Amp

Q (i)









At V_1

Σ (Incoming) $= \Sigma$ (outgoing)

$$1.25 + 1.25 = \left(\frac{V_1 - V_2}{4}\right) + \left(\frac{V_1 - V_0}{4}\right) + \left(\frac{V_1 - V_0}{2}\right)$$

$$2.5 = \frac{1}{4}V_1 - \frac{1}{4}V_2 + \frac{1}{4}V_1 + \frac{1}{2}V_1$$

$$2.5 = V_1 - \frac{1}{4}V_2$$

$$V_1 - 0.25V_2 = 2.5 \quad \text{---(i)}$$

At V_2

Σ (incoming) $= \Sigma$ (outgoing)

$$0 = 1.25 + 1.25 + \frac{V_1 - V_1}{4} + \frac{V_2 - V_0}{1} + \frac{V_2 - V_0}{4}$$

$$-2.5 = \frac{1}{4}V_2 - \frac{1}{2}V_1 + V_2 + \frac{1}{4}V_2$$

$$-2.5 = -0.25V_1 + 1.5V_2$$

$V_1 = 2.13$

$V_2 = -1.30$

Current flowing from 5V. $I = \frac{V_1}{A} = \frac{1.25}{}$

$= 0.7075$ Amp.

From 5V

$I = \frac{V_2}{4} + 1.25 = 0.925$ A

From another 5V

$I = \frac{V_1 - V_2 - 1.25}{4}$

$= 0.8675 - 1.25$

$= -0.3825$ Amp.