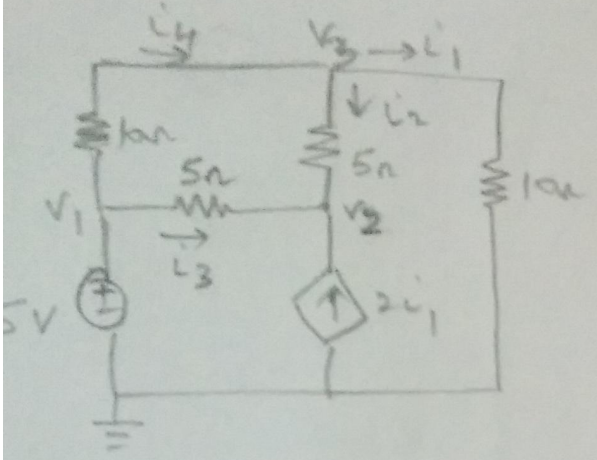
uestion 1.



$V_1 = 5$ V

$i_1 = \frac{V_3}{10}$

@ node 2.

$$\frac{V_1 - V_2}{5} + \frac{V_3 - V_2}{5} + 2i_1 = 0$$

$$\frac{5 - V_2}{5} + \frac{V_3 - V_2}{5} + 2 \times \frac{V_3}{10} = 0$$

or $2V_2 - 2V_3 = 5$ — (1)

@ node 3,

$$\frac{5 - V_3}{10} = \frac{V_3}{10} + \frac{V_3 - V_2}{5}$$

or $-2V_2 + 4V_3 = 5$ — (2)

Solving (1) & (2)

$V_2 = \frac{15}{2}$ V $= 7.5$ V

$V_3 = 5$ V

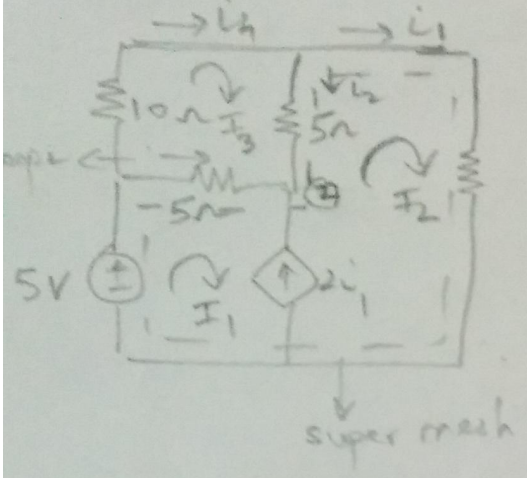
$i_1 = \frac{5}{10} = 0.5$ A

$i_2 = \frac{V_3 - V_2}{5} = -0.5$ A

$i_3 = \frac{V_1 - V_2}{5} = -0.5$ A

$i_4 = \frac{V_1 - V_3}{10} = 0$ A

Question 2



in super mesh,

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

$$5 I_1 + 15 I_2 - 10 I_3 = 5 \quad -(1)$$

in loop 2,

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

$$-5 I_1 - 5 I_2 + 20 I_3 = 0 \quad -(2)$$

$I_2 = i_1$

@ node 2; $2i_1 = I_2 - I_1$

or $I_1 = -i_1$

$\Rightarrow I_2 = -I_1$ or $I_1 + I_2 + 0 I_3 = 0$ $\quad -(3)$

Substituting this in (1) & (2) & solving,

$I_1 = -0.5$ A $\qquad i_1 = 0.5$ A

$I_2 = 0.5$ A $\qquad i_2 = -0.5$ A

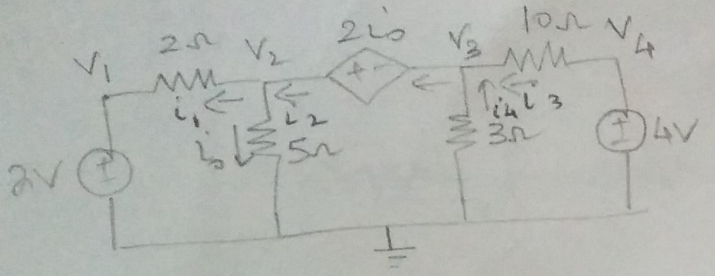
$I_3 = 0$ A $\qquad i_3 = -0.5$ A

$i_4 = 0$ A

$\Rightarrow V_3 = 0.5 \times 10 = 5$ V $\qquad V_3 = 5$ V

$\frac{5 - V_2}{5} = I_1$ or $V_2 = \frac{15}{2}$

Question 3 :



$V_1 = 2V$

$V_4 = 4V$

⊖ supernode 2 - 3,

$$\frac{V_2 - V_1}{2} + \frac{V_2}{5} = -\frac{V_3}{3} + \frac{V_4 - V_3}{10}$$

$$\frac{V_2 - 2}{2} + \frac{V_2}{5} = -\frac{V_3}{3} + \frac{4 - V_3}{10}$$

$$0.7V_2 - 1 = -0.433V_3 + 0.4$$

$$0.7V_2 = -0.433V_3 + 1.4 \quad — (1)$$

$V_2 - V_3 = 2i_o$ & $i_o = \frac{V_2}{5}$

$\Rightarrow 0.6V_2 = V_3$

substituting in (1)

$0.7V_2 = -0.433 \times 0.6\, V_2 + 1.4$

$0.7V_2 = -0.26V_2 + 1.4$

$V_2 = 1.46\ V$

$V_3 = 0.875\ V$

$i_1 = \frac{V_2 - V_1}{2} = -0.27$ A

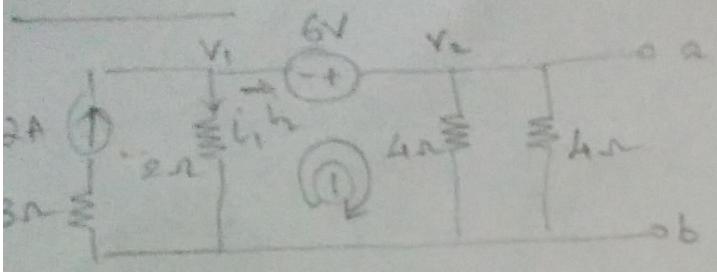
$i_o = \frac{V_2}{5} = 0.29$ A

$i_2 = 0.02$ A

$i_4 = \frac{-V_3}{3} = -0.29$

$i_3 = \frac{V_4 - V_3}{10} = 0.3$

Question 4



$V_2 - V_1 = 6V$

$i_1 + i_2 = 2 \quad -①$

KVL around loop 1

$-2i_1 - 6 + i_2(4||4) = 0$

$2i_2 - 2i_1 = 6 \quad -②$

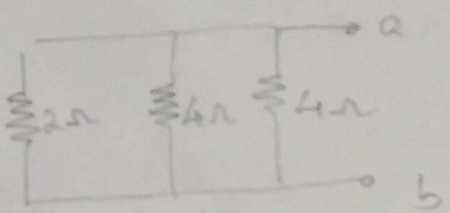
solving ① & ②

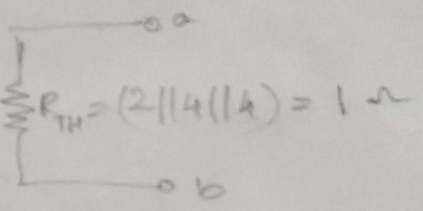
$i_2 = 2.5\ A$

$i_1 = -0.5\ A$

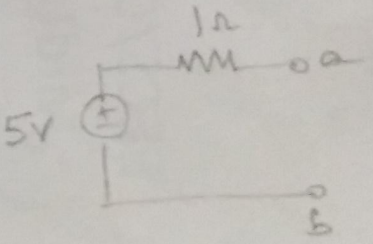
$\therefore V_{TH} = 4\left(\frac{i_2}{2}\right) = 5\ V$

To find R_{TH}, short the voltage source & open the current source.

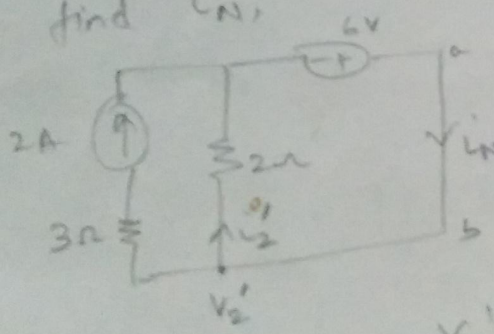




Thevenin circuit,



To find i_N,



at node 2',

$V_2' = 6V$

$i_N = 2 + \frac{V_2'}{2}$

$i_N = 2 + \frac{6}{2} = 5\ A$

Norton circuit,