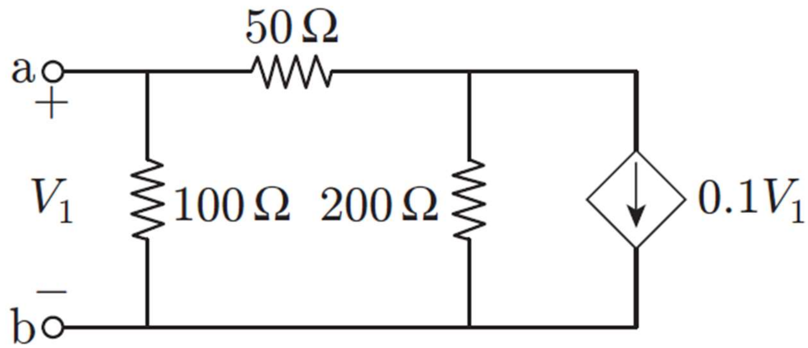
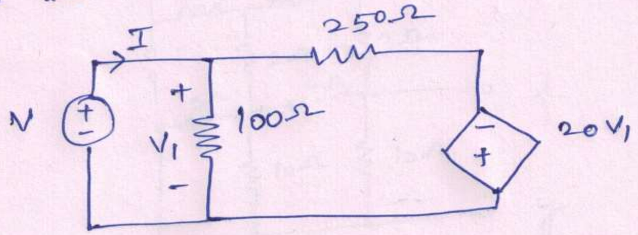
1. Determine the Thevenin equivalent resistance R_{Th} between terminals a and b, shown in the figure below.



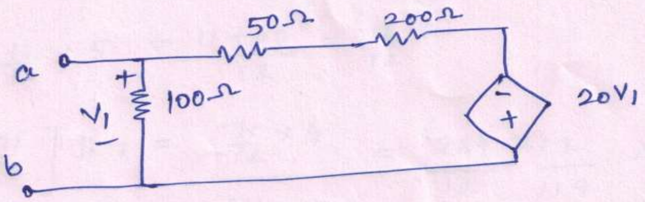
Sol^n: The problem can be solved using source transformation.

The N/W contains only dependent source, therefore its $V_{TH} = 0$

For finding, R_{TH}, one test voltage 'V' is applied b/w terminals a and b.



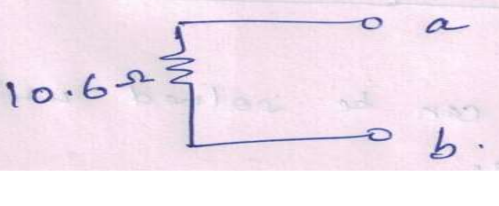
$$-I + \frac{V}{100} + \frac{V + 20V_1}{250} = 0$$



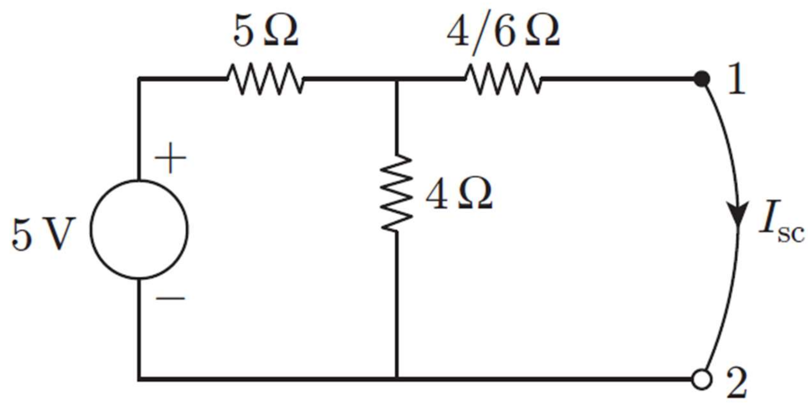
Here, $V = V_1$, therefore

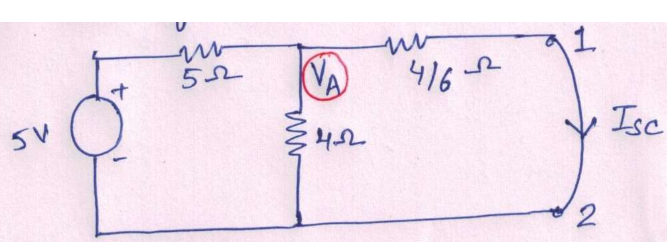
$$I = \frac{V}{100} + \frac{21V}{250}$$

$$\frac{V}{I} = R_{TH} = \frac{500}{47} = 10.6\Omega$$



2. In the Norton's equivalent of the given network, the values of current, I_{sc}, and Thevenin equivalent resistance, R_{Th}, are, respectively:





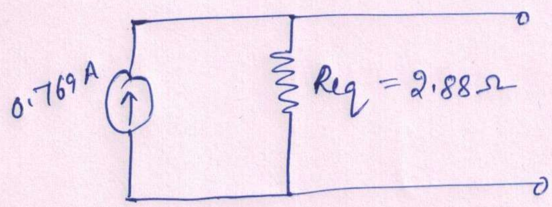
Sol^n: Consider the given circuit, the nodal analysis of node 1 gives :

$$\frac{V_A-5}{5} + \frac{V_A}{4} + \frac{V_A \times 6}{4} = 0$$

$$\frac{4A - 20 + 5V_A + 30V_A}{20} = 0$$

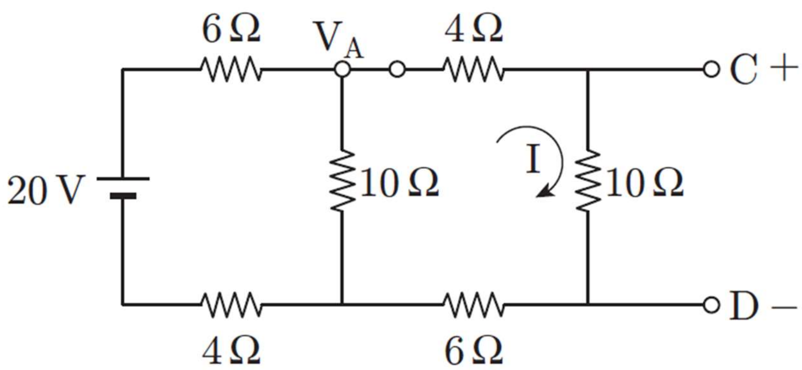
or $39 V_A = 20 \Rightarrow V_A = \frac{20}{39} = 0.512V$

$$I_{sc} = \frac{0.512 \times 6}{4} = 0.769 \text{ A}$$



$$R_{eq} = \frac{4}{6} + \frac{20}{9} = 2.88\,\Omega$$

3. Find the parameters of Thevenin equivalent circuit for the following circuit.



Sol^n: From the circuit,

$$\frac{V_A-20}{6}+\frac{V_A}{10}+\frac{V_A}{20}=0$$

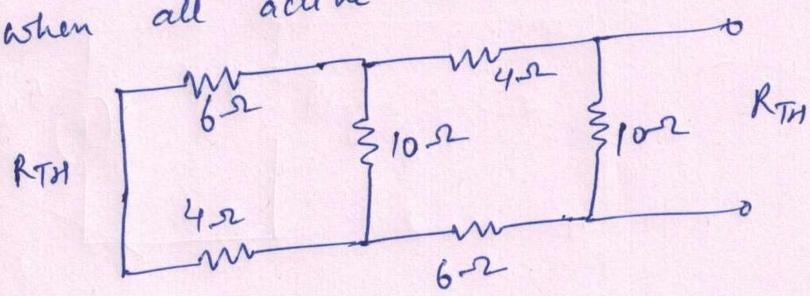
$$2V_A-40+2V_A+V_A=0$$

$$5V_A=40 \implies V_A=8\,V$$

$$I=\frac{8}{20}=0.4\,A$$

$$V_{CD}=10\times 0.4=4\,V.$$

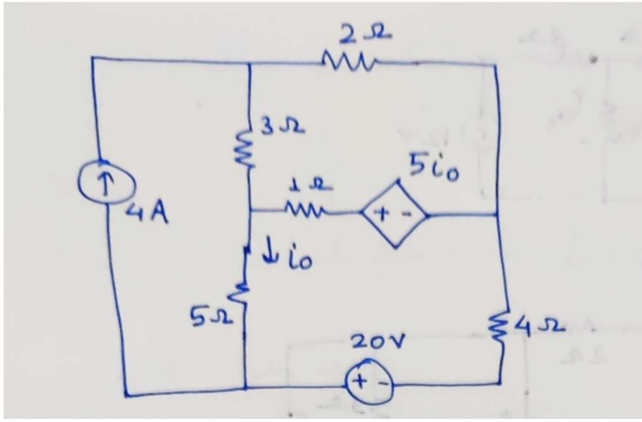
The equivalent resistance across the terminals, when all active sources are zero is :-



$$\Rightarrow\left(\frac{10\times10}{20}+10\right)\|10=\frac{15\times10}{25}=6\,\Omega.$$

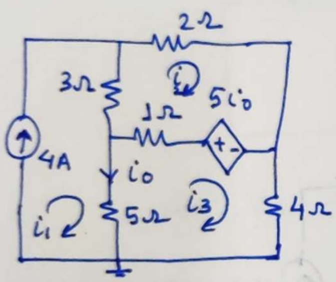
$\boxed{R_{TH}=6\,\Omega}$ $\boxed{V_{TH}=4\,V}$

4. Find the current i_o in the following circuit using superposition theorem.



Solution -

For 4A Source



For loop 1, $i_1 = 4A$

For loop 2,

$-3i_1 - 6i_2 - i_3 - 5i_o = 0$

For loop 3

$-5i_1 - i_2 + 10i_3 + 5i_o = 0$

At ground node,

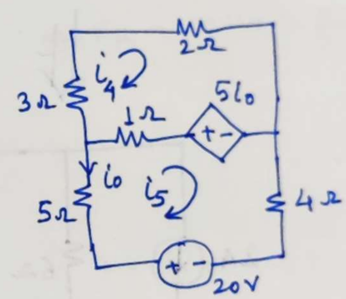
$i_3 = 4 - i_o$

∴ $3i_2 - 2i_o = 8$

$i_2 + 5i_o = 20$

∴ $i_o = \frac{52}{17}$ A

For 20V source



For loop-4

$6i_4 - i_5 - 5i_o = 0$

For loop - 5

$-i_4 + 10i_5 - 20 + 5i_o = 0$

also $i_5 = -i_o$

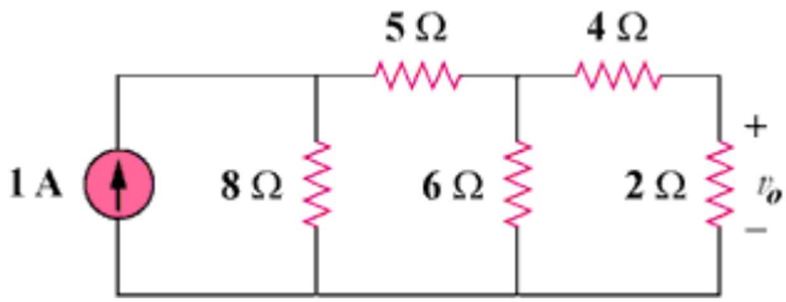
∴ $6i_4 - 4i_o = 0$

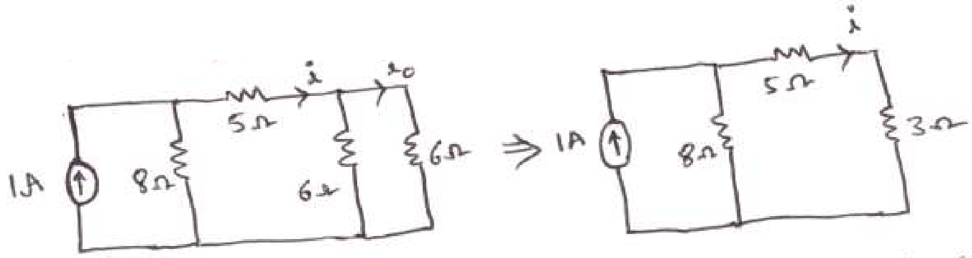
$i_4 + 5i_o = -20$

∴ $i_o = -\frac{60}{17}$ A

Resultant $\boxed{i_o = \frac{-8}{17} \text{ Amp}}$

5. Find V0 in the circuit below where the source is 1 Ampere current source. Let this v_0 be $v_{0,old}$. Now, if the current source is reduced to 1 mA and the v_0 be $v_{0,new}$, the values of $v_{0,old}$ and $v_{0,new}$ respectively are,





⇒ Since we have two parallel 8Ω resistors, current gets divided equally. So, $i = 0.5$ A.

⇒ From this circuit, we can see that 'i' gets divided equally along two parallel 6Ω resistors. So, $i_o = 0.25$ A

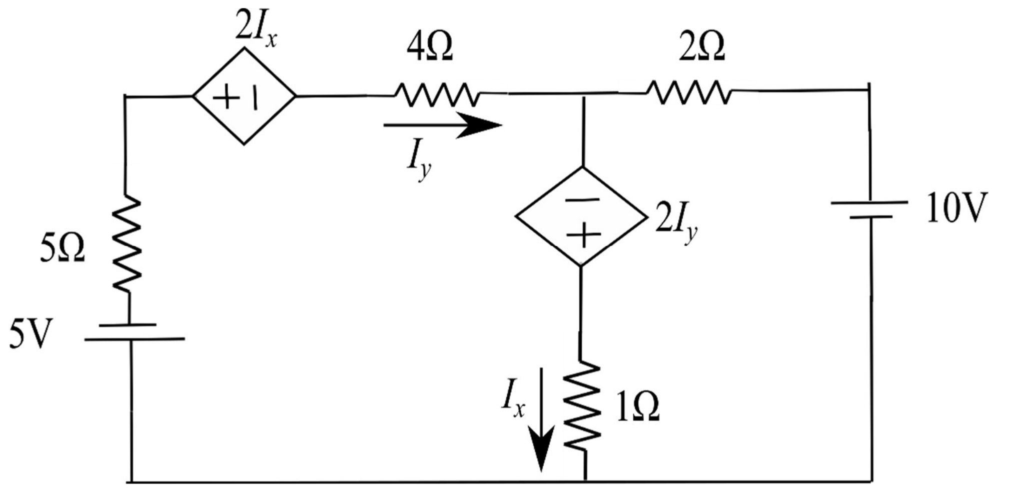
⇒ So, current through 2Ω resistor in the original circuit is $i_o = 0.25$ A. So, $v_o = 2 \times 0.25 = 0.5$ V. $\boxed{V_{o,old} = 0.5V}$

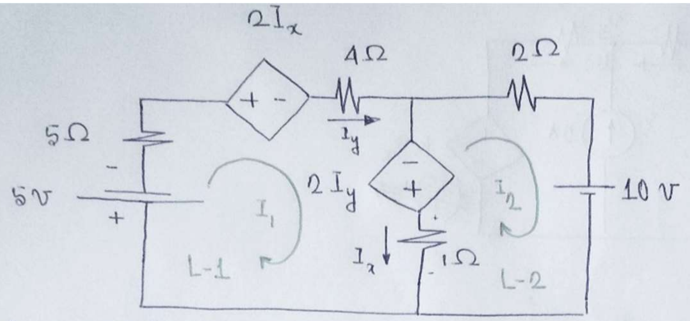
⇒ If current source is reduced to 1mA, by linearity principle, 'v_o' also gets reduced by same proportion.

Source		v_o
1 A	⟶	0.5 V
1 mA	⟶	0.5 mV

⟶ $\boxed{V_{o,new} = 0.5 \text{ mV}}$

6. Find the value of I_x in the circuit shown in figure below -





$I_y = I_1$

$I_x = I_1 - I_2$

Loop eqn. for L-1 is:-

$$5 + 5I_1 + 2I_x + 4I_1 - 2I_y + I_x = 0$$

or, $5 + 9I_1 + 3I_x - 2I_y = 0$

or $5 + 9I_1 + 3(I_1 - I_2) - 2I_1 = 0$

or $5 + 10I_1 - 3I_2 = 0$ ———— (1)

Loop eqn. for L-2 is:-

$$I_x - 2I_y - 2I_2 - 10 = 0$$

or, $I_1 - I_2 - 2I_1 - 2I_2 - 10 = 0$

or, $-I_1 - 3I_2 - 10 = 0$

or $I_1 + 3I_2 + 10 = 0$ ———— (2)

Solving (1) & (2) we get,

$$I_1 = -1.3636 \text{ A}$$

$$I_2 = -2.8787 \text{ A}$$

$$I_x = I_1 - I_2 = 1.5152 \text{ A} \quad (\text{A})$$