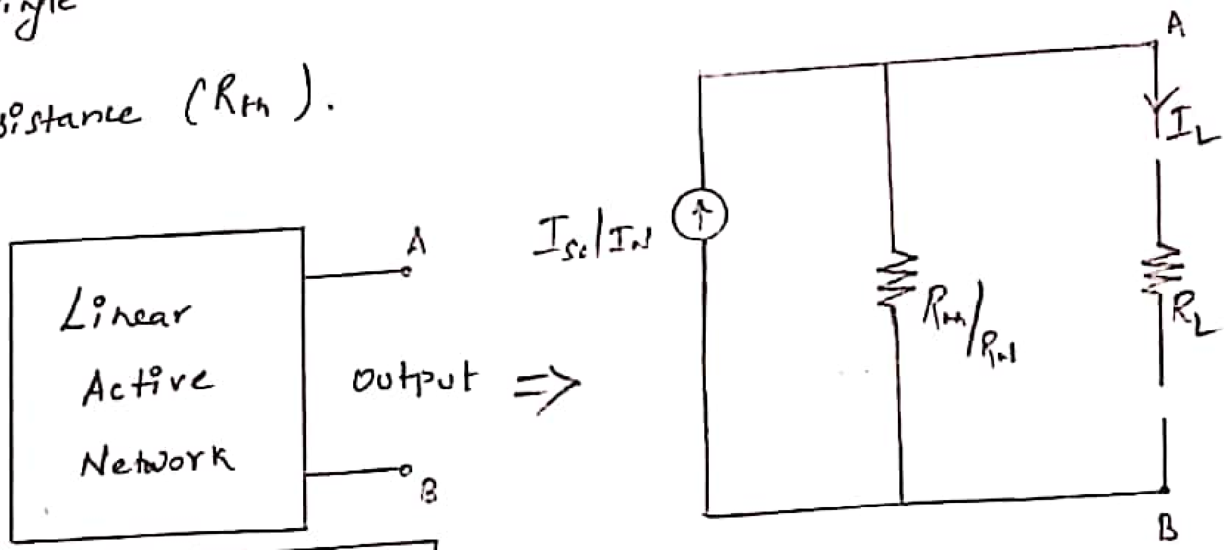
Norton's theorem:

Statement: Any linear active network can be replaced by a single current source (I_{sc}) in parallel with a single resistance (R_{th}).

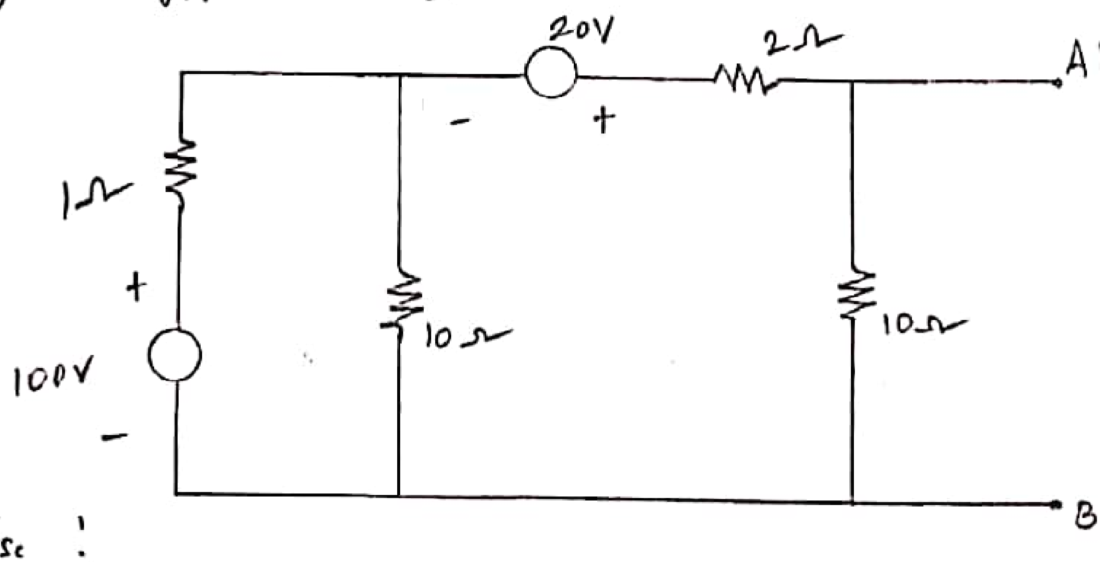


$$\boxed{I_L = \frac{I_{sc} R_{th}}{R_{th} + R_L}}$$

Steps to find I_{sc} / I_N and R_{th} / R_N :

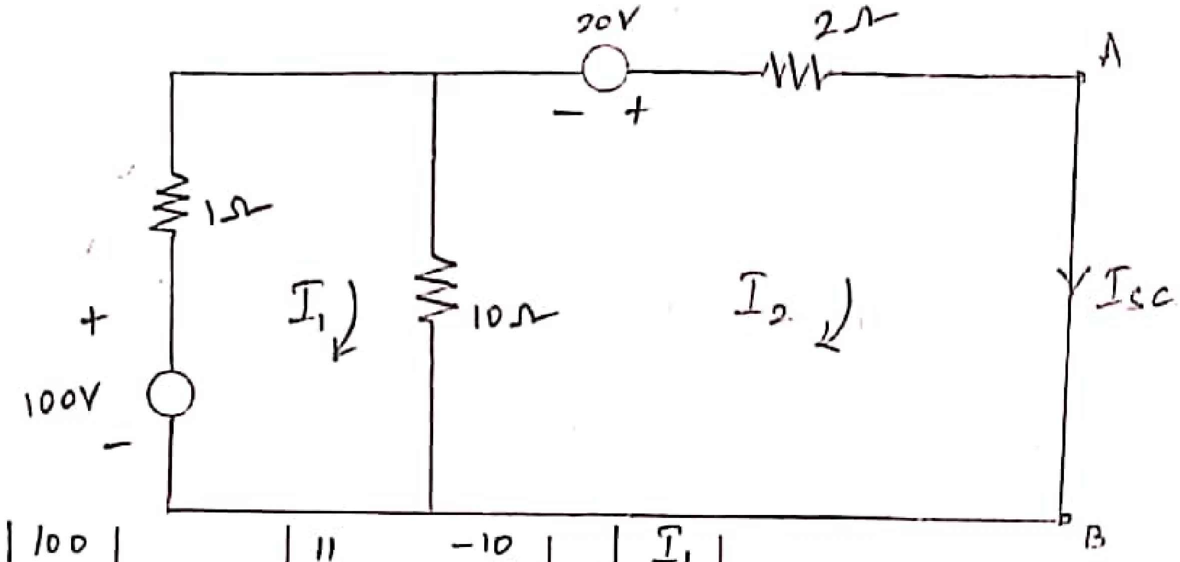
1. Remove R_L , mark the terminals A, B
2. Short circuit the terminals A, B , Find I_{sc} / I_N
3. Remove R_L, mark the terminals A, B
4. Kill the Sources (open circuit the current Source short circuit the voltage source)
5. Find R_{th}

1. Obtain the Norton's equivalent circuit at the terminals A & B for the network shown.



I_N / I_{sc} :

1. Remove R_L , . Mark terminals A & B
2. Short circuit terminals A & B, Find I_{sc} / I_N



$$\begin{vmatrix} 100 \\ 20 \end{vmatrix} = \begin{vmatrix} 11 & -10 \\ -10 & 12 \end{vmatrix} \begin{vmatrix} I_1 \\ I_2 \end{vmatrix}$$

$$\Delta = \begin{vmatrix} 11 & -10 \\ -10 & 12 \end{vmatrix} = 132 - 100$$

$$= 32$$

$$\boxed{\Delta = 32}$$

$$\Delta_2 = \begin{vmatrix} 11 & 100 \\ -10 & 20 \end{vmatrix} = 220 + 1000$$

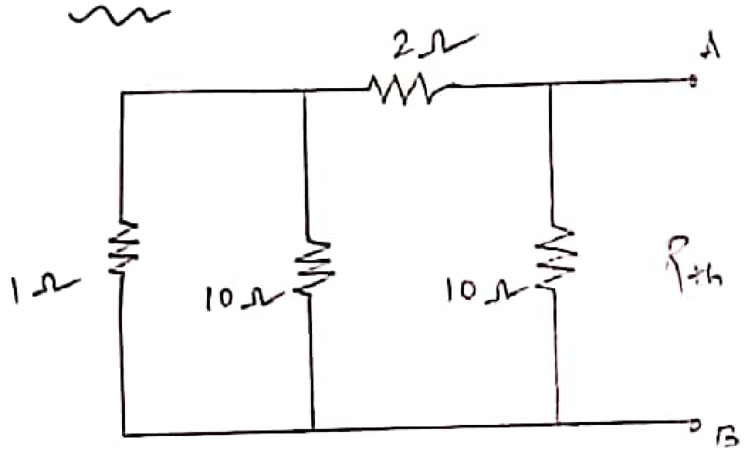
$$= 1220$$

$$\boxed{\Delta_2 = 1220}$$

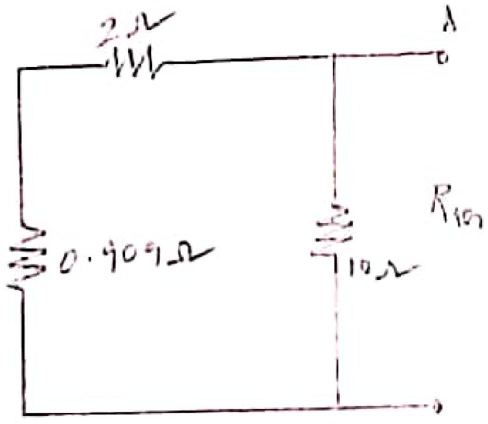
$$I_2 = \frac{\Delta_2}{\Delta} = \frac{1220}{32} = 38.125\ A$$

$$\boxed{I_{sc} / I_N = I_2 = 38.125\ A.}$$

R_{th} :

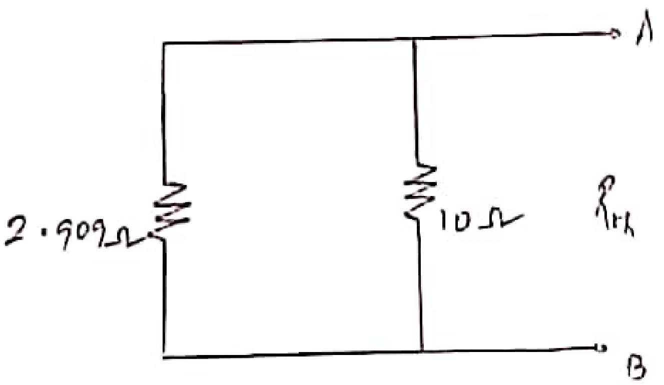


$\Rightarrow$



$$\frac{1 \times 10}{1+10} = \frac{10}{11} = 0.909 \Rightarrow$$

$$2 + 0.909 = 2.909$$

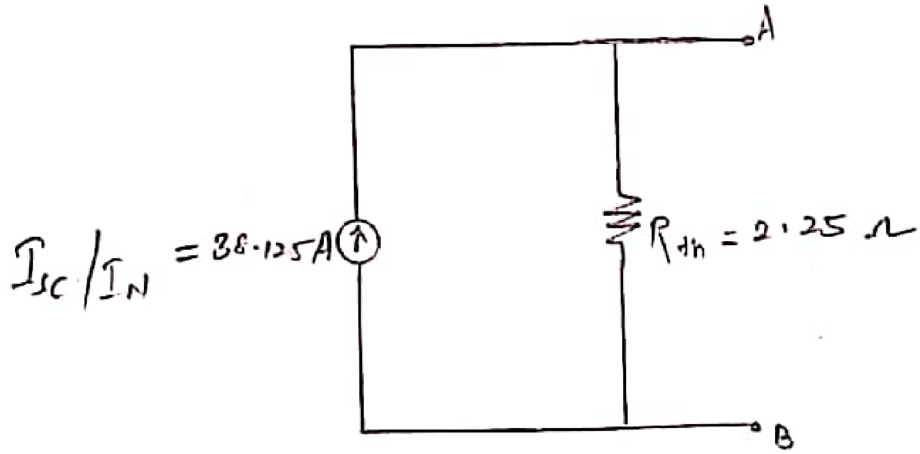


$$= \frac{2.909 \times 10}{2.909 + 10}$$

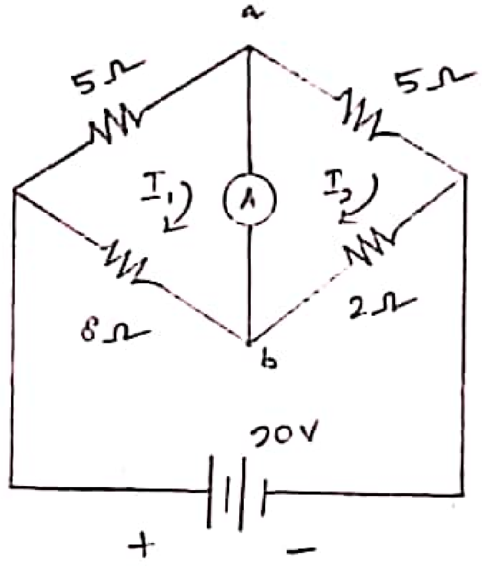
$$= 2.254\ \Omega$$

$$\boxed{R_{th} = 2.254\ \Omega}$$

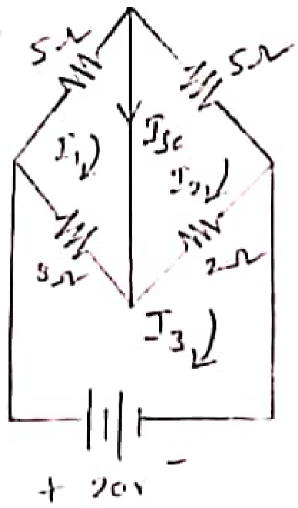
Norton's equivalent circuit :



2. In the circuit shown, compute the current through the 0 resistance ammeter. Use Norton's theorem.



Soln:



$$\begin{vmatrix} 13 & 0 & -8 \\ 0 & 7 & -2 \\ -8 & -2 & 10 \end{vmatrix} \begin{vmatrix} I_1 \\ I_2 \\ I_3 \end{vmatrix} = \begin{vmatrix} 0 \\ 0 \\ 20 \end{vmatrix}$$

$$\Delta = \begin{vmatrix} 13 & 0 & -8 \\ 0 & 7 & -2 \\ -8 & -2 & 10 \end{vmatrix} = 13(70-4) - 8(56)$$

$$= 410$$

$$\boxed{\Delta = 410}$$

$$\Delta_1 = \begin{vmatrix} 0 & 0 & -8 \\ 0 & 7 & -2 \\ 20 & -2 & 10 \end{vmatrix} = -8(-20 \times 7)$$

$$= 1120$$

$$\boxed{\Delta_1 = 1120}$$

$$\Delta_2 = \begin{vmatrix} 13 & 0 & -8 \\ 0 & 0 & -2 \\ -8 & 20 & 10 \end{vmatrix} = 13(40) - 8(10)$$

$$= 520$$

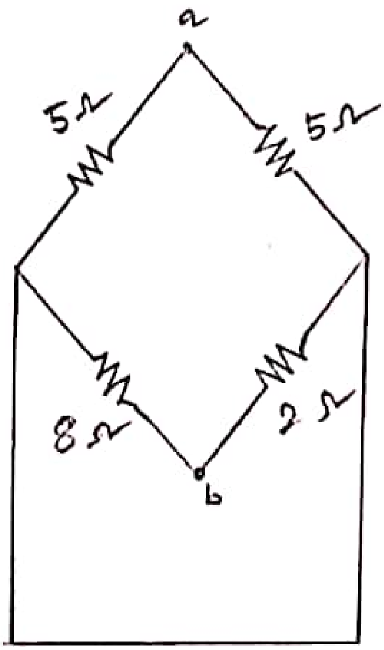
$$\boxed{\Delta_2 = 520}$$

$$I_{sc} = I_1 - I_2$$

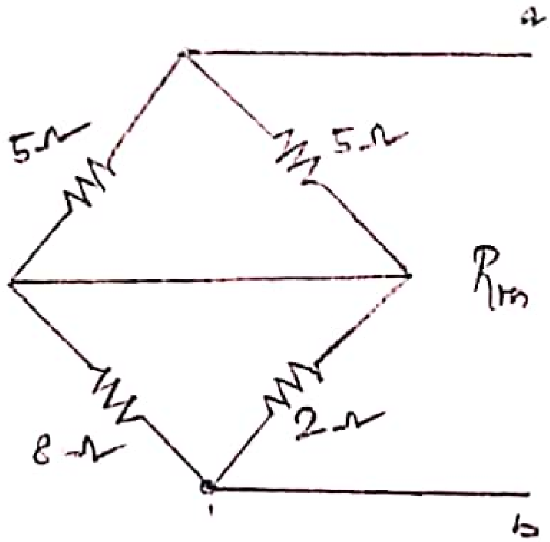
$$I_{sc} = 2.73 - 1.268$$

$$\boxed{I_{sc} = 1.462\,A}$$

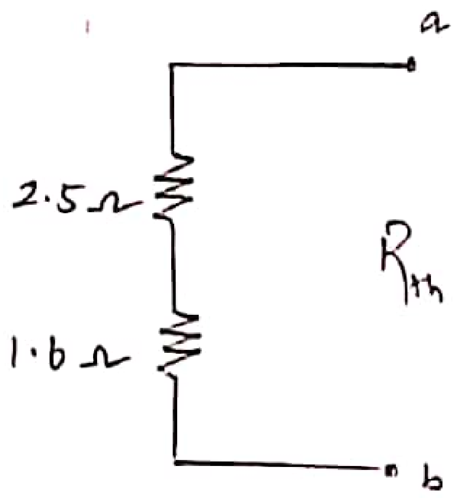
R_{th} :



$\Rightarrow$



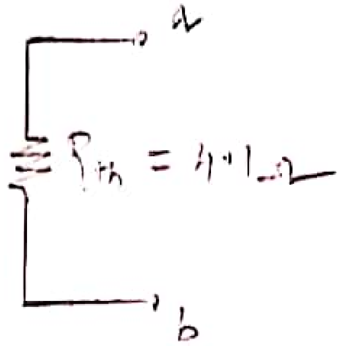
$$\frac{8 \times 2}{8+2} = \frac{16}{10} = 1.6\,\Omega \qquad \frac{5 \times 5}{5+5} = \frac{25}{10} = 2.5\,\Omega$$



$2.5 + 1.6 = 4.1\,\Omega$

$\boxed{R_{th} = 4.1\,\Omega}$

$\Rightarrow$



Norton's equivalent circuit :