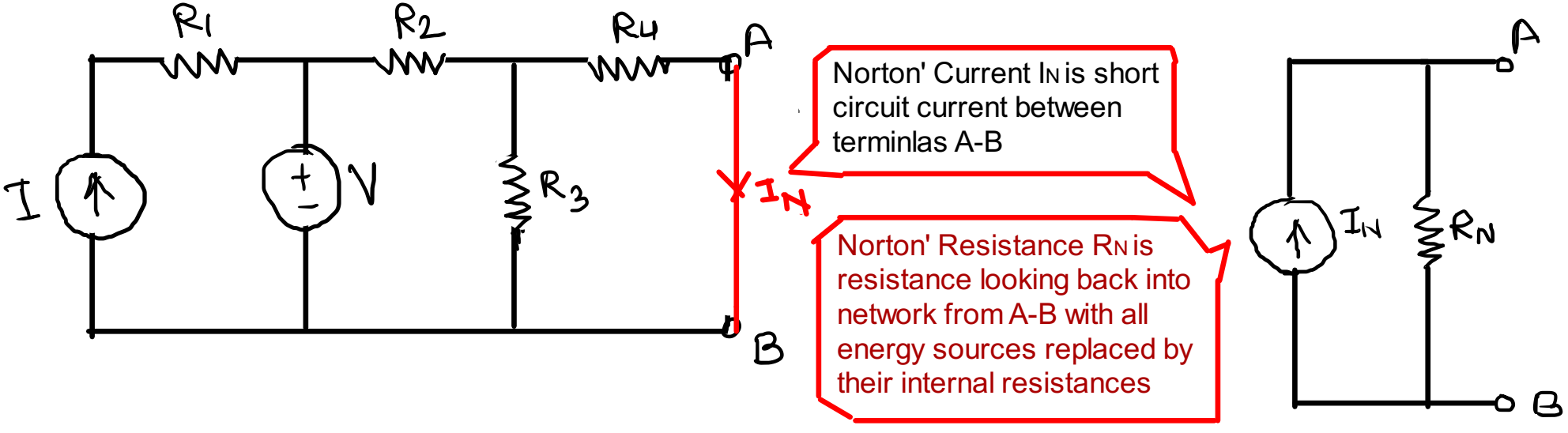
Norton's Theorem

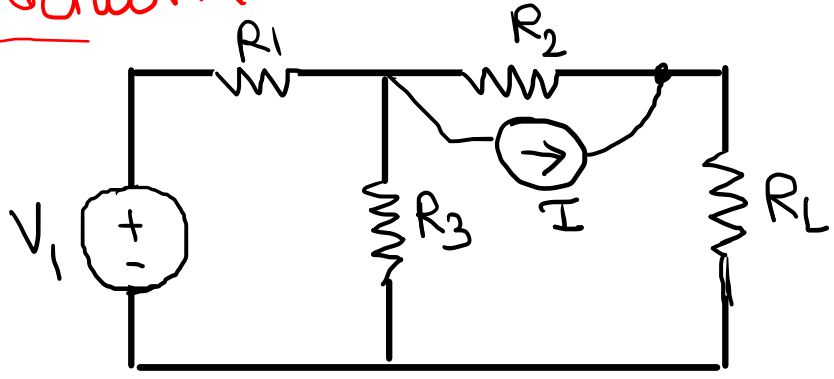
Statement:

Any linear, active bilateral network can be replaced by a current source (I_N) in parallel with a resistance (R_N) where I_N is the short-circuit current (i.e. current through the two terminals when RL is removed) and R_N is the internal resistance of the network as viewed back into the open-circuited network from terminals A and B with all energy sources replaced by their internal resistance (if any) and current sources by infinite resistance.

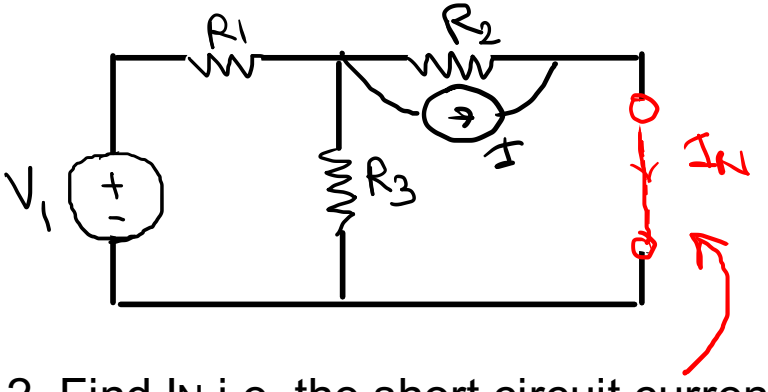


Norton's Theorem

Given Network

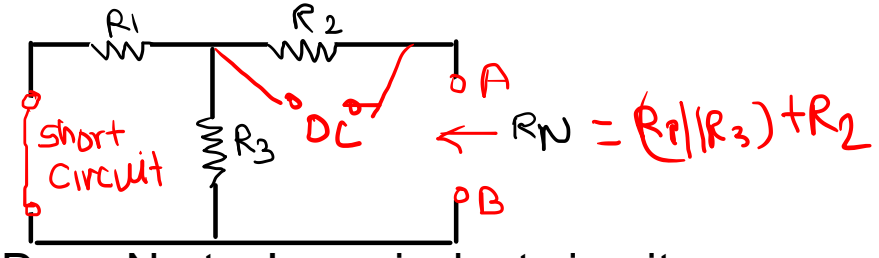


1. Remove the load RL from the circuit

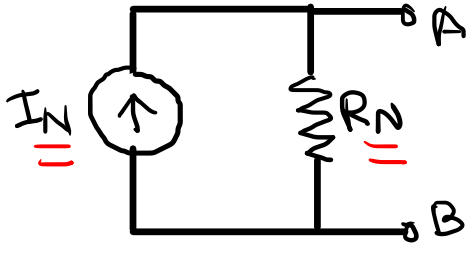


2. Find I_N i.e. the short circuit current between the terminals (A-B) from where the load is removed, using any suitable method (mesh, nodal, source transformation etc..)

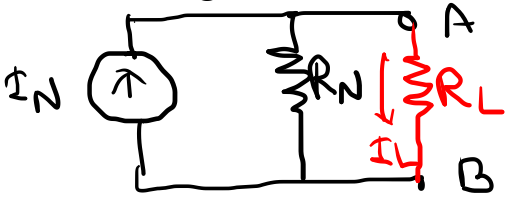
3. Find R_N i.e. resistance looking back into the network from the terminals (A-B) from where the load is removed with energy sources replaced by their internal resistances.



4. Draw Norton's equivalent circuit



5. Connect the load RL and find current/ voltage across load RL



$$I_L = \frac{R_N \cdot I_N}{R_N + R_L}$$

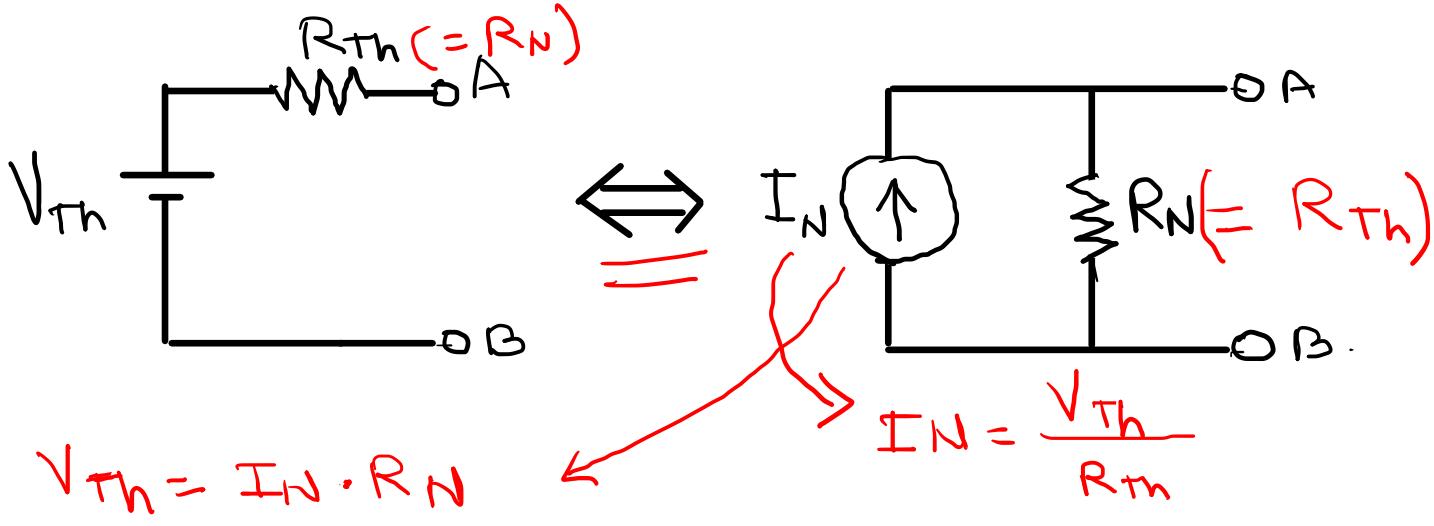
OR

$$V_L = I_L \cdot R_L$$

Relation between Thevenin and Norton Equivalent Circuit

Thevenin's Equivalent Circuit

Norton's Equivalent Circuit



Norton's equivalent circuit can be obtained by applying source transformation to Thevenin's equivalent circuit.

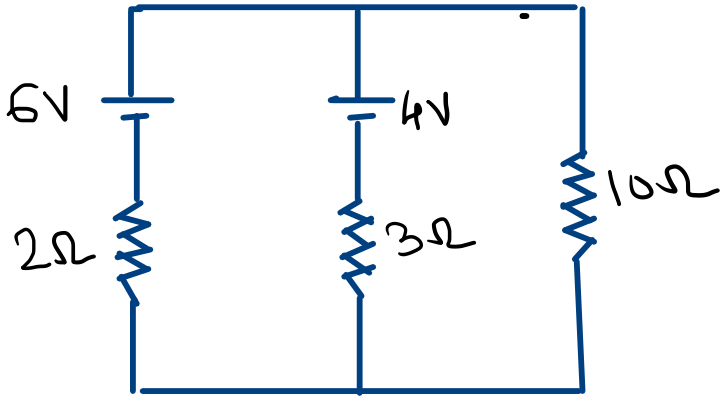
Also

Thevenin's equivalent circuit can be obtained by applying source transformation to Norton's equivalent circuit.

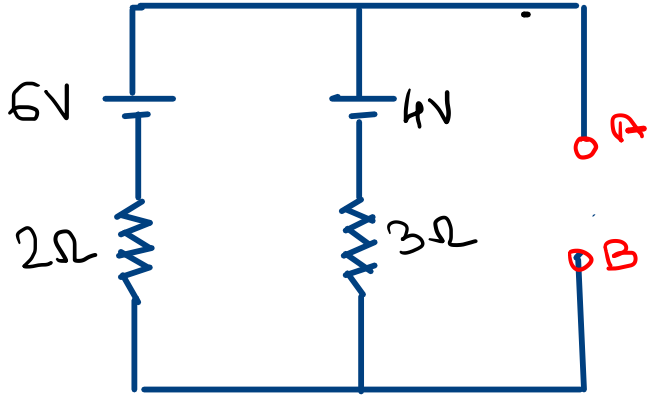
Norton's Theorem

Q.1 Find current flowing through 10 Ohm resistance using Norton's theorem

$I_{10} = 0.46A$

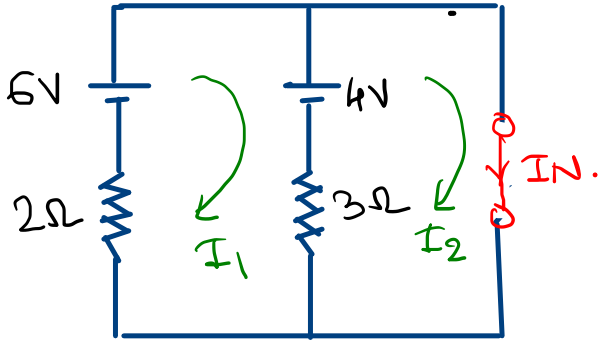


① Remove load $R_L = 10\Omega$



② Short circuit A & B & find

$I_N = I_{SC}$



$I_N = I_2$

→ Using mesh Analysis.

→ Mesh (I) $-2I_1 + 6 - 4 - 3(I_1 - I_2) = 0$

$5I_1 - 3I_2 = 2$ ---(1)

→ mesh (II) $-3(I_2 - I_1) + 4 = 0$.

$3I_1 - 3I_2 = -4$ ---(II)

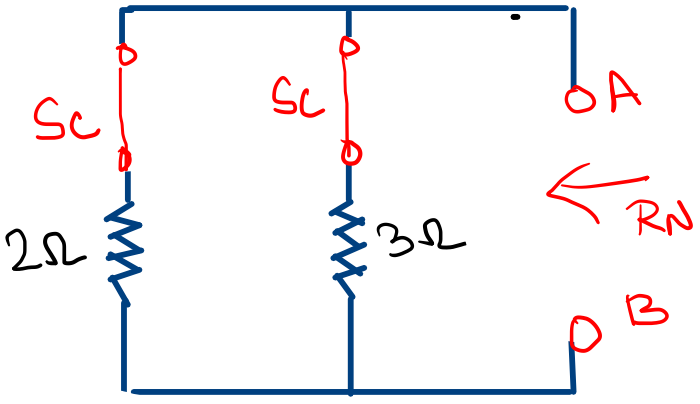
Solving (I) & (II) $I_1 = 3A$ $I_2 = 4.33A$

Norton's Theorem

Q.1 .....

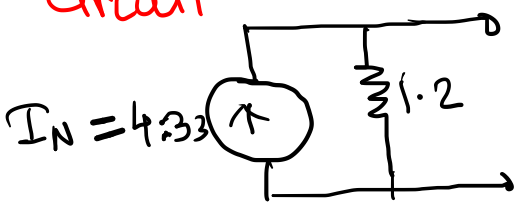
$I_{10} = 0.46A$

③ Find $R_N = R_{eq}$.



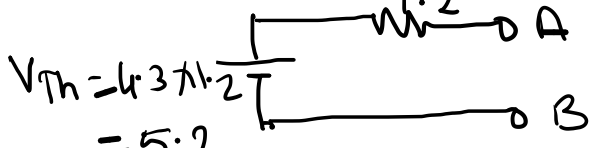
$R_N = 2||3 = \frac{6}{5} = 1.2\Omega$

④ Draw Norton's Equivalent Circuit

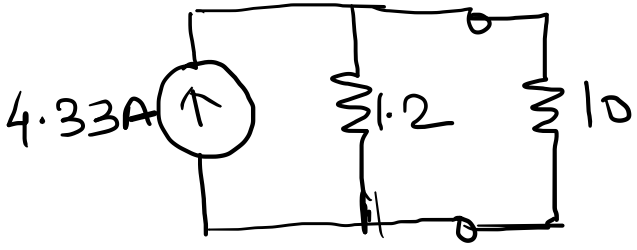


⇒

source transformation (Thevenin Equivalent



⑤ Connect $R_L = 10\Omega$

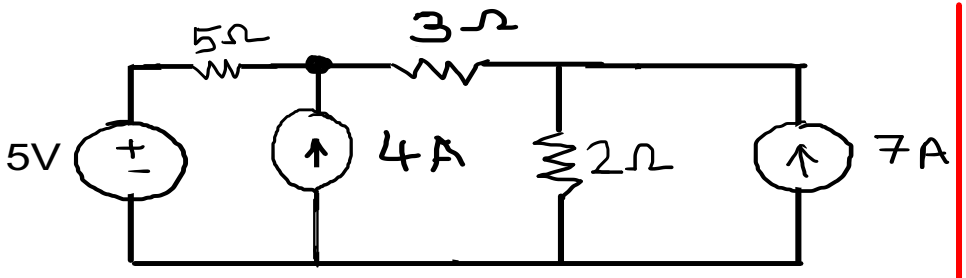


using current division formula

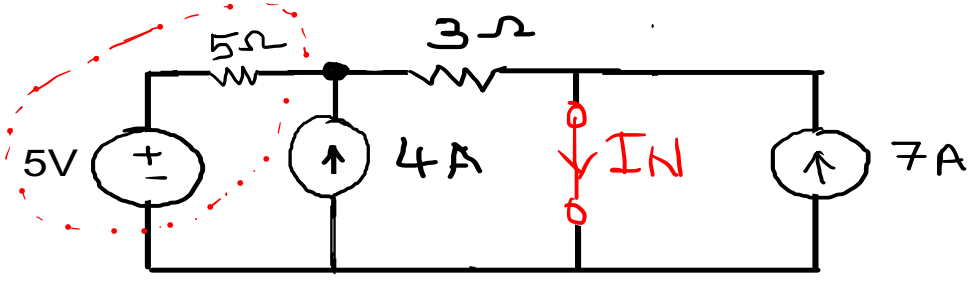
$$I_{10\Omega} = \frac{1.2 \times 4.33}{1.2 + 10}$$

$$I_{10\Omega} = 0.46A$$

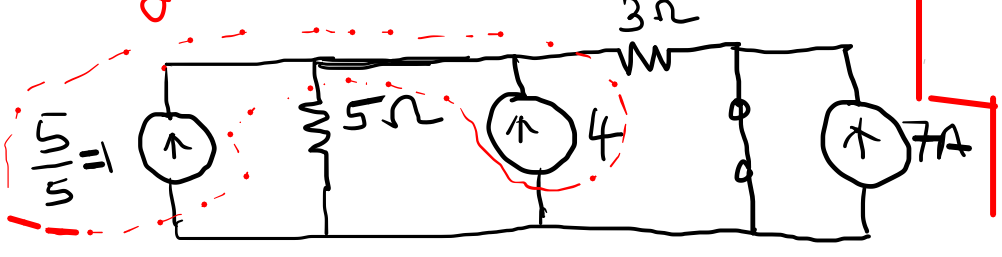
Example:- 2. Find voltage across 2 Ohm resistor using Norton's Theorem

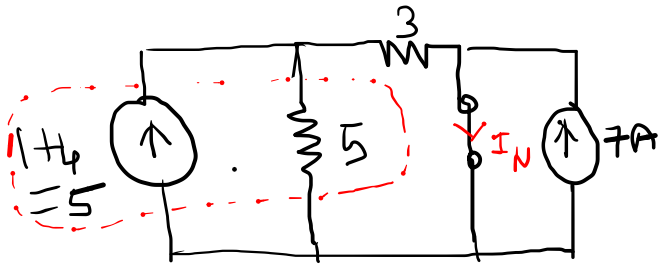


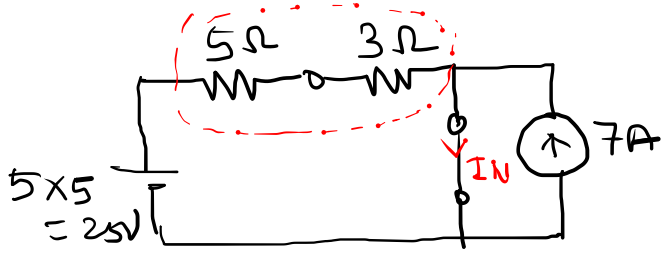
① Remove $R_L = 2\Omega$ & find I_N

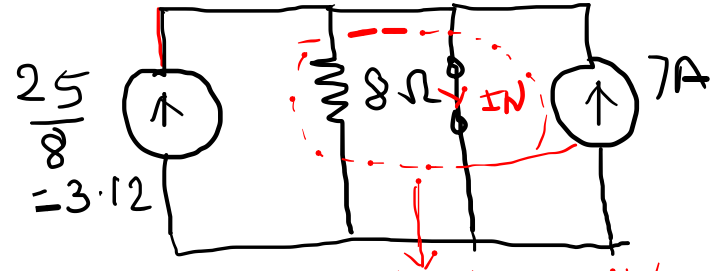


using source transformation

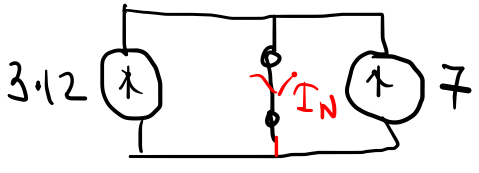








Short circuit (8Ω)



$I_N = 3.12 + 7$

$I_N = 10.12A$

$I_N = \frac{81}{8}$

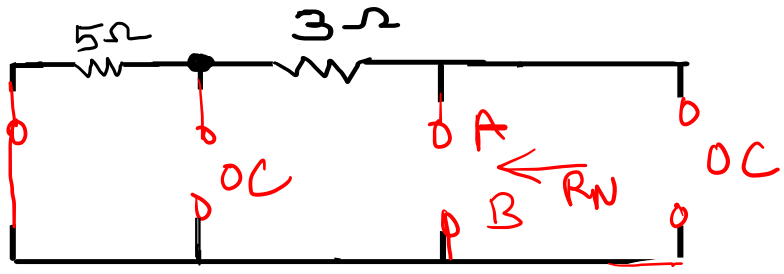
$R_N = 8\Omega$

$I_{2\Omega} = \frac{81}{10}$

$V_{2\Omega} = 16.2$

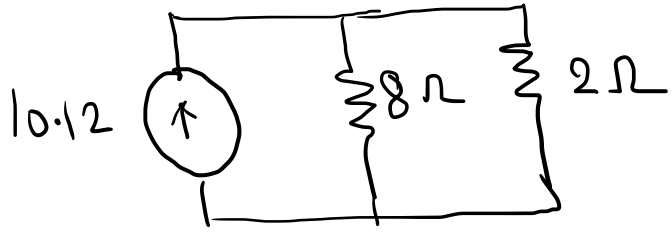
Example:- 2. .....

③ Find R_N



$R_N = 5+3 = 8\Omega$

④ Draw Norton's Equivalent circuit & Connect load.



Using Current division

$$I_{2\Omega} = \frac{10.12 \times 8}{10}$$

$$I_{2\Omega} = 8.09\,A$$

$$V_{2\Omega} = I_{2\Omega} \times 2$$

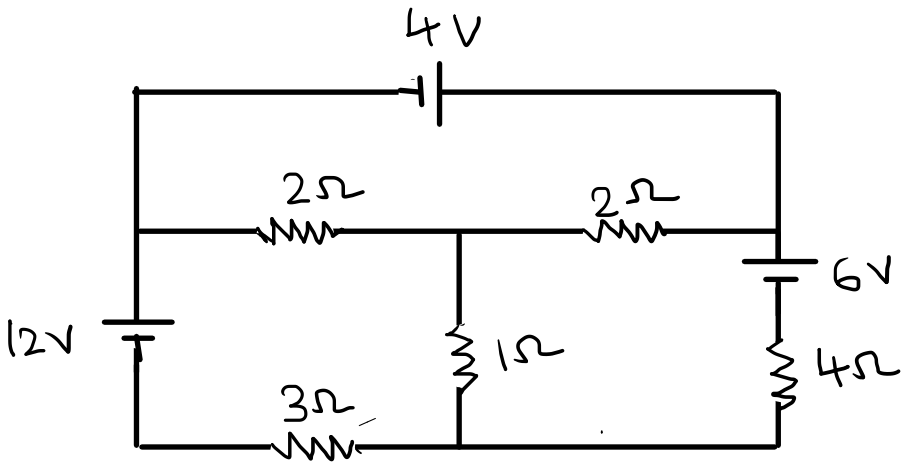
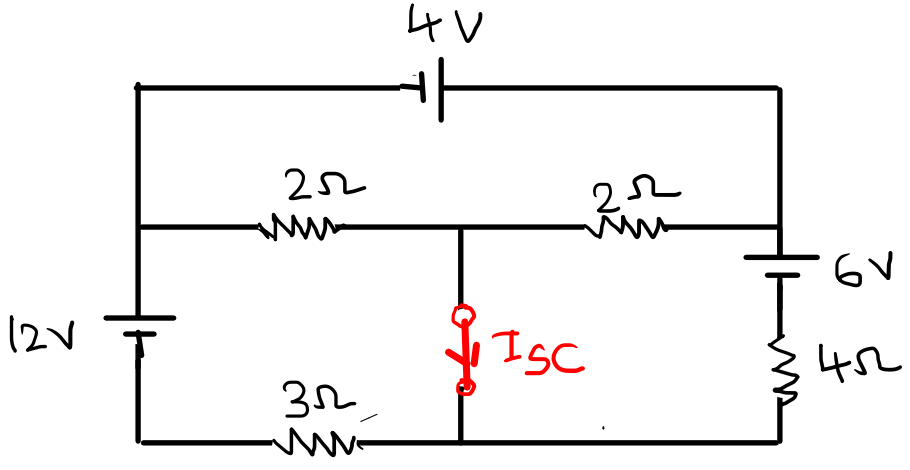
$$= 8.09 \times 2$$

$$V_{2\Omega} = 16.2\,V$$

$I_N = \frac{81}{8}$

$R_N = 8\Omega$

$I_{2\Omega} = \frac{81}{10}$

$V_{2\Omega} = 16.2$

Example:- 3. Find current flowing through 1Ohm resistor.