Marwari college Darbhanga

Subject---physics (Hons)

Class--- B.Sc. part 2

Paper – 04 ; Group – A

Topic--- Norton's Theorem

Lecture series --50

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Nortons Theorem

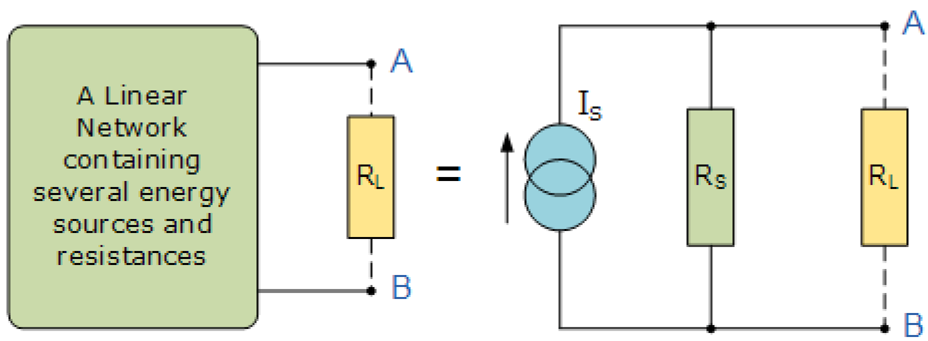
Nortons theorem is an analytical method used to change a complex circuit into a simple equivalent circuit consisting of a single resistance in parallel with a current source

Norton on the other hand reduces his circuit down to a single resistance in parallel with a constant current source.

Nortons Theorem states that "*Any linear circuit containing several energy sources and resistances can be* *replaced by a single Constant Current generator in parallel with a Single Resistor*".

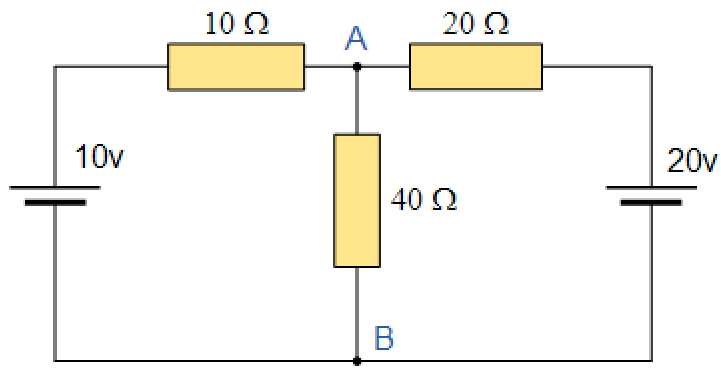
As far as the load resistance, R_L is concerned this single resistance, R_S is the value of the resistance looking back into the network with all the current sources open circuited and I_S is the short circuit current at the output terminals as shown below.

- **Nortons equivalent circuit**

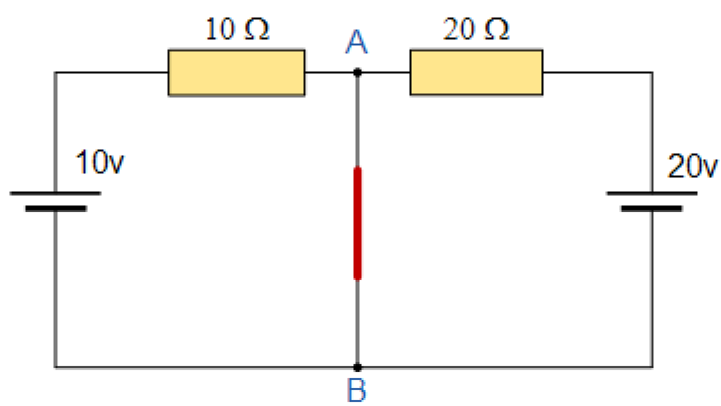


The value of this "constant current" is one which would flow if the two output terminals where shorted together while the source resistance would be measured looking back into the terminals, (the same as Thevenin).

For example, consider our now familiar circuit from the previous section.



To find the Nortons equivalent of the above circuit we firstly have to remove the Centre **40Ω** load resistor and short out the terminals **A** and **B** to give us the following circuit.



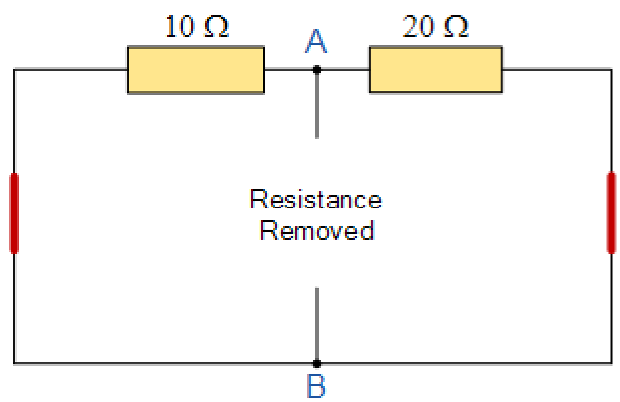
When the terminals **A** and **B** are shorted together the two resistors are connected in parallel across their two respective voltage sources and the currents flowing through each resistor as well as the total short circuit current can now be calculated as

with A-B Shorted Out

$$I_1 = \frac{10v}{10\Omega} = 1amp, \quad I_2 = \frac{20v}{20\Omega} = 1amp$$

$$\text{therefore,} \quad I_{\text{short-circuit}} = I_1 + I_2 = 2amps$$

If we short-out the two voltage sources and open circuit terminals *A* and *B*, the two resistors are now effectively connected together in parallel. The value of the internal resistor *Rs* is found by calculating the total resistance at the terminals *A* and *B* giving us the following circuit.



Find the Equivalent Resistance (Rs)

10Ω Resistor in Parallel with the 20Ω Resistor

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{20 \times 10}{20 + 10} = 6.67\Omega$$

Having found both the short circuit current, Is *and* equivalent internal resistance, *Rs* this then gives us the following Nortons equivalent circuit.