Practical No: 6

Aim: To study and verify Norton's Theorem.

AIM: To Study and verify Norton's Theorem

APPARATUS:

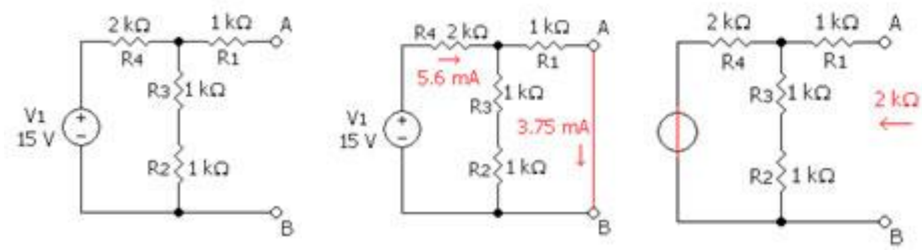
1 Resistance

2 Battery

3 connectiting wire

THEORETICAL BACKGROUND:

Norton's theorem states that a network consists of several voltage sources, current sources and resistors with two terminals, is electrically equivalent to an ideal current source " I_{NO}" and a single parallel resistor, R_{NO}. The theorem can be applied to both A.C and D.C cases. The Norton equivalent of a circuit consists of an ideal current source in parallel with an ideal impedance (or resistor for non-reactive circuits).



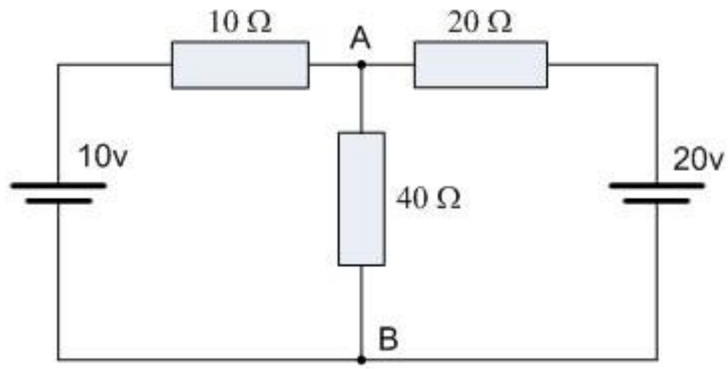
The Norton equivalent circuit is a current source with current "I_{NO}" in parallel with a resistance R_{NO}.To find its Norton equivalent circuit,

1. Find the Norton current "I_{NO}". Calculate the output current, "I_{AB}", when a short circuit is the load (meaning 0 resistances between A and B). This is INo.
2. Find the Norton resistance RNo. When there are no dependent sources (i.e., all current and voltage sources are independent), there are two methods of determining the Norton impedance RNo.

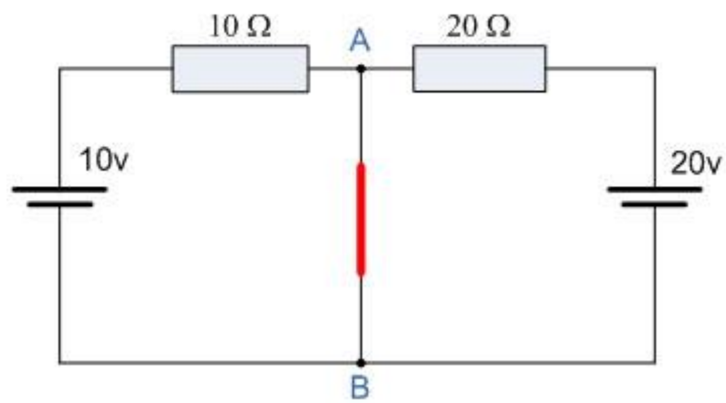
- Calculate the output voltage, VAB, when in open circuit condition (i.e., no load resistor — meaning infinite load resistance). RNo equals this VAB divided by INo. or
- Replace independent voltage sources with short circuits and independent current sources with open circuits. The total resistance across the output port is the Norton impedance RNo. However, when there are dependent sources the more general method must be used. This method is not shown below in the diagrams.
- Connect a constant current source at the output terminals of the circuit with a value of 1 Ampere and calculate the voltage at its terminals. The quotient of this voltage divided by the 1 A current is the Norton impedance RNo. This method must be used if the circuit contains dependent sources, but it can be used in all cases even when there are no dependent sources.

Example 1:-

Consider this circuit-



To find the Norton's 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.



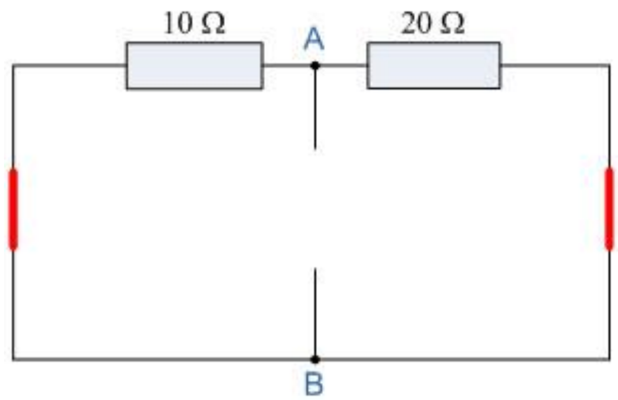
When the terminals A and B are shorted together the two resistors are connected in parallel across their two respective voltage sources and the currents flowing through each resistor as well as the total short circuit current can now be calculated as:

With A-B Shorted :

$$I_1 = \frac{10v}{10\Omega} = 1amps, \qquad I_2 = \frac{20v}{20\Omega} = 1amps$$

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

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.



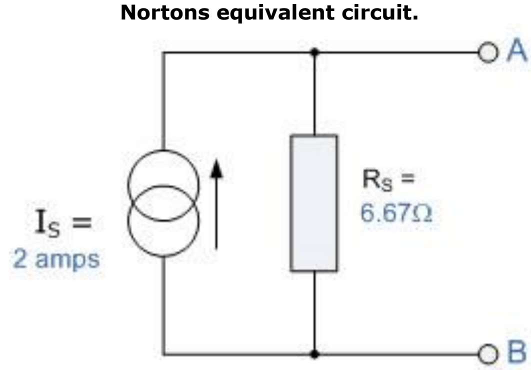
Find the Equivalent Resistance (Rs):

10Ω Resistor in parallel with the 20Ω Resistor

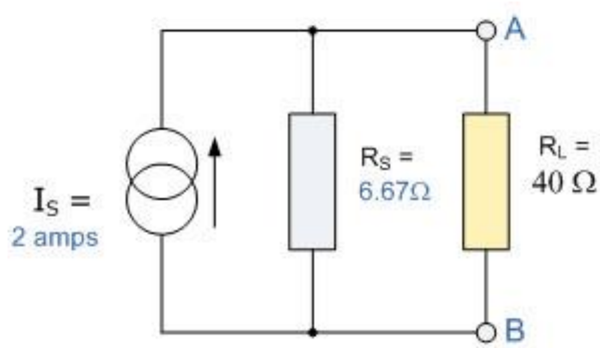
$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{20 \times 10}{20 + 10} = 6.67\Omega$$

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

Nortons equivalent circuit.



Ok, so far so good, but we now have to solve with the original 40Ω load resistor connected across terminals A and B as shown below.



Again, the two resistors are connected in parallel across the terminals A and B which gives us a total resistance of:

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{6.67 \times 40}{6.67 + 40} = 5.72\Omega$$

The voltage across the terminals A and B with the load resistor connected is given as:

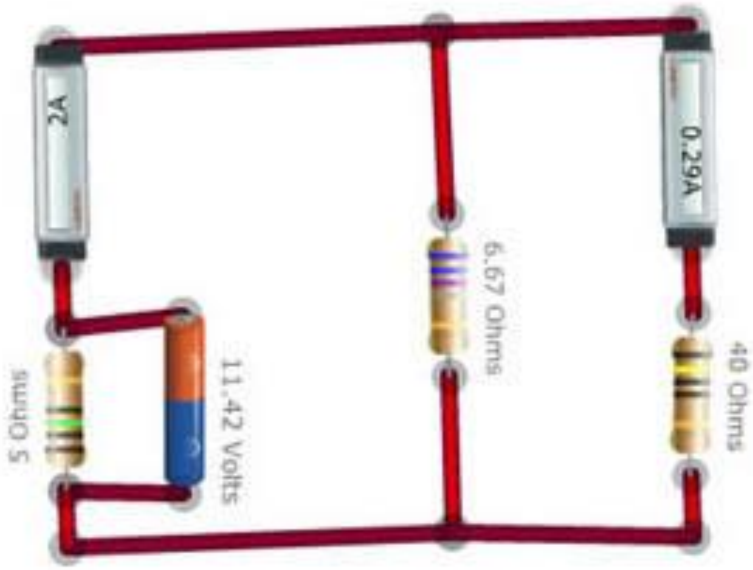
$$V_{A-B} = I \times R = 2 \times 5.72 = 11.44v$$

Then the current flowing in the 40Ω load resistor can be found as:

$$I = \frac{V}{R} = \frac{11.44}{40} = 0.29amps$$

step1:- Create the actual circuit and measure the current across the load points.

Step 2:- Create the Norton's equivalent circuit by first creating a current source of required equivalent current in amperes (2 A in this case), and then measure the current across the load using an ammeter.



RESULT TABLE:

Sr. No		IN	RN	I L
1	**Theoretically**			
2	**Practically**			

CONCLUSION: