Verification of Norton's Theorem

5.1 Purpose/Objective:

The aim of this experiment is-

- To be familiar with the Norton's theorem and also to verify it.
- To know about its applicability.

5.2 Theory:

- **Norton's Theorem** states that "a*ny linear bilateral circuit containing several energy sources and resistances can be replaced by a single constant current source* I_{Norton} *in parallel with a single resistor* R_{Norton}" which is connected in parallel to a load resistor R_L where the value of the current source (I_{Norton}) is the short circuit current between the two terminals of the network and the resistance (R_{Norton}) is equal to the equivalent resistance measured between the terminals with all the energy sources eliminated.
- The voltage sources are eliminated by shorting their terminals and the current sources are eliminated by opening their terminals.
- The Norton's equivalent network looks like this:

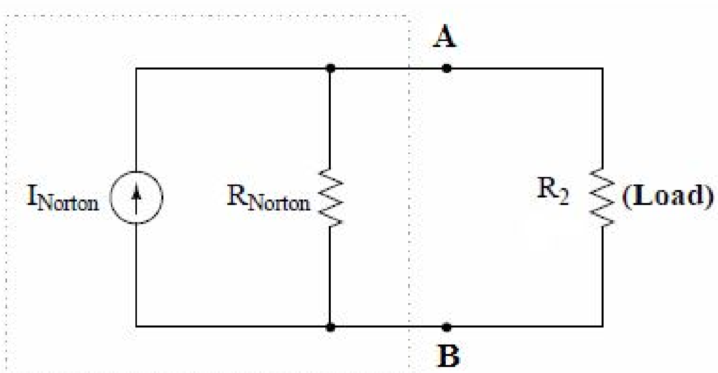

Figure-1: Norton's equivalent Circuit

- Consider the circuit given below where R_2 is designated as the "load" resistor. We apply Norton's Theorem to it:

Lab Work: Experiment-6: Verification of Norton's Theorem

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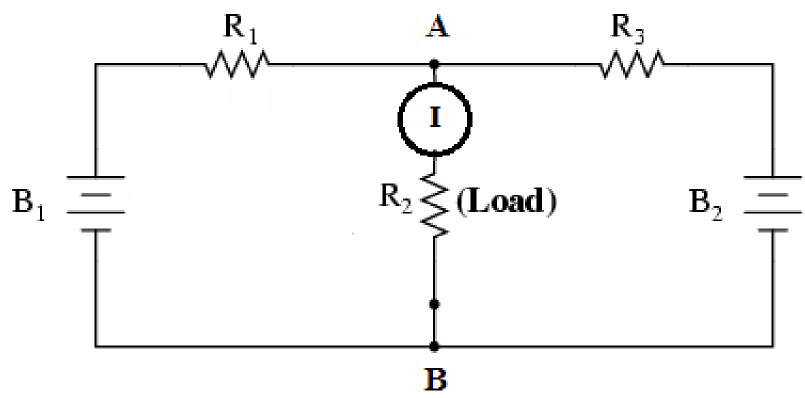

Figure-2: The original circuit under test

In the above circuit, ***I*** represent the value of current through the load resistor R_2. We want to find this current using Norton's theorem.

- To find the current ***I*** through the load resistor ***R_2***, just follow the steps below:

   1. Remove the load resistor R_2 between terminal A and B and connect an ammeter between these terminals. Now the circuit looks like this:

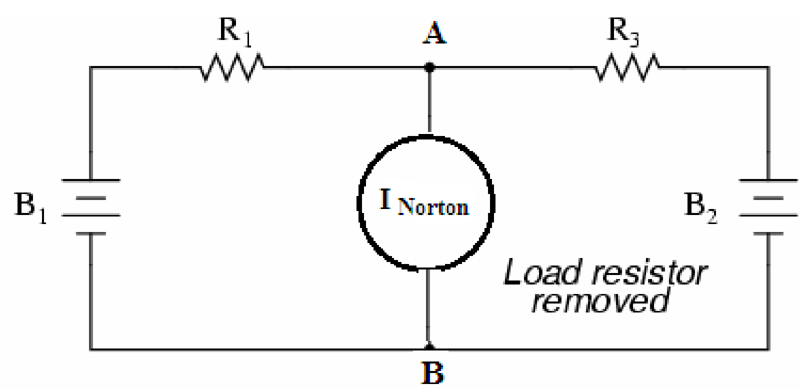

Figure-3: Calculating I_{Norton} by removing load resistor R_2

   2. Determine Norton's current I_{Norton} by the above circuit.
   3. Now determine the Norton resistance R_{Norton} by removing load resistor from terminal A and B, and removing the power sources and then shorting their terminals as shown in the figure below:

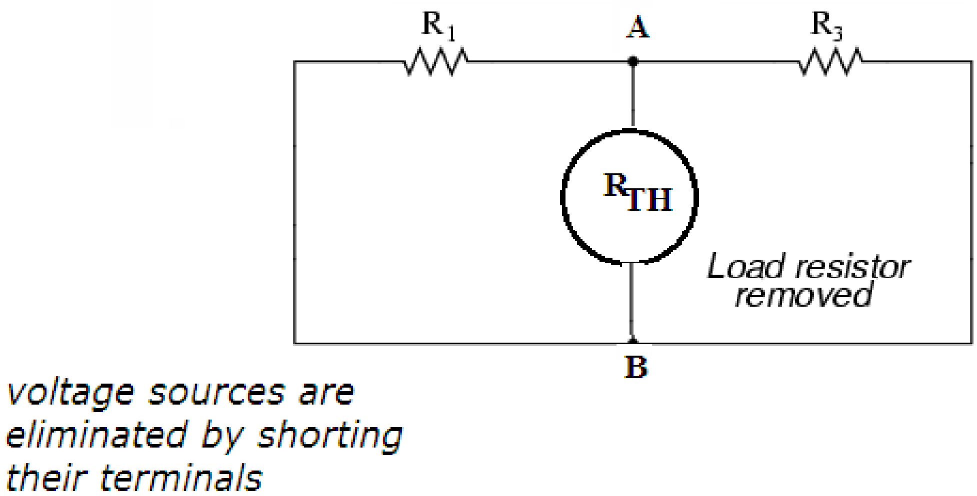

Figure-4: Calculating R_{Norton}

4. After determining the value of I_{Norton} and R_{Norton}, the Norton's equivalent circuit is constructed and load resistor R_2 is attached between the terminal A and B shown below:

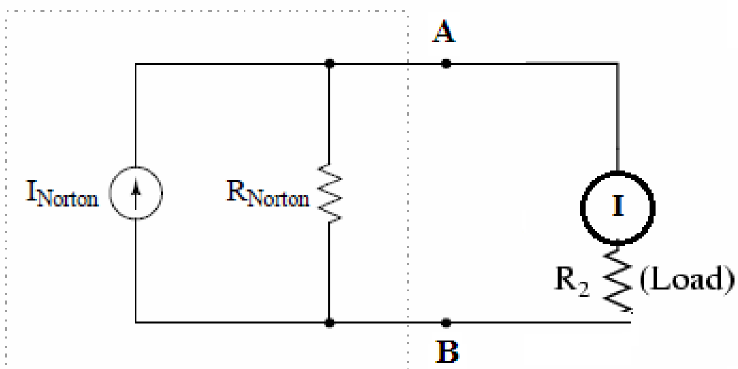

Figure-5: Norton's equivalent circuit with load resistor reattached

- If the current reading of figure-2 is same as the reading found in figure-5, then Norton's theorem will be verified.

5.3 Equipment/ Apparatus:

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a) Two regulated variable Power Supply (0-30 V)

b) One constant current source

c) One Digital Multimeter

d) Circuit Experiment Board (Breadboard)

e) Three resistors

f) Connecting wires

g) Cutting tools etc.

5.4 Cautions:

1. All connections should be tight and correct.
2. Switch off the supply when not in use.
3. Reading should be taken carefully.

5.5 Circuit Diagram:

The circuit diagrams to verify Norton's theorem are shown in figure-2, figure-3, figure-4 and figure-5 above.

5.6 Procedure:

1. Construct the circuit on the breadboard, as shown in figure-2 and observe the voltage of the two sources B_1 and B_2. Now take the ammeter reading I.
2. Remove the load resistor R_2 by opening terminal A and B. Connect an ammeter between these terminals as shown in the figure-3. Now take the ammeter reading I, which is I_{Norton}.
3. Eliminate the voltage sources by shorting their terminals. Place an ohmmeter across terminal A and B as shown in the figure-4. Now take the ohmmeter reading which is R_{Norton}.
4. Now construct the Norton's equivalent circuit by adding I_{Norton} in parallel with R_{Norton}. Then connect load resistor R_2 parallel to R_{Norton} between terminal A and B. The circuit should look like figure-5. Now take the ammeter reading I.

5. If the current reading of figure-2 is same as the reading found in figure-5, then Norton's theorem will be verified.
6. From the exact values of R_1, R_2, R_3, E_1 and E_2, calculate I through R_2 analytically. Compare the analytical value with that of the experimental value.

5.7 Data Table:

Fill up the following table and discuss on the experimental results.

Reading No.	I **(mA) Fig-2**	I_{Norton} **(mA)**	R_{Norton} **(Ohm)**	I **(mA) Fig-5**
1.				
2.				
3.				
4.				
5.				

5.8 Result:

Norton's Theorem has been verified.