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2K20/A6/56

Experiment 2

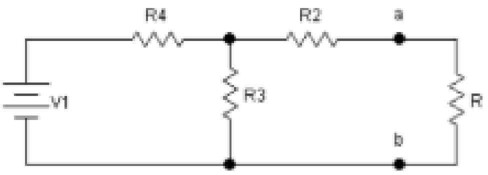
Aim:

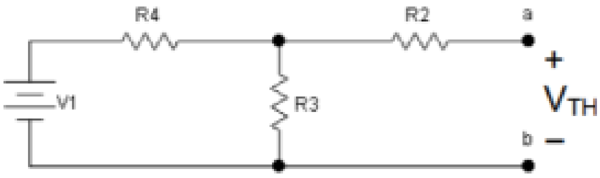
To Verify Thevenin's Theorem.

Theory:

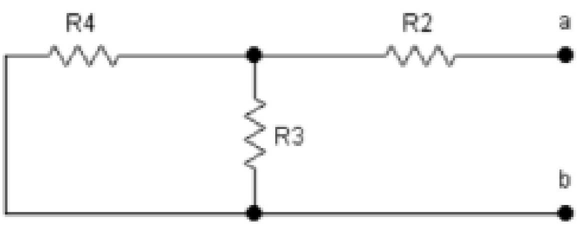
Thevenin's theorem states that it is possible to simplify any linear circuit, no matter how complex, to an equivalent circuit with just a single voltage source and series resistance connected to a load. In this electrical practical, we will verify this theorem.
The steps used for Thevenin's Theorem are listed below:

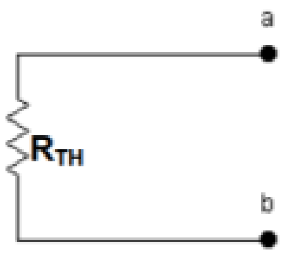
Step 1:
Remove the resistor (R) through which you wish to calculate the current or across which you want to know the voltage. Label these terminals (where the resistor was removed) "a" and "b". Calculate the voltage across these open terminals. This is called the open circuit voltage or the Thevenin equivalent voltage, V_{TH}.



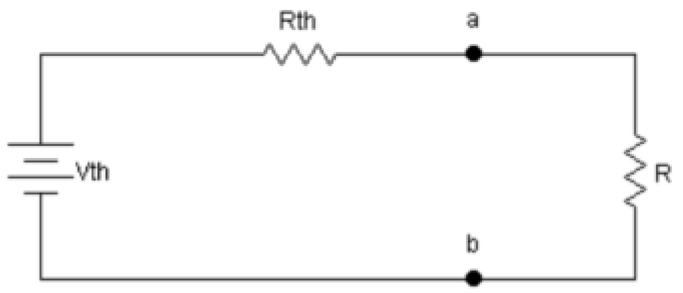


Step 2:
From the open terminals, ("a" and "b") calculate the resistance "looking back" from the open terminals with all voltage sources removed and replaced by their internal resistances (if $R_{Internal} = 0$, replace the voltage source with a short). This resistance is R_{TH}.





Now we have the components we need to create the Thevenin equivalent circuit as shown below using the Thevenin equivalent voltage and resistance values calculated above connected in series with the load resistor as shown below.



Step 3:
The current (through R) you wish to calculate will be:

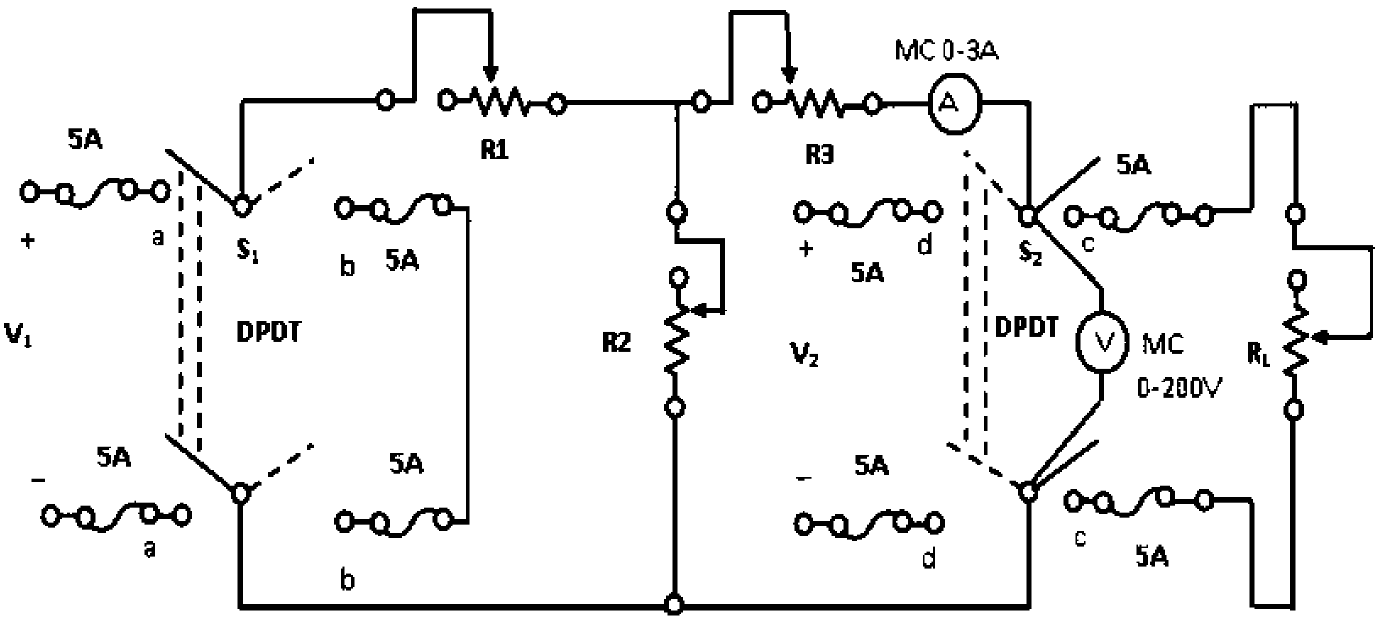
$$I_R = \frac{V_{TH}}{R_{TH} + R}$$

and the voltage across R will be:

$$V_R = I_R R = \frac{V_{TH} R}{R_{TH} + R}$$

where: V_{TH} is from Thevenin equivalent voltage obtained in Step 1 and R_{TH} is the Thevenin equivalent.

Procedure:



1. Keep all the resistance close to their maximum respective values.
2. Close the switch S_1 to "aa" and S_2 to "cc" positions. Observe the load current (I_L) and voltage (V_L) readings. The load resistance,

$$R_L = \frac{V_L}{I_L}$$

3. Remove the load by opening the switch S_2 and read the open circuit voltage (or Thevenin equivalent voltage) V_{TH}.

4. Next, compute the resistance (R_{TH}) of the network as seen from the load terminals, Replace the 220 V source by a short by closing S_1 to "bb". Apply 110 V at the output terminals by closing S_2 to "dd". Read the voltmeter (V) and ammeter (I) and get,

$$R_{TH} = \frac{V}{I}$$

5. Now compute the load current. Applying Thevenin theorem,

$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

6. Compare the above computed load current with its observed value in step (2) and verify the theorem.

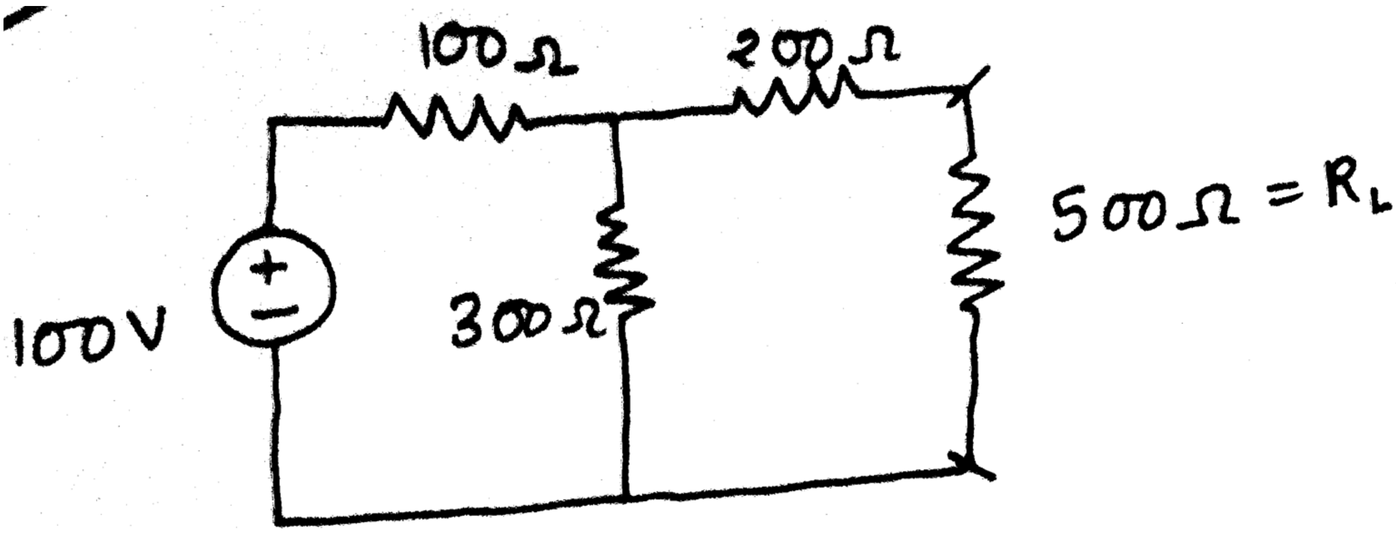
Observations:

Serial no. of Observation	Load Current(I_L) from case 1	Load Voltage(V_L)	Load Resistance (R_L)=V_L/I_L	Thevenin Voltage(V_{th}) from case 2(a)	2nd Voltage source(v) for case 2(b)	Ammeter Reading(I) from case 2(b)	Thevenin Resistance R_{th}=V/I	Load current (I_L)=V_{th}/(R_{th}+R_L)
1st	0.096774	48.387	500	75.000	200	0.72727	275.00	0.096774
2nd	0.19355	96.775	500	150.00	100	0.36364	275.00	0.19355
3rd	0.14516	72.58000000	500	112.50	150	0.54545	275.00	0.14516
4th	0.24194	120.97	500	187.50	100	0.36364	275.00	0.24194
5th	0.29032	145.1600000	500	225.00	250	0.90909	275.00	0.29032

Calculations:

1st observation:

$$V = 100V\ , R_1 = 100\ ohm\ , R_2 = 200\ ohm\ , R_3 = 300\ ohm\ , R_L = 500\ ohm$$



Current from the source 100V,

$$i = \frac{V}{R_1 + \frac{R_3 * (R_2 + R_L)}{R_2 + R_3 + R_L}} = \frac{100}{100 + \frac{700 * 300}{700 + 300}} = \frac{10}{31} A$$

Load Current,

$$i_L = \frac{R_3}{R_2 + R_3 + R_L} i = \frac{300}{1000} * \frac{10}{31} = \frac{3}{31} = 0.096774\ A$$

Using Thevenin's theorem:

Thevenin's Resistance,

$$R_{TH} = \frac{R_1 * R_3}{R_1 + R_3} + R_2 = \frac{100 * 300}{400} + 200 = 275\ ohm$$

Thevenin's Voltage,

$$V_{TH} = \frac{V}{R_1 + R_3} * R_3 = \frac{100}{100 + 300} * 300 = \frac{300}{4} = 75\ V$$

Load Current,

$$i_L = \frac{V_{TH}}{R_{TH} + R_L} = \frac{75}{275 + 500} = 0.096774\ A$$

As Load current from both cases are same,
So, Thevenin's theorem is verified.

Similarly we can verify Thevenin's theorem for all of the other cases.
In all of the cases the load current from case 1 is same as we get from Thevenin's theorem.
So, Thevenin's theorem is verified for all of the cases.

Results:

We have successfully verified Thevenin's Theorem.
All of the observations are verified.