Ayush Nagpure Batch – 2024 Application No - 158377
Subgroup – 1H3

Experiment: To study the Thevenin's Theorem

Objective: To verify the Thevenin's Theorem.

Apparatus: Virtual using Tinkercad (www.tinkercad.com)

Theory:

This circuit states that the current in any bilateral circuit element (R_L) in a network is the same as would be obtained if that circuit element (R_L) is supplied with a source Voltage in series with an equivalent resistance R_{th} being the open circuit voltage at the terminals from which R_L has been removed and R_{th} being the resistance that would be measured at these terminals after all sources have been replaced by their internal resistance respectively.According to this theorem, if resistance R_L be connected between two terminals in a linear bilateral network, then resulting steady state current through resistor will be $V_{th}/(R_L+R_{th})$, where V_{th} is the potential difference between points A and B after removing R_L such that for network shown in figure.

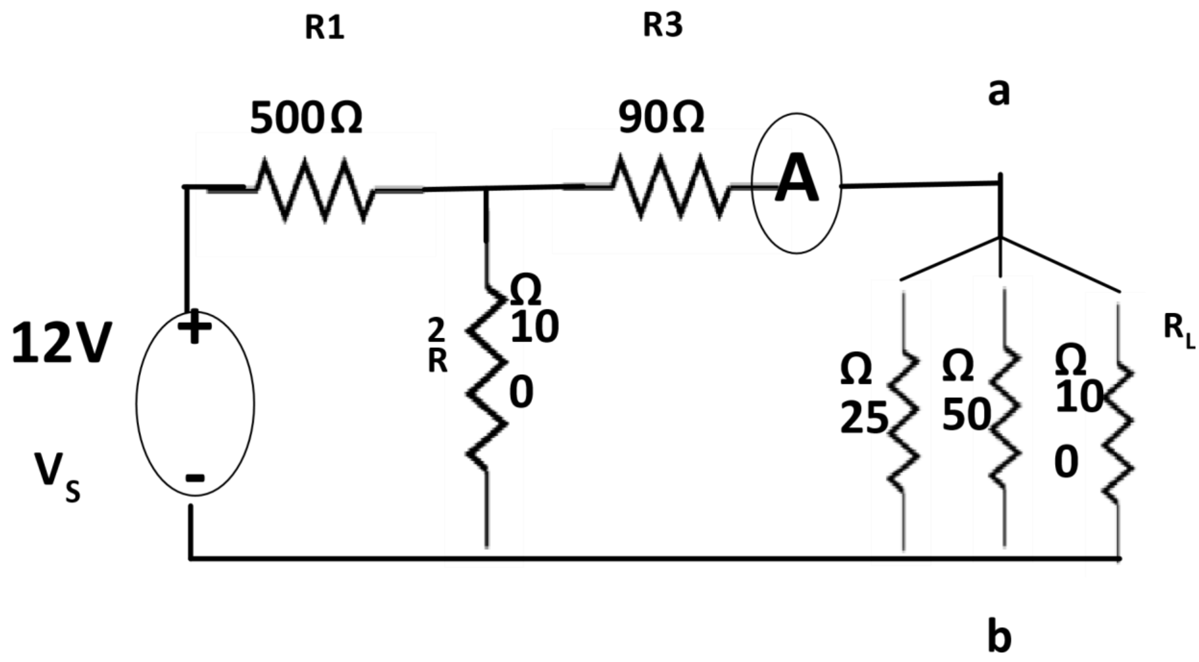


Fig. Circuit diagram for verification of Thevenin's Theorem

$\mathbf{V_{th} = V*R_2/(R_1+R_2)}$ And Thevenin's resistance measured between terminals ab (with source removed and replaced by its internal resistance if any, otherwise replace by short circuit) is given by: $\mathbf{R_{th} = [R1*R2/R1+R2]+R3}$

Now external resistance R_L is connected between terminals ab such that Thvenin's equivalent circuit for the network will be as shown in figure. Current through R_L will be

$$\mathbf{I_l = V_{th}/ (R_{th}+R_L)}$$

Procedure:

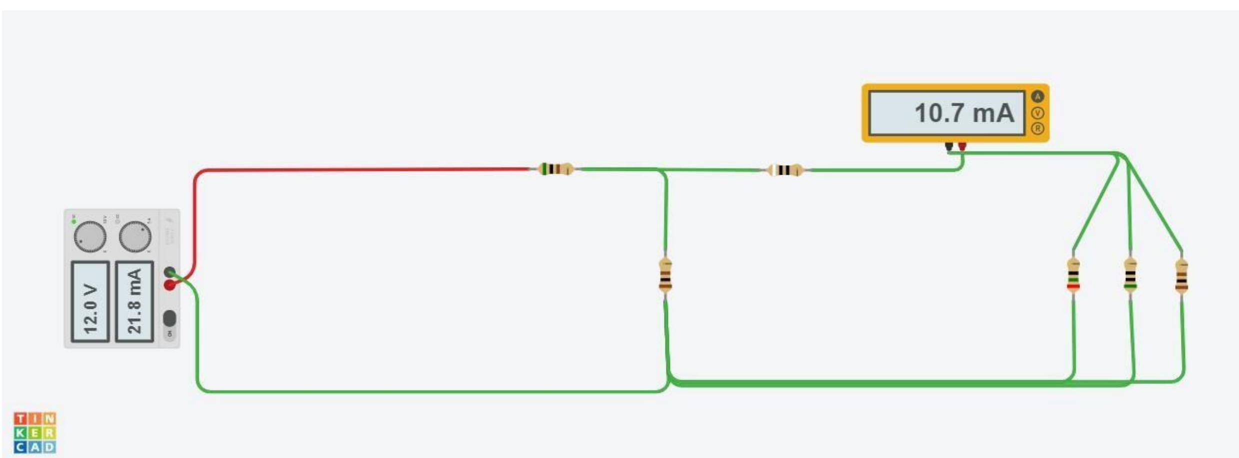
1. Connect the circuit as shown in the circuit diagram on tinkercad workspace. Once the circuit is made take a snapshot and paste in the manual.
2. To verify the theorem, measure Thevenin resistance by removing the load and deactivating the sources in the circuit.
3. Remove R_L from the circuit and measure the open circuit voltage $\mathbf{V_{th}}$ across the end points by a DC voltmeter.
4. Once R_{th} and V_{th} are know, draw the Thevenin's equivalent circuit.

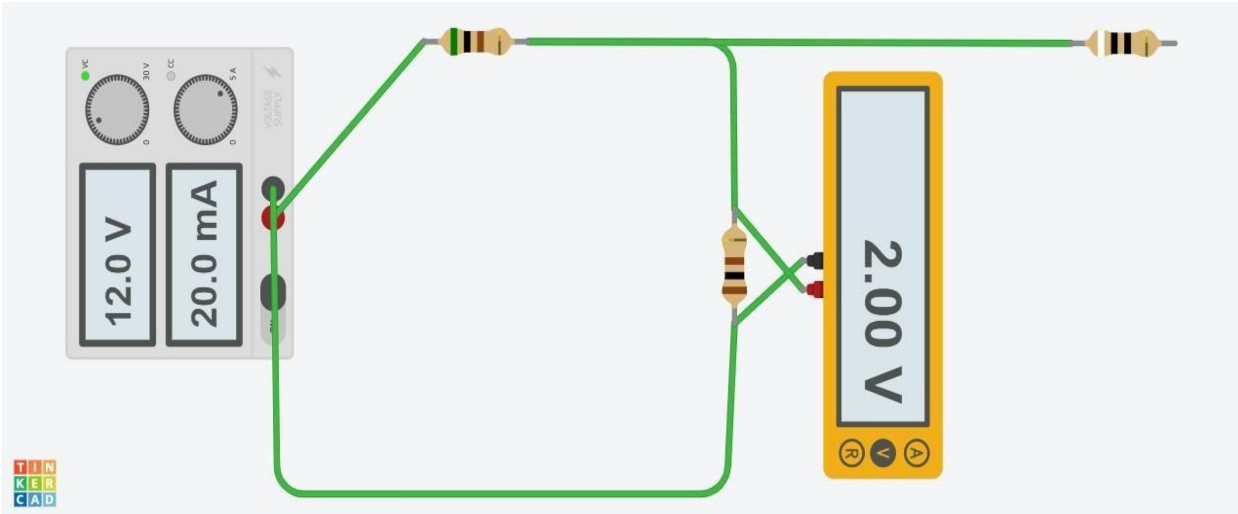
5. Now measure current I_L by selecting the load resistance of 25, 50 and 100 Ω respectively by the multimeter.
6. Again find the Thevenin equivalent of the circuit theoretically and compare it with the simulation readings.

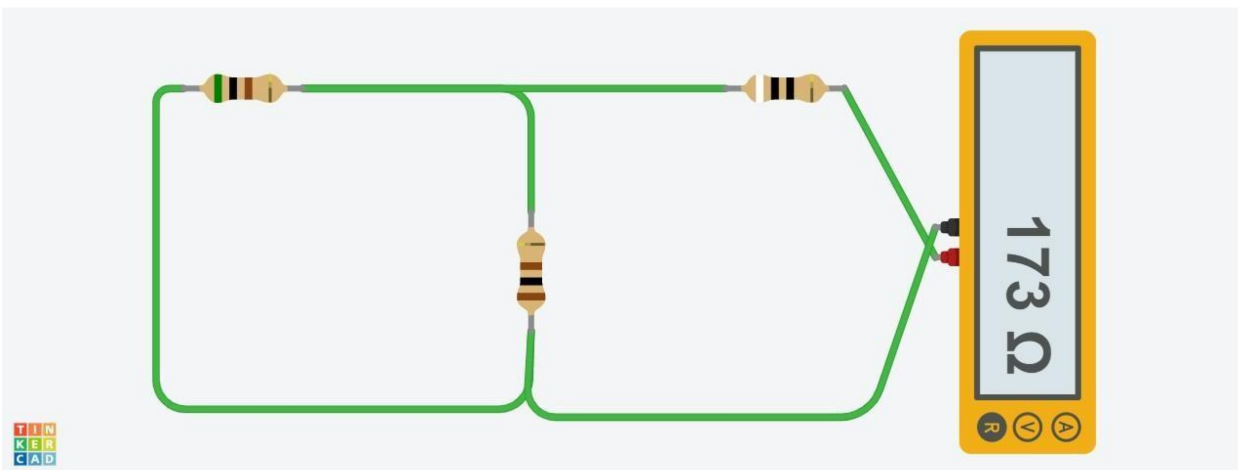
Observation table:

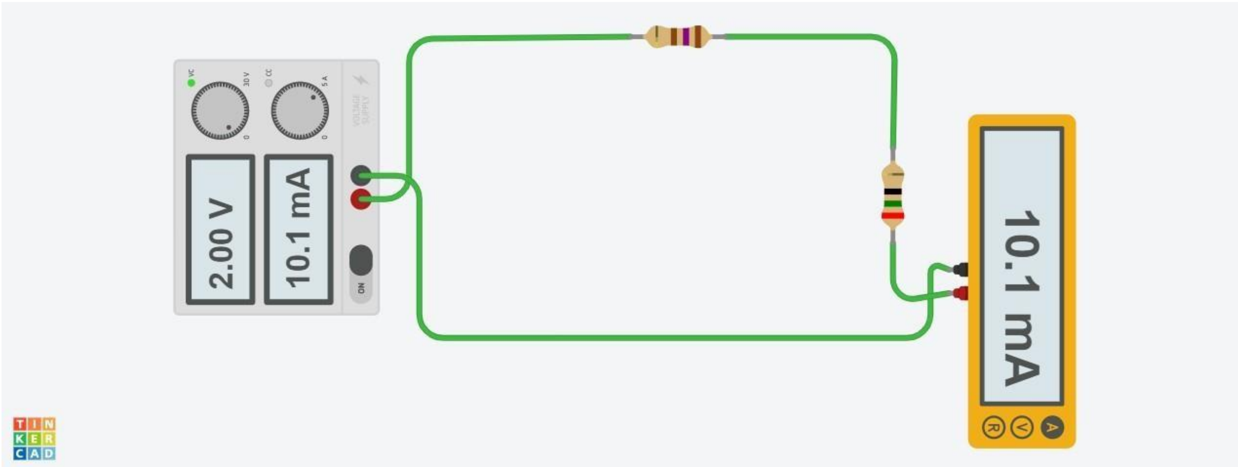
S. No.	Load resistance	V_{th}	R_{th}	I_L	Theoritical I_L	% Error
1	25 Ω	2 V	173 Ω	10.1 mA	10.08mA	0.19%
2	50 Ω	2 V	173 Ω	8.97 mA	8.95 mA	0.11%
3	100 Ω	2 V	173 Ω	7.31 mA	7.31 mA	0.27%

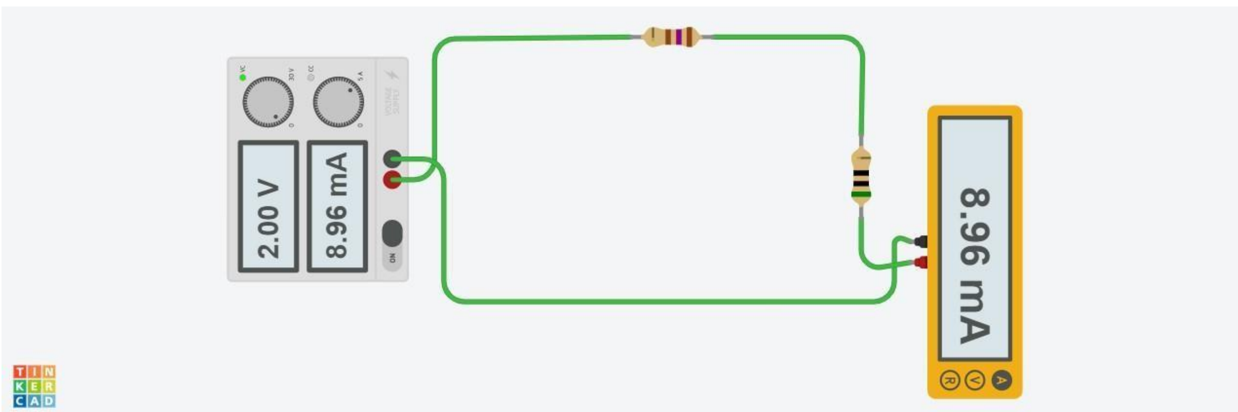
Circuit diagram on Tinkercad:

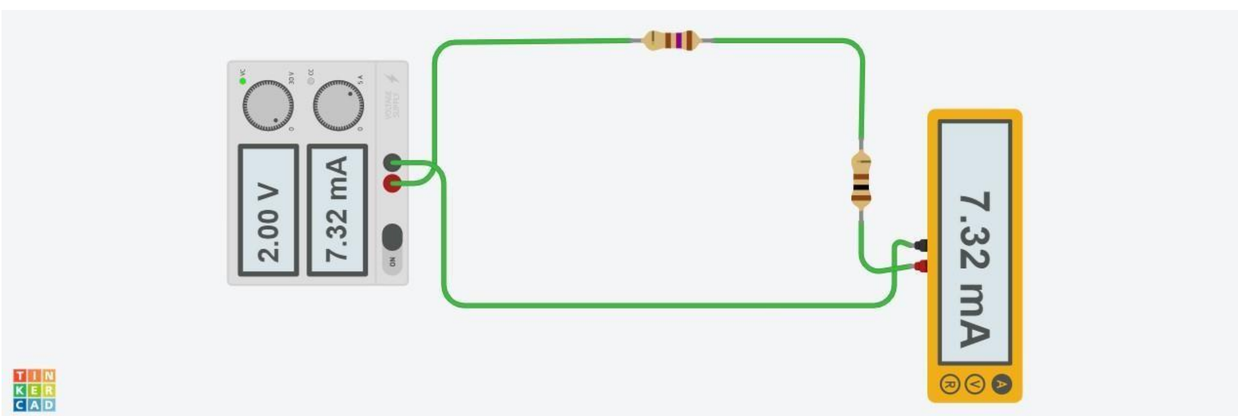



12.0 V
20.0 mA
2.00 V

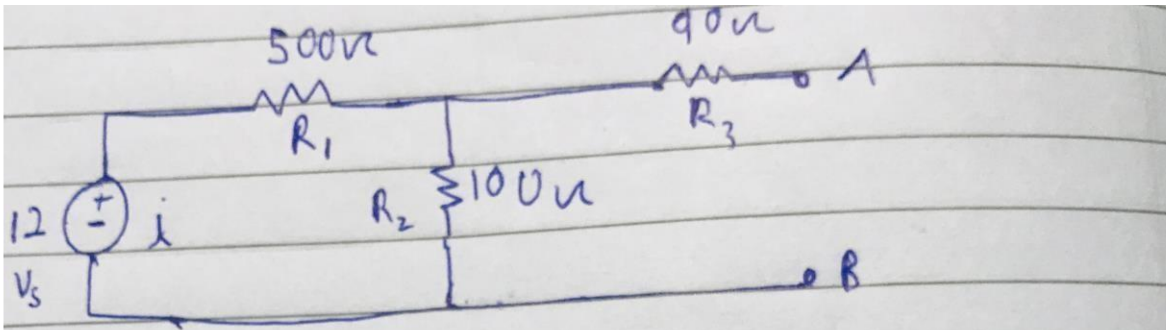

173 Ω





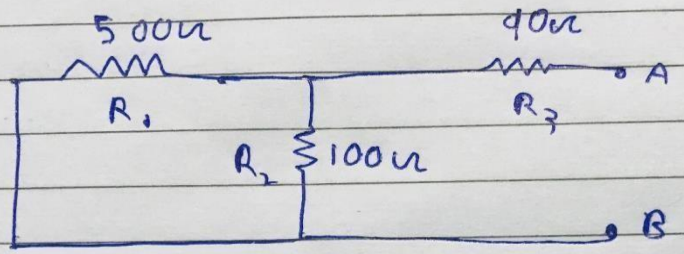


Calculations:



$i = \frac{12}{(500+100)} = \frac{12}{600} = \underline{0.02\ A}$

$= i \times R_2 = 0.02 \times 100 = \underline{2V}$

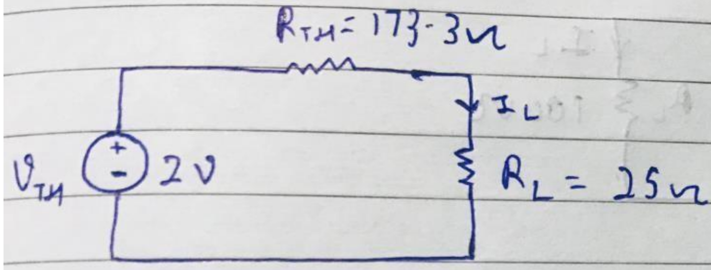


R_1 & R_2 are in parallel

$R' = \frac{1}{500} + \frac{1}{100} = \frac{500 \times 100}{600} = 83.3\Omega$

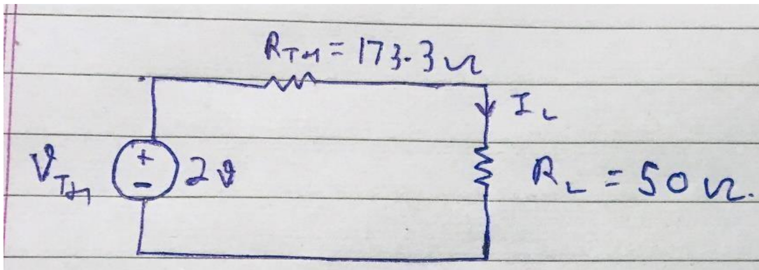
R' is in series with R_3

~~Req~~ $R_{Th} = 83.3 + 90 = 173.3\Omega$



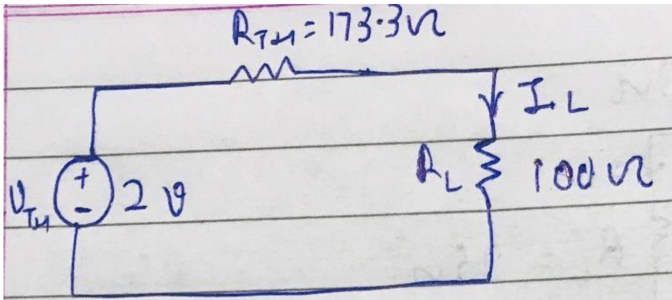
$$I_L = \frac{V_{TH}}{(R_{TH} + R_L)} = \frac{2}{173.3 + 25} = 0.010 \, A = 10.01 \, mA$$

$$\% \text{ Error} = \left(\frac{10.1 - 10.01}{10.1}\right) \times 100 = 0.189 \%$$



$$I_L = \frac{V_{TH}}{(R_{TH} + R_L)} = \frac{2}{(173.3 + 50)} = 8.95 \, mA$$

$$\% \text{ Error} = \left(\frac{8.96 - 8.95}{8.96}\right) \times 100 = 0.112 \%$$



$$I_L = \frac{2}{173.3+100} = 7.31\ mA$$

$$\%\ Error = \left(\frac{7.32-7.31}{7.32}\right)\times 100 = 0.26\%$$

Conclusion: Hence Thevenin's Theorem is verified.