North South University
Department of Electrical & Computer Engineering

LAB REPORT

Course Name: **EEE141 Lab**

Experiment Number**: 06**

Experiment Name: **Verification of Thevenin's, Norton's and Maximum Power Transfer Theorem**

Faculty: **SSH1**

Experiment Date: **07-08-22**

Report Submission Date: **14-08-22**

Section: **08**

Group: **04**

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Remarks:	

Experiment - 06: Verification of Thevenin's, Norton's and Maximum Power Transfer Theorem.

Objective:

In this experiment we have learnt

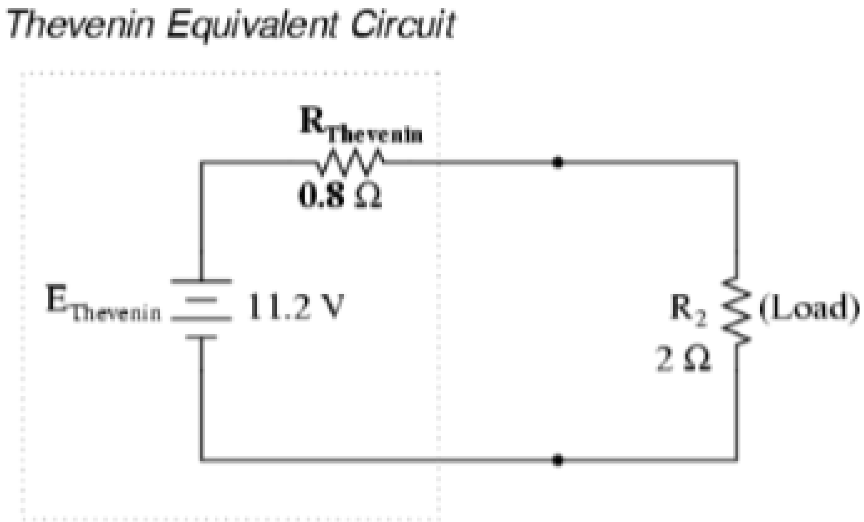
- Understanding the Thevenin's theorem, Norton's theorem and Maximum Power theorem
- Performing theoretical calculations.
- Verifying the experimental values with theoretical values.

List of Equipment:

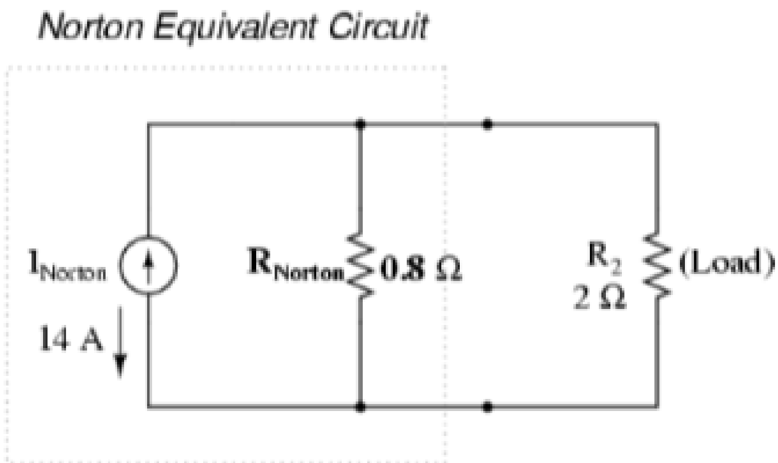
- Bread Board
- DC power source
- DMM
- POT
- 2 x 10kΩ resistor
- 1 x 1KΩ resistor

Theory:

Thevenin's Theorem: 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. The Thévenin equivalent circuit consists of a single dc source referred to as the Thévenin voltage. V_{TH} a single fixed resistor called the Thévenin resistance R_{TH}



Norton's Theorem: Norton's Theorem states that it is possible to simplify any linear circuit, no matter how complex, to an equivalent circuit with just a single current source I_N and parallel resistance connected to a load R_N



Thevenin Norton Equivalence:

$$R_N = R_{TH}$$

$$E_{TH} = I_N \times R_{TH}$$

Maximum Power Theorem: Maximum Power will be delivered to the load when that load resistance is equal to the Thevenin/Norton resistance of the network supplying the power. If the load resistance is lower or higher than the Thevenin/Norton resistance of the source network, its dissipated power will be less than maximum.
A load impedance that is too high will result in low power output. A load impedance that is too low will not only result in low power output

$$\begin{aligned} I_L &= V_{TH}/(R_{TH} + R_L) \\ &= V_{TH}/(R_{TH} + R_{TH}) \\ &= V_{TH}/2R_{TH} \end{aligned}$$

$$\begin{aligned} Where, P_{max} &= I_L^2 R_L \\ &= V_{TH}^2/4R_{TH} \end{aligned}$$

Circuit Diagram:

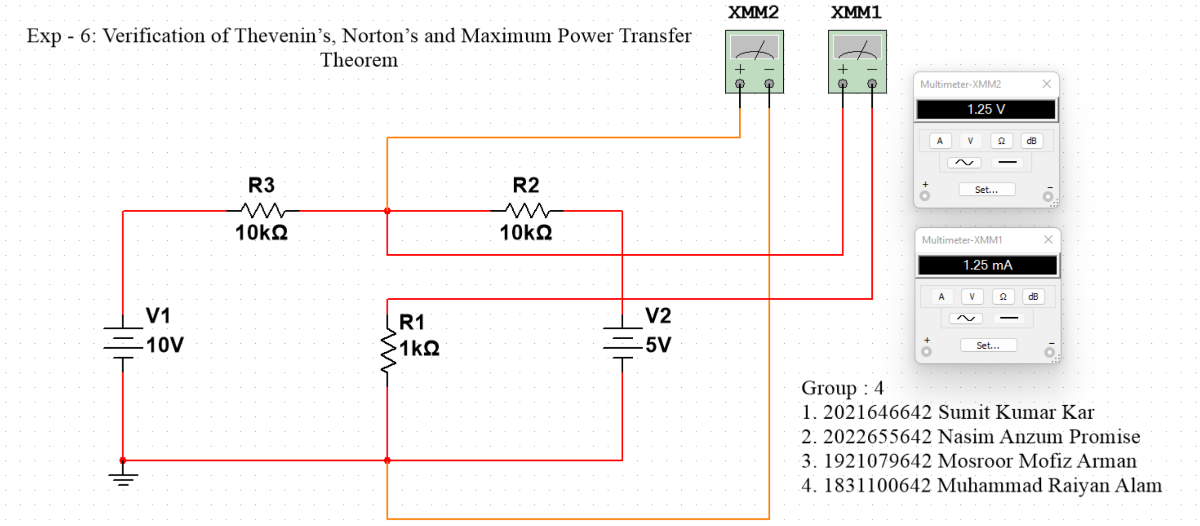


Figure 1: Circuit 1

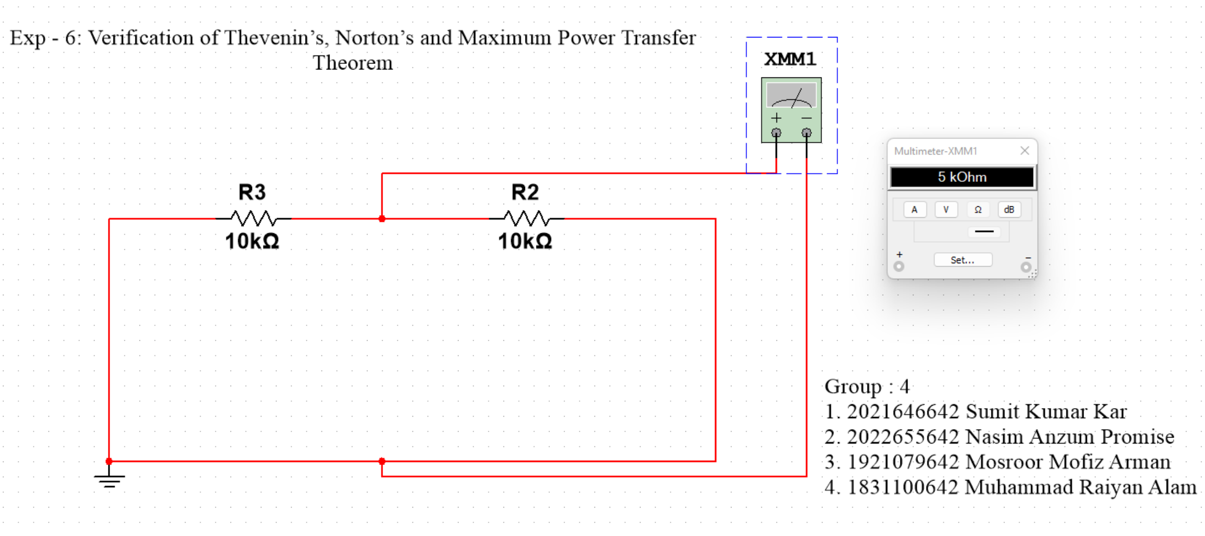


Figure 2: Circuit 2

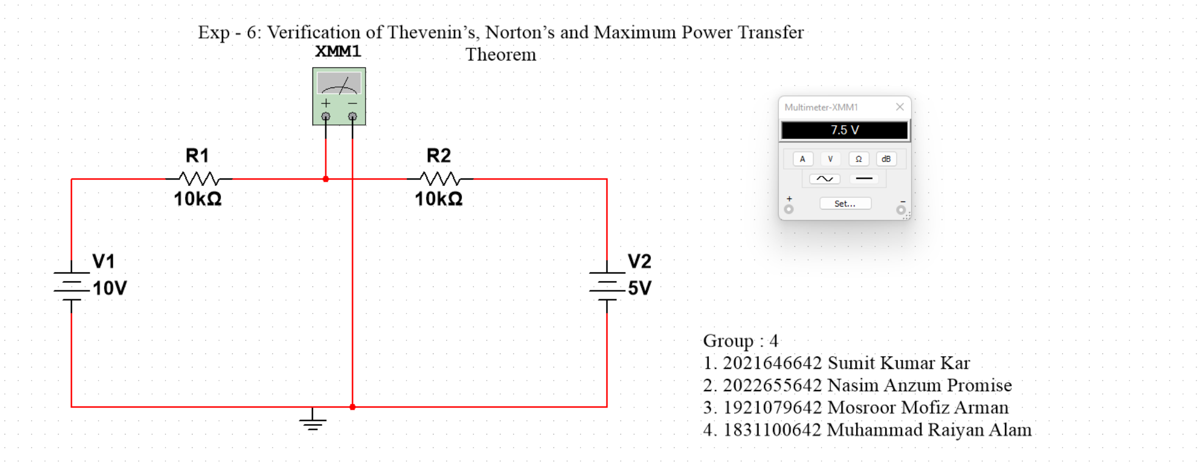


Figure 3: Circuit 3

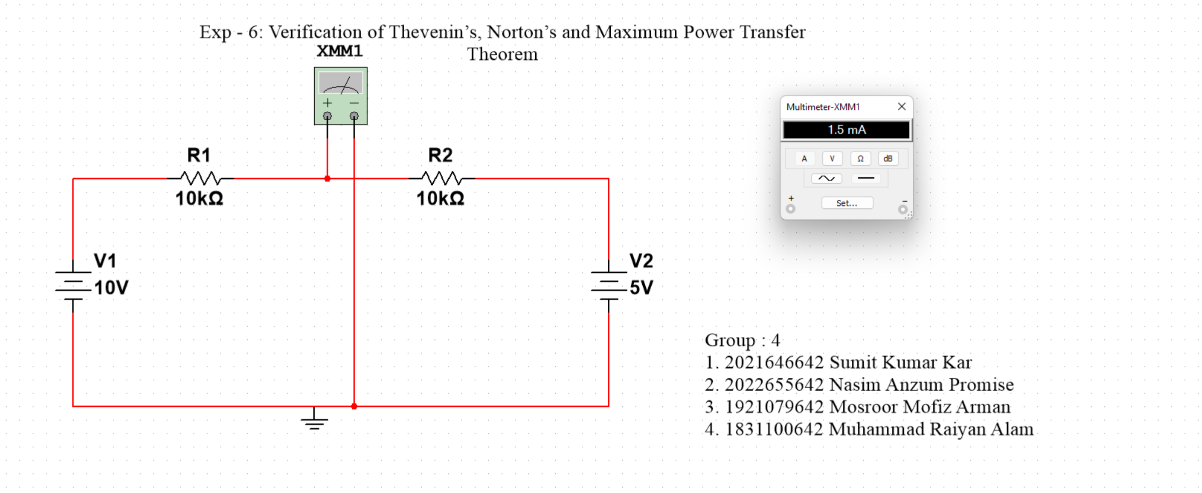


Figure 4: Circuit 4

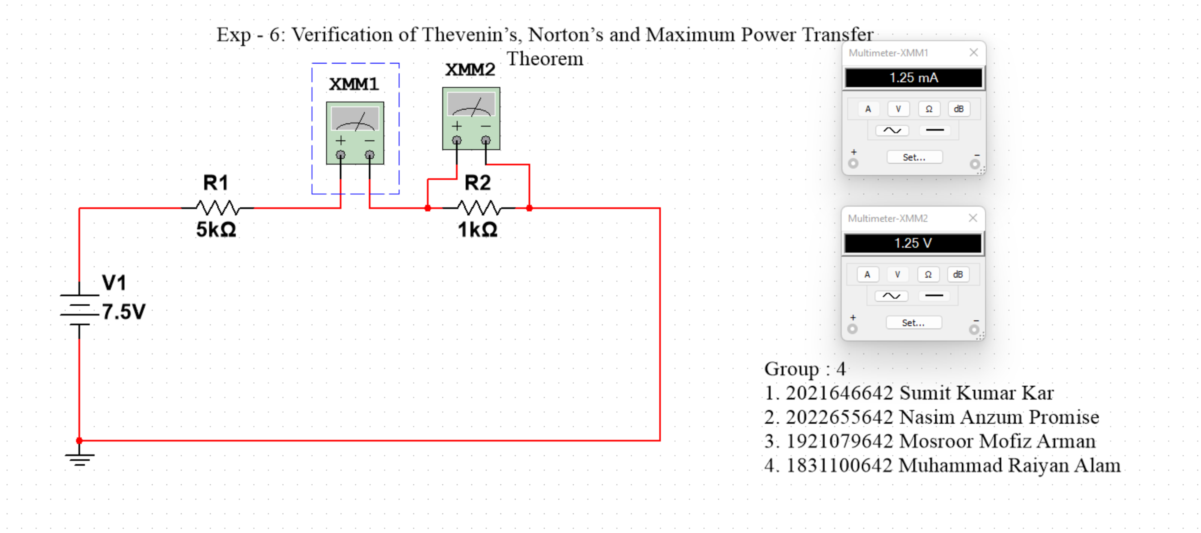


Figure 5: Circuit 5

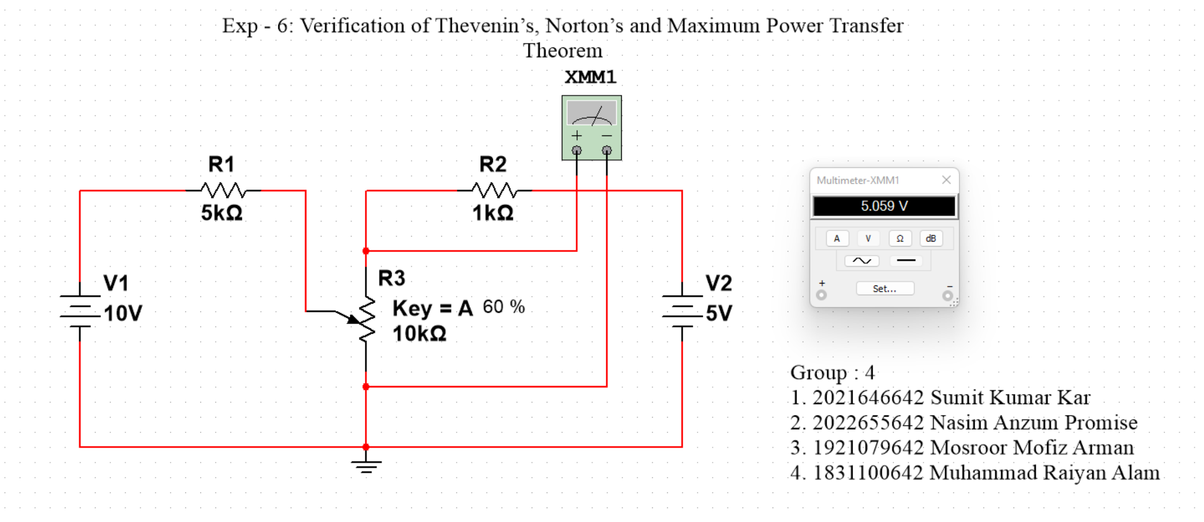


Figure 6: Circuit 6

Question and Answers:

1. Calculate all the theoretical values of Table 2. Show all steps

Answer: Let's first calculate R_{TH} using thevenins theorem. For this we replace the voltage source with shorted line. See Figure-2.
Here, R_1 and R_3 is in parallel so,

$$R_{TH} = R_1||R_3 = \frac{R_1R_3}{R_1 + R_3} = \frac{10k\Omega 10k\Omega}{10k\Omega + 10k\Omega} = 5k\Omega$$

Now using Thevenin's Theorem, Let's Calculate V_{TH} Let's use Superposition theorem because the circuit has multiple voltage sources.
Now First we remove 5V source and only keep 10V then find out V'_{TH}

$$V'_{TH} = \frac{E_1R_1}{R_1 + R_3} = \frac{10V \times 10k\Omega}{10k\Omega + 10k\Omega} = 5V$$

Again we remove 10V source and only keep 50V then find out $V'_{TH}\prime$

$$V'_{TH}\prime = \frac{E_1R_3}{R_1 + R_3} = \frac{5V \times 10k\Omega}{10k\Omega + 10k\Omega} = 2.5V$$

Finally

$$V_{TH} \ = V'_{TH} + V'_{TH}\prime = 5v + 2.5V = 7.5V$$

Now Lets Calculate V_L using Voltage divider rule in the new Thevenins equivalent circuit.

$$V_L = \frac{E_{TH}R_L}{R_{TH} + R_L} = \frac{7.5V1k\Omega}{1k\Omega + 5k\Omega} = 1.25V$$

$$I_L = \frac{V_L}{R_L} = \frac{1.25V}{1k\Omega} = 1.25mA$$

2. Comparing experimental values to theoretical values, verify Thevenin and Norton theorem.

Answer: Theoretical Values: $I_L = 1.25mA$ $V_L = 1.25V$ Practical values: $I_L = 1.25mA$ $V_L = 1.25V$ Here the values are the same
So, yes Thevenin and Norton theorem works for this

3. Prove Thevenin Norton equivalence.

Answer: We know that,

$$R_N = R_{TH}$$

$$E_{TH} = I_N \times R_{TH}$$

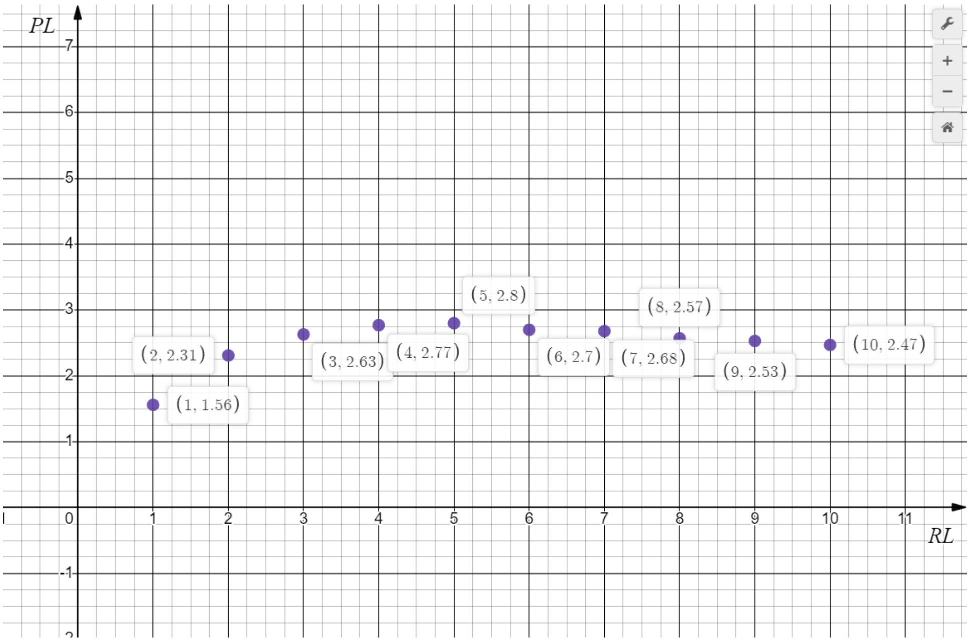
From Our experiment we get, E_{TH} = 1.25V, $R_{TH} = 1k\Omega$ and $I_N = 1.25mA$ Now,

$$E_{TH} = I_N \times R_{TH} = 1.25mA \times 1k\Omega = 1.25V$$

Here we can see that experimental values satisfies the equations.

4. In a graph paper, draw P_L vs R_L

Answer:



5. From the graph state the value of R_L for which maximum power is obtained.

Answer: From the graph state the value of $R_L = 5k\Omega$ where $P_max = 2.8mW$

6. Theoretically calculate the maximum power.

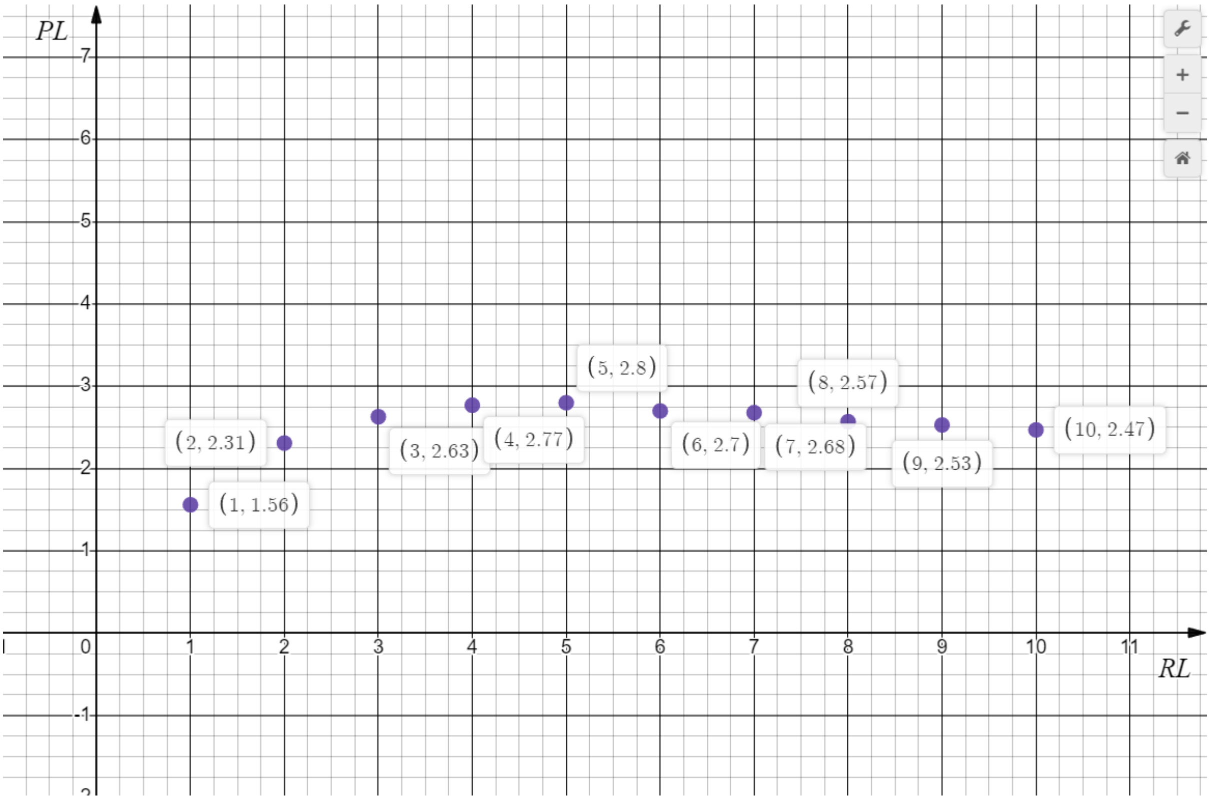
Answer: We know that,

$$P_{max} = V_{TH}^2/4R_{TH} = \frac{(7.5V)^2}{4 \times 5k\Omega} = 2.8mW$$

7. Verify the maximum power theorem

Answer: Here we can see that theoretical value of P_{max} and experimental values are same.
Theoretical P_{max} = 2.8mW
Experimental P_{max} = 2.8mW

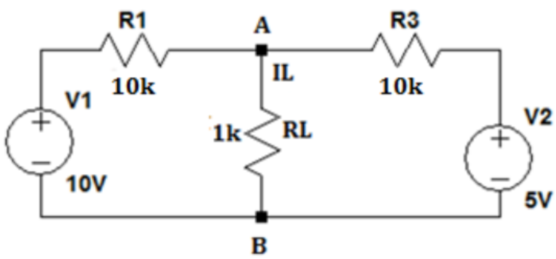
Graphical Analysis:



Here We can see the rise and fall of power in respect to resistance. In the horizontal axis we have resistance and in vertical axis we have power. We can see that at 5kohm the power was the highest. This is consistent to the maximum power theorem.

Result analysis and Discussion

In this experiment we learned about Thevenin's Norton's and Maximum Power Transfer Theorem. For this experiment we were provided Trainer broad 1× 1K, 2 × 10KΩ, POT (10K) ,Digital Multimeter (DMM) and Wires. First, we measured the values of resistance using DMM.



Then we constructed circuit-1. Next, we measured V_L and I_L of R_L for circuit 1 and recorded the values in Table-2. After that, we removed R_L from the original circuit and measured the open circuit voltage V_{TH}.We also measured the short circuit current I_N by placing an Ammeter between A and B.Next, we replaced the voltage sources with short circuits. With R_L removed from the circuit we measure R_{TH} using multimeter (placed DMM across A and B). We have recorded the values in Table-3. Next we drew the Thevenin and Norton Equivalent circuit in Table-4. Then, we constructed the Thevenin equivalent circuit drawn in Table-4 and measured $I_L$and V_L . We recorded the readings in Table 2. After that, we replaced the load resistor with a POT, vary the load resistance and for each resistance value measure V_L We filled up the values in Table-5. That was the end of our experiment.

Table of Contributions

During the experiment in class:

- 2021646642 Sumit Kumar Kar and 2022655642 Nasim Anzum Promise :
  Building the Circuit
- 1831100642 Muhammad Raiyan Alam:
  Wrote data in Lab Manual and helped group members with the steps
- 1921079642 Mosroor Mofiz Arman:
  Checked whether all the circuits were built correctly or not and whether all the data were written carefully and accurately or not.

During Lab Report:

- 2022655642 Nasim Anzum Promise:
  Wrote objective, theory part and Discussion.
- 2021646642 Sumit Kumar Kar:
  Drew Multisim and Solved Questions and Answers
- 1831100642 Muhammad Raiyan Alam:
  Helped with Question and Answer
- 1921079642 Mosroor Mofiz Arman:
  Report Writing according to the Guideline given in the canvas.