BOLD and Underline Word should be written with color pen. Use pencil margin, Page number with color pen, all drawing with pencil, table body with pencil but text will be ball pen, write both sides.

Experiment Name: Verification of Maximum Power Transfer Theorem.

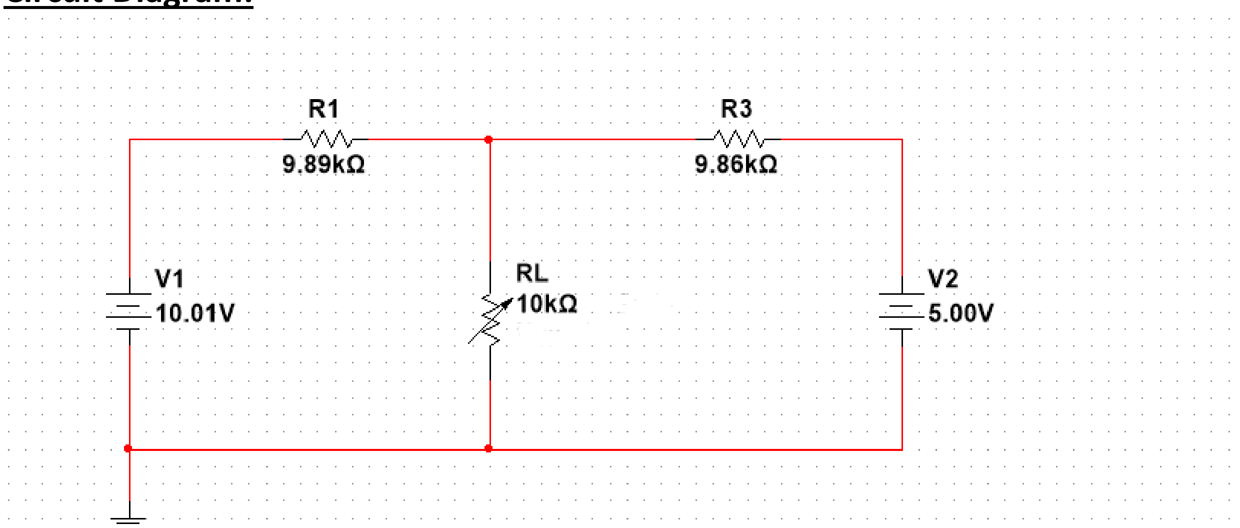
Objectives:

- Experimentally perform Maximum Power Transfer theorem.
- Perform theoretical calculations.
- Verify the experimental values with theoretical values.

Apparatus:

- Breadboard
- Resistors (2x 10 kΩ)
- Variable Resistors (0 kΩ - 10 kΩ)
- Digital Multimeter (DMM)
- DC Power Supply
- Wires

Circuit Diagram:

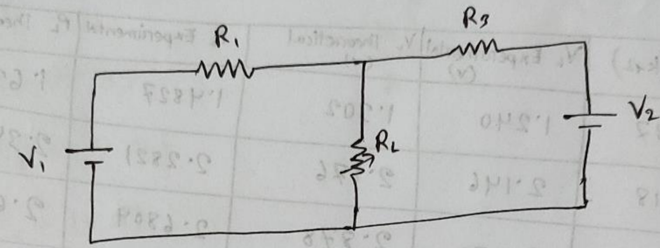


Data Table & Calculation:

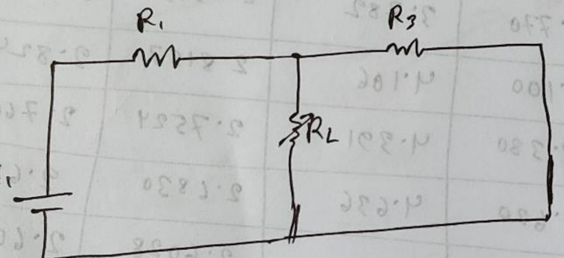
Table - 1:

R_L (kΩ)	V_L Experimental (V)	V_L Theoretical (V)	P_L Experimental	P_L Theoretical
1.037	1.240	1.302	1.4827	1.6347
2.018	2.146	2.176	2.2821	2.3464
3.073	2.870	2.878	2.6804	2.6954
4.00	3.345	3.357	2.7973	2.8174
5.02	3.770	3.782	2.8313	2.8493
5.97	4.100	4.106	2.8157	2.8240
6.97	4.380	4.391	2.7524	2.7662
7.99	4.630	4.636	2.6830	2.6899
9.00	4.840	4.844	2.6028	2.6071
10.06	5.030	5.032	2.5150	2.5170

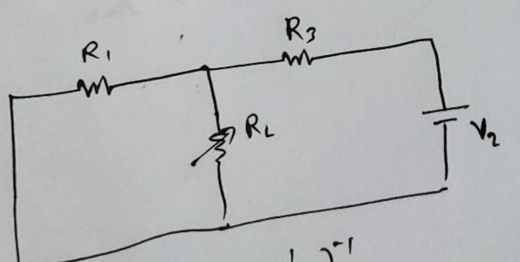
Theoretical Value Calculation:



Using Superposition Theorem,



$$V_L' = \frac{\left(\frac{1}{R_L} + \frac{1}{R_3}\right)^{-1}}{R_1 + \left(\frac{1}{R_L} + \frac{1}{R_3}\right)^{-1}} \times V_1$$



$$V_L'' = \frac{\left(\frac{1}{R_L} + \frac{1}{R_1}\right)^{-1}}{R_3 + \left(\frac{1}{R_L} + \frac{1}{R_1}\right)^{-1}} \times V_2$$

$$\therefore V_L = V_L' + V_L''$$

$$= \frac{\left(\frac{1}{R_L}+\frac{1}{R_3}\right)^{-1}}{R_1+\left(\frac{1}{R_L}+\frac{1}{R_3}\right)^{-1}} \times V_1 + V_2 \frac{\left(\frac{1}{R_L}+\frac{1}{R_1}\right)^{-1}}{R_3+\left(\frac{1}{R_L}+\frac{1}{R_1}\right)^{-1}}$$

And $P_L = \frac{(V_L)^2}{R_L}$

Here,

$R_1 = 9.89\ k\Omega$

$R_3 = 9.86\ k\Omega$

$V_1 = 10.01\ V$

$V_2 = 5.00\ V$

Now,

For $R_L = 1.037\ k\Omega$,

$$\therefore V_L = 10.01 \frac{\left(\frac{1}{1.037}+\frac{1}{9.86}\right)^{-1}}{9.89+\left(\frac{1}{1.037}+\frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{1.037}+\frac{1}{9.89}\right)^{-1}}{9.86+\left(\frac{1}{1.037}+\frac{1}{9.89}\right)^{-1}}$$

$= 1.302\ V$

$$\therefore P_L = \frac{(1.302)^2}{1.037} = 1.6347\ mW$$

For $R_L = 2.018\ k\Omega$

$$\therefore V_L = 10.01 \frac{\left(\frac{1}{2.018} + \frac{1}{9.86}\right)^{-1}}{9.89 + \left(\frac{1}{2.018} + \frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{2.018} + \frac{1}{9.89}\right)^{-1}}{9.86 + \left(\frac{1}{2.018} + \frac{1}{9.89}\right)^{-1}}$$

$$= 2.176\ V$$

$$\therefore P_L = \frac{(2.176)^2}{2.018} = 2.3464\ mW$$

For, $R_L = 3.073\ k\Omega$

$$\therefore V_L = 10.01 \frac{\left(\frac{1}{3.073} + \frac{1}{9.86}\right)^{-1}}{9.89 + \left(\frac{1}{3.073} + \frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{3.073} + \frac{1}{9.89}\right)^{-1}}{9.86 + \left(\frac{1}{3.073} + \frac{1}{9.89}\right)^{-1}}$$

$$= 2.878\ V$$

$$P_L = \frac{(2.878)^2}{3.073} = 2.6954\ mW$$

For, $R_L = 4.00\ k\Omega$,

$$V_L = 10.01 \frac{\left(\frac{1}{4}+\frac{1}{9.86}\right)^{-1}}{9.89+\left(\frac{1}{4}+\frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{4}+\frac{1}{9.89}\right)^{-1}}{9.86+\left(\frac{1}{4}+\frac{1}{9.89}\right)^{-1}}$$

$$= 3.357\ V$$

$$P_L = \frac{(3.357)^2}{4.00} = 2.8174\ mW$$

For $R_L = 5.02\ k\Omega$,

$$V_L = 10.01 \frac{\left(\frac{1}{5.02}+\frac{1}{9.86}\right)^{-1}}{9.89+\left(\frac{1}{5.02}+\frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{5.02}+\frac{1}{9.89}\right)^{-1}}{9.86+\left(\frac{1}{5.02}+\frac{1}{9.89}\right)^{-1}}$$

$$= 3.782\ V$$

$$P_L = \frac{(3.782)^2}{5.02} = 2.8493\ mW$$

For $R_L = 5.97\ k\Omega$

$$V_L = 10.01 \frac{\left(\frac{1}{5.97}+\frac{1}{9.86}\right)^{-1}}{9.89+\left(\frac{1}{5.97}+\frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{5.97}+\frac{1}{9.89}\right)^{-1}}{9.86+\left(\frac{1}{5.97}+\frac{1}{9.89}\right)^{-1}}$$

$$= 4.106\ V$$

$$P_L = \frac{(4.106)^2}{5.97} = 2.8240\ mW$$

For $R_L = 6.77\ k\Omega$

$$V_L = 10.01 \frac{\left(\frac{1}{6.77}+\frac{1}{9.86}\right)^{-1}}{9.89+\left(\frac{1}{6.77}+\frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{6.77}+\frac{1}{9.89}\right)^{-1}}{9.86+\left(\frac{1}{6.77}+\frac{1}{9.89}\right)^{-1}}$$

$$= 4.391\ V$$

$$P_L = \frac{(4.391)^2}{6.77} = 2.7662\ mW$$

For $R_L = 7.77\ k\Omega$

$$V_L = 10.01 \frac{\left(\frac{1}{7.77}+\frac{1}{9.86}\right)^{-1}}{9.89+\left(\frac{1}{7.77}+\frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{7.77}+\frac{1}{9.89}\right)^{-1}}{9.86+\left(\frac{1}{7.77}+\frac{1}{9.89}\right)^{-1}}$$

$$= 4.636\ V$$

$$P_L = \frac{(4.636)^2}{7.77} = 2.6877\ mW$$

For $R_L = 9.00\ k\Omega$

$$V_L = 10.01 \frac{\left(\frac{1}{9}+\frac{1}{9.86}\right)^{-1}}{9.89+\left(\frac{1}{9}+\frac{1}{9.86}\right)^{-1}} + 5.00 \frac{\left(\frac{1}{9}+\frac{1}{9.89}\right)^{-1}}{9.86+\left(\frac{1}{9}+\frac{1}{9.89}\right)^{-1}}$$

$$= 4.844\ V$$

$$P_L = \frac{(4.844)^2}{9.00} = 2.6071\ mW$$

For $R_L = 10.06\ k\Omega$

$$V_L = 10.01\ \frac{\left(\frac{1}{10.06}+\frac{1}{9.86}\right)^{-1}}{9.89+\left(\frac{1}{10.06}+\frac{1}{9.86}\right)^{-1}} + 5.00\ \frac{\left(\frac{1}{10.06}+\frac{1}{9.89}\right)^{-1}}{9.86+\left(\frac{1}{10.06}+\frac{1}{9.89}\right)^{-1}}$$

$$= 5.032\ V$$

$$P_L = \frac{(5.032)^2}{10.06} = 2.5170\ mW$$

Theoretical Value of maximum power,

$$R_{TH} = 4.94\ k\Omega$$

$$V_{TH} = 7.520\ V$$

$$\therefore\ P_{max} = \frac{(V_{TH})^2}{4R_{TH}} = \frac{(7.520)^2}{4\times 4.94}$$

$$= 2.8619\ mW$$

From Graph,

$$R_{TH} = 4.7\ k\Omega$$

$$P_{max} = 2.8500\ mW$$

$$\therefore\ \text{Error}: \left|\frac{2.8619 - 2.8500}{2.8619}\right| \times 100\%$$

$$= 0.42\%$$

Graph:

Attached.

Result Analysis:

From the data table of this experiment, we found that the theoretical and measured values of V_L and P_L are approximately the same. We also get that the theoretical value of P_{max} and the P_{max} from the graph are also approximately the same. Therefore, our circuits completely follow the Maximum Power Transfer theorem.

Questions and Answers:

01. Already showed in Data Table Section.

02. Already showed in Data Table Section.

Discussion:

After completing this experiment, we learnt to verify the Maximum Power Transfer Theorem. Now we can calculate the maximum Power of a circuit using this theorem. We need to remove the load and measure the R_t and the voltage of Thevenin's Theorem at points a and b; then, using the maximum power transfer formula, we can calculate the maximum power. In this experiment, we don't face any difficulties. We completed this experiment on time.

Attachment:

01. Signed Data Table.

02. Simulation using Multisim.

03. Graph of R_L vs P_{max}.