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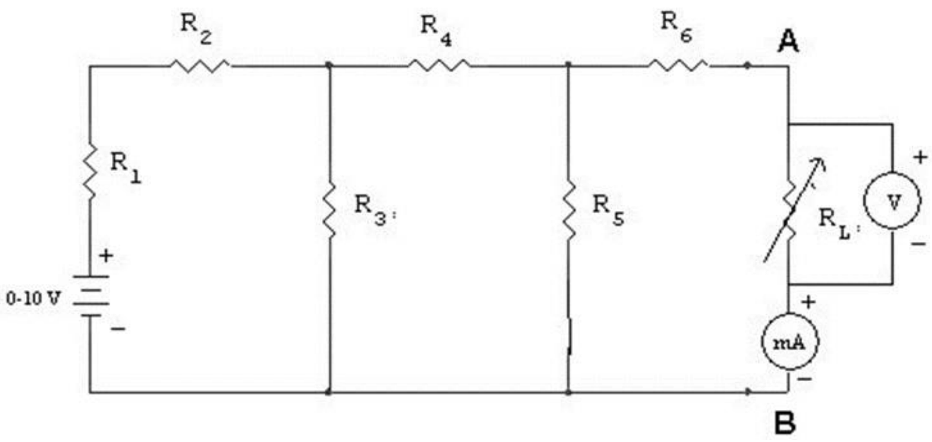
Branch: Comps B (Batch B2)

Verification of Thevenin's, Norton's and Maximum Power Transfer Theorem

CIRCUIT DIAGRAM:



OBSERVATIONS:

R1 = <u>0 Ω</u>, R2 = <u>100 Ω</u>, R3 = <u>330 Ω</u>, R4 = <u>100 Ω</u>, R5 = <u>330 Ω</u>, R6 = <u>470 Ω</u>, V1 = <u>10 V</u>

Sr. No.	**R_L (Ω)**	**V_L (V)**	**I_L (mA)**	**P_L (mW)**
1	383	2.046	5	10.23
2	403	2.088	5	10.44
3	423	2.146	4.95	10.62
4	443	2.202	5	11.01
5	463	2.246	5	11.23
6	483	2.275	5	11.375
7	503	2.360	4.75	11.21
8	523	2.405	4.6	11.063
9	543	2.451	4.5	11.029
10	563	2.497	4.4	10.987

V_{Th} (V)	**$R_{Th} = R_N$ (Ω)**	**I_N (mA)**
5.01	582	8

CALCULATIONS:

Thevenin :

R_{th}

Obs.	Calculated
582 Ω	585.092 Ω

V_{th}

Obs.	Calculated
5.01	8.543

Norton

I_N	R_N(cal.)	Obs.
8	585.098Ω	582

V_L(V)	I_L(mA)	R_L(Ω)	P(mW)
2.046	5	383	10.23
2.088	5	403	10.44
2.146	4.95	423	10.62
2.202	5	443	11.01
2.246	5	463	11.23
2.275	5	483	11.375
2.360	4.75	503	11.21
2.405	4.6	523	11.063
2.451	4.5	543	11.029
2.497	4.4	563	10.987

Pmax.

Obs.	Cal
10.78	10.68

EXPERIMENT NO.: 3 **DATE: 20 / 06 / 2022**

Verification of Thevenin's, Norton's, and Maximum Power Transfer Theorem

AIM:

To verify Thevenin's, Norton's, and Maximum Power Transfer Theorem for the given circuit by circuit implementation on breadboard and using simulator.

APPARATUS AND COMPONENTS REQUIRED:

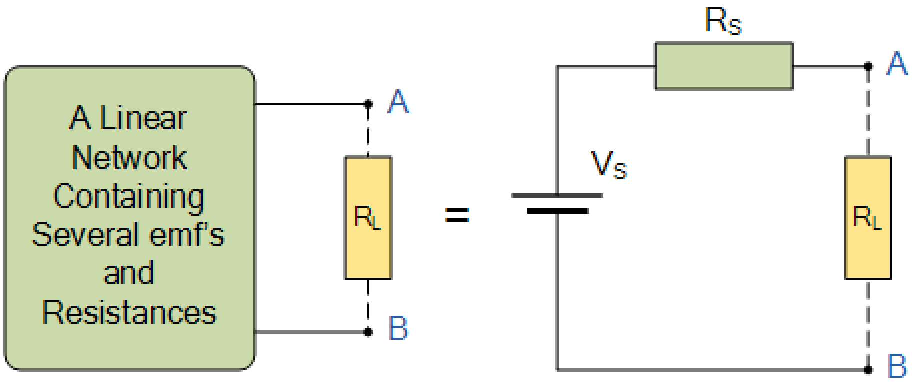
Resistors, DC Voltage source, Ammeter, DMM, breadboard, connecting wires, Sequel Simulator

THEORY:

Thevenin's Theorem:

Thevenin theorem is an analytical method used to change a complex circuit into a simple equivalent circuit consisting of a single resistance in series with a source voltage. Thevenin's Theorem states that "Any linear circuit containing several voltages and resistances can be replaced by just one single voltage in series with a single resistance connected across the load ". In other words, it is possible to simplify any electrical circuit, no matter how complex, to an equivalent two-terminal circuit with just a single constant voltage source in series with a resistance (or impedance) connected to a load as shown below. Thevenin's Theorem is especially useful in the circuit analysis of power or battery systems and other interconnected resistive circuits where it will have an effect on the adjoining part of the circuit.

Thevenin's equivalent circuit:

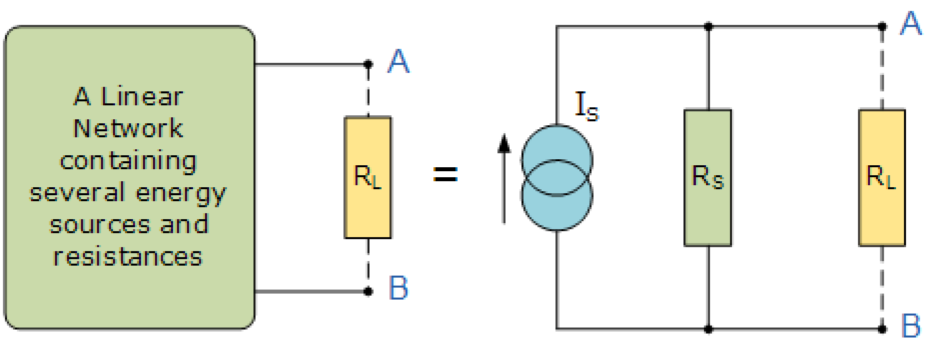


Norton's Theorem:

Norton's theorem is an analytical method used to change a complex circuit into a simple equivalent circuit consisting of a single resistance in parallel with a current source. Norton's Theorem states that "Any linear circuit containing several energy sources and resistances can be replaced by a single Constant Current generator in parallel with a Single Resistor ".

As far as the load resistance, RL is concerned with this single resistance, RS is the value of the resistance looking back into the network with all the current sources open-circuited and IS is the short circuit current at the output terminals as shown below.

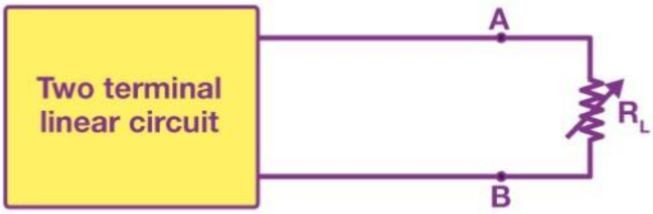
Norton's equivalent circuit:

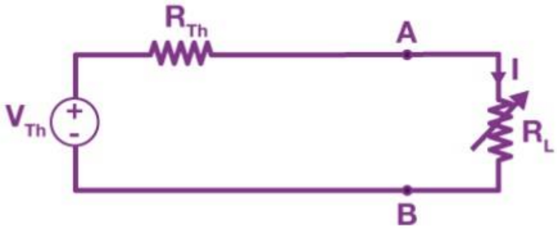


Maximum Power Transfer Theorem:

Maximum Power Transfer Theorem explains that to generate maximum external power through a finite internal resistance (DC network), the resistance of the given load must be equal to the resistance of the available source.

In other words, the resistance of the load must be the same as Thevenin's / Norton's equivalent resistance.





The fundamental Maximum Power Transfer formula is:

$P_{max} = V_{Th2} / 4R_{Th}$

$$\frac{dP}{dR_L} = 0$$

$$= \frac{d}{dR_L}\left(\frac{V_0}{R_L + R_{Th}}\right)^2 R_L = 0$$

$$= \frac{d}{dR_L}\frac{V_0^2 R_L}{(R_L + R_{Th})^2} = 0$$

$$= \frac{(R_L + R_{Th})^2 \frac{d}{dR_L}(V_0^2 R_L) - V_0^2 R_L \frac{d}{dR_L}((R_L + R_{Th})^2)}{(R_L + R_{Th})^4} = 0$$

$$= \frac{(R_L + R_{Th})^2 V_0^2 - V_0^2 R_L \, X \, 2(R_L + R_{Th})}{(R_L + R_{Th})^4} = 0$$

$$= \frac{V_0^2 (R_L + R_{Th})(R_L + R_{Th} - 2R_L)}{(R_L + R_{Th})^4} = 0$$

$$= \frac{V_0^2 (R_L + R_{Th})(R_{Th} - R_L)}{(R_L + R_{Th})^4} = 0$$

$$R_{Th} - R_L = 0$$

$$R_{Th} = R_L$$

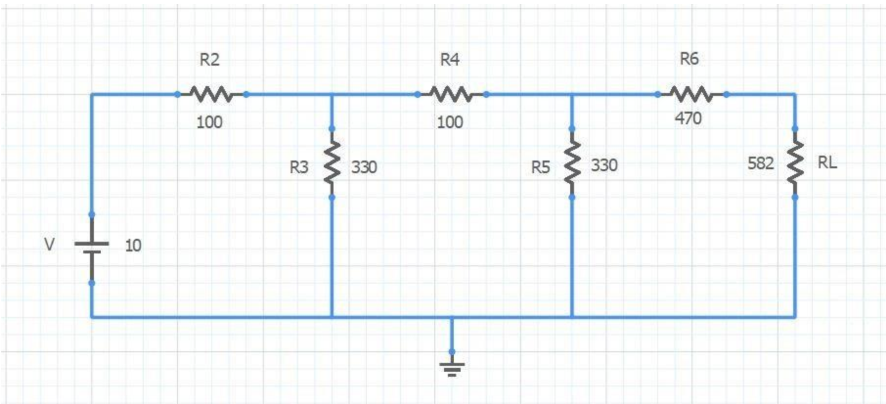
Therefore, the value of $P_{max} = I^2R = [V_{Th} / (R_{Th} + R_L)]^2 * R_{Th} = V_{Th}^2 / 4R_{Th}$

PROCEDURE:

1) Connect the circuit as shown in the circuit diagram.
2) Keep the voltage such that the maximum current does not go beyond the range of the milliammeter.
3) Vary the load resistance from minimum to maximum.
4) Note the corresponding load current (I_L) and the voltage across the load V_L.
5) Calculate the power dissipated in the load resistance as V_L* I_L.
6) Plot the graph of P_L v/s R_L.
7) Obtain observed values of V_{Th} and R_{Th} and IN 8) Implement the given circuit using Sequel Simulator.
9) Simulate the circuit, find V_{Th}, I_N and get the graph of P_L v/s R_L

10) Verify with the theoretical solution.

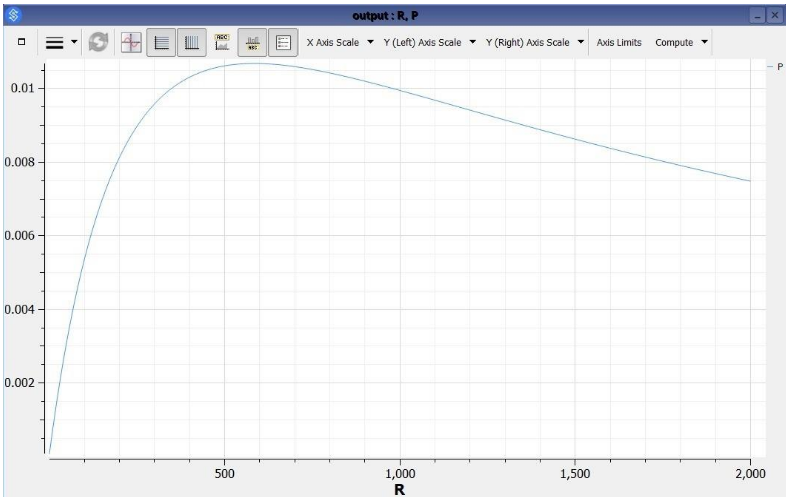
RESULT:

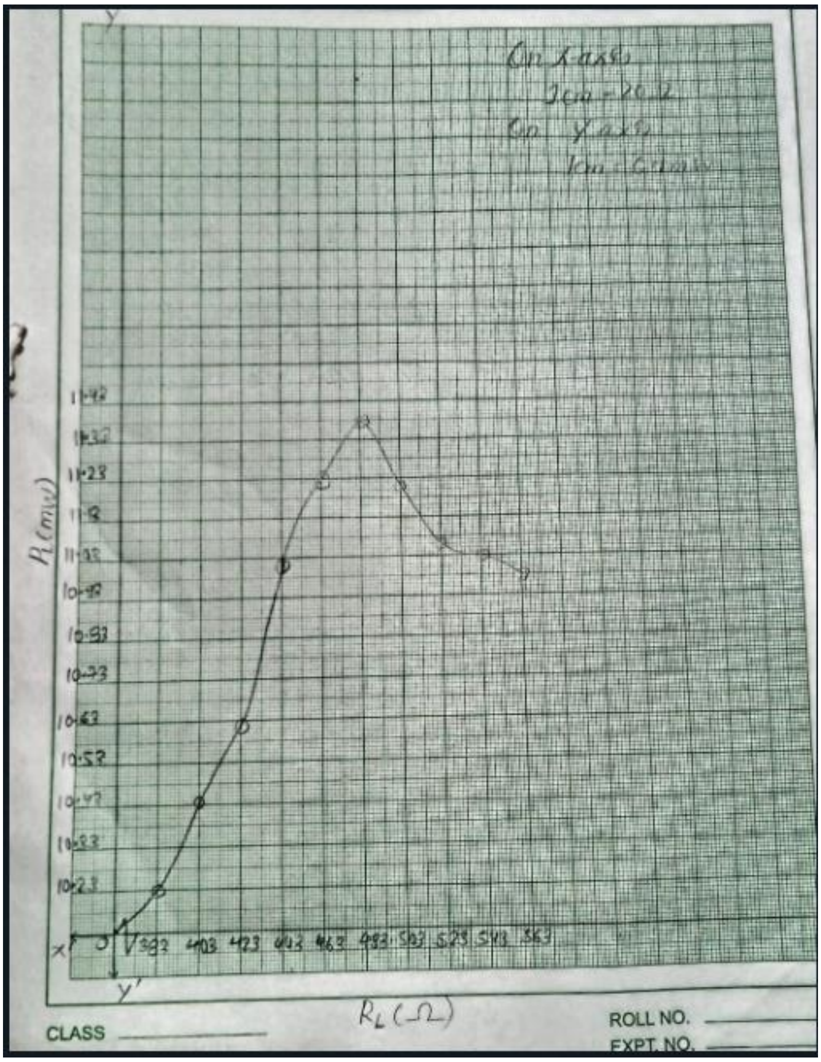


	Variable	Value
1	V	2.492218e+000
2	I	4.282162e-003
3	P	1.067208e-002
4	R	5.820000e+002

V_{Th} (V)			$R_{Th} = R_N$ (Ω)			I_N (mA)			P_{max} (mW)		
Theoretical	**Observed**	**By Simulation**	**Theoretical**	**Observed**	**By Simulation**	**Theoretical**	**Observed**	**By Simulation**	**Theoretical**	**Observed**	**By Simulation**
5.00	5.01	5.00	585.098	582	585.098	8.543	8	8.543	10.68	10.78	10.68

GRAPH:


output : R, P
X Axis Scale
Y (Left) Axis Scale
Y (Right) Axis Scale
Axis Limits
Compute
P
0.01
0.008
0.006
0.004
0.002
500
1,000
1,500
2,000
R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CONCLUSION:

In this experiment we learned about
Thevenin's, Norton, & Maximum Power transfer
theorem
We verified by implementing, calculating
and simulating on sequel.
We also plotted a graph.