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VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM

AIM:-

To design a simplified equivalent circuit in analysing the power systems and other circuits where the load resistor is subject to change in order to determine the voltage across it and current through it using Thevenin's theorem. To design the circuit for maximising the power transferred from the source to the load using Maximum Power Transfer Theorem.

APPARATUS REQUIRED:-

S. NO.	Name of component	Range	Type	Quantity Required
1.	DC Power Supply	15V	RPS	1
2.	Resistor	1KΩ	Wire	Each 1
		3.3KΩ	Wound	
		2.2KΩ		
3.	Voltmeter	(0-30)V	MC	1
4.	Ammeter	(0-25)mA	MC	1
5.	Wires	-	Single strond	Few numbers
6.	Variable resistor	(0-9)KΩ	Wire Wound	1
7.	Breadboard	-	-	1

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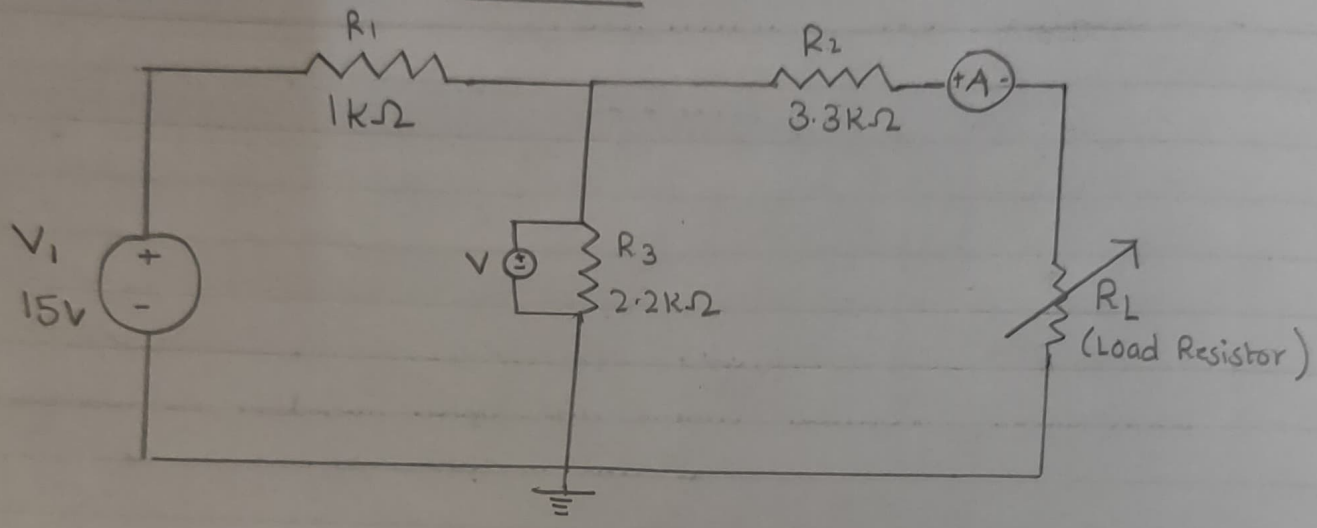
CIRCUIT DIAGRAM



OBSERVATION TABLE

SL. NO.	R_L (KΩ)	V_L (V)	I_L (mA)	P_L (mW)
1.	0	0	2.5	0
2.	1	2.06	2	3.61
3.	2	3.43	1.75	4.5
4.	3	4.41	1.5	4.6
5.	4	5.15	1.25	6.25
6.	5	5.72	1	5
7.	6	6.18	0.9	4.86
8.	7	6.55	0.75	3.93
9.	8	6.86	0.6	2.88
10.	9	7.13	0.5	2.25

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THEORY:-

Any 2-terminal linear network composed of voltage sources, current sources and resistors can be replaced by an equivalent two-terminal network consisting of an independent voltage source in series with a resistor. The value of voltage source is equivalent to the open circuit voltage (V_{TH}) across two terminals of the network and the resistance is equal to the equivalent resistance (R_{TH}) measured between the terminals with all energy sources replaced by their internal resistances.

The Maximum Power Transfer Theorem states that - "Maximum power is delivered from a source to a load when the load resistance is equal to the equivalent source resistance. ($R_L = R_{TH}$).

Formulae:-

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

2) $V_L = I_L R_L = \frac{V_{TH} \cdot R_L}{R_{TH} + R_L}$

3) $P_{max} = \frac{V_{TH}^2}{4R_{TH}}$

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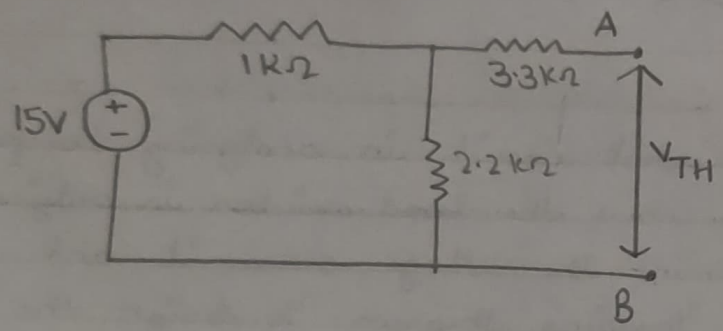
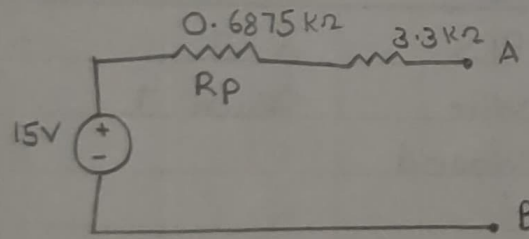
THEORETICAL CALCULATIONS:-

Determination of Thevenin's voltage (V_{TH}):-



$$V_{TH} = \frac{2200}{2200+1000} \times 15 = \underline{10.3125\,V}$$

Determination of Thevenin's Resistance (R_{TH}):-



$$R_{TH} = 0.6875 + 3.3 = \underline{3.9875\,K\Omega}$$

Sample calculation:-

- $R_L = 4K\Omega$

$$I_L = \frac{V_{TH}}{R_{TH}+R_L} = \frac{10.3}{8} = \underline{1.2875\,mA}$$

$$P_L = I_L^2 R_L = (1.28)^2(4) = \underline{6.55\,mW}$$

$$V_L = \frac{V_{TH} \cdot R_L}{R_{TH}+R_L} = \frac{10.3 \times 4}{8} = \underline{5.15\,V}$$

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PROCEDURE :-

1) Connect the circuit on the breadboard as per the circuit diagram
2) Switch on the power supply.
3) Measure the value of R_{TH} and V_{TH}
4) Change the value of R_L and for each value of R_L, measure the voltage V_L, current I_L and power P_L and tabulate the results as obtained
5) Plot the curve of power against the load resistance and determine the maximum power.
6) Compare between the theoretical and practical results to verify the Maximum Power Transfer Theorem.

RESULT :-

The value of V_L, I_L and P_L for different values of load resistance are compared, both practically and theoretically. Hence, the maximum power transfer theorem is verified.

Maximum Power = 6.25mW when R_L = 4KΩ

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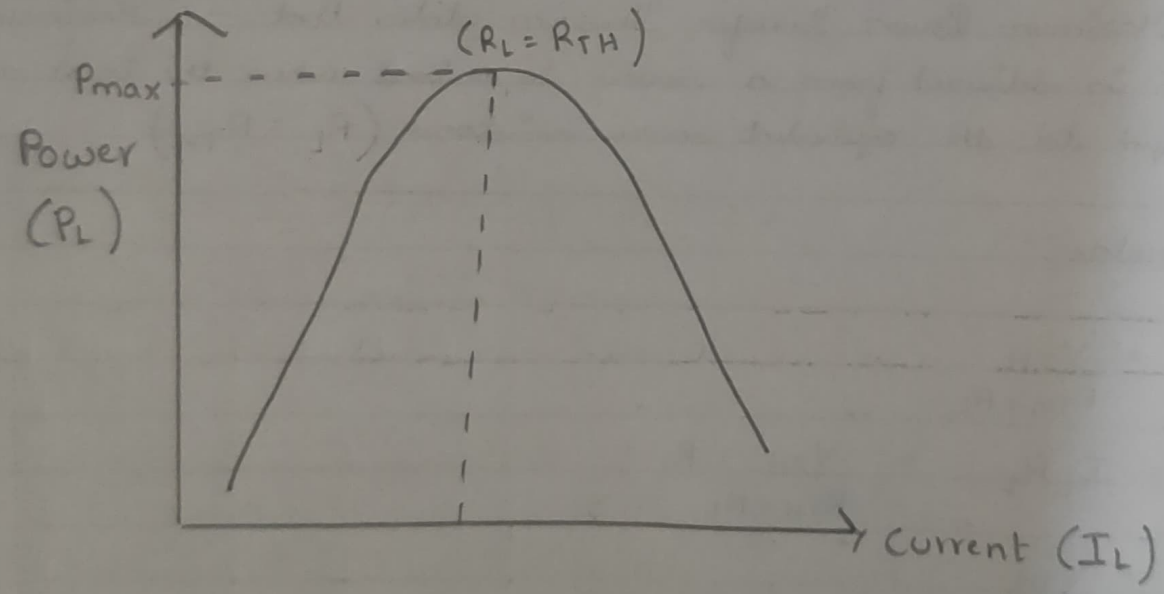
ERROR :- $R_L = 4K\Omega$

Parameter	Theoretical	Experimental	% Error
V_L	5.15 V	5.15 V	0 %
I_L	1.2875 mA	1.25 mA	-3%
P_L	6.55 W	6.25 W	-4.8%

MODEL GRAPH :-



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LTspice SIMULATION

SOFTWARE USED :- LTspice

PROCEDURE:-

1) Open LTspice. Go to File - New Schematic.
2) Select the DC voltage source, resistors, connecting wires and ground wire from the components list.
3) Connect the components using connecting wires as per the circuit diagram.
4) Enter the fixed DC source voltage value along with the value of resistors R_1, R_2 and R_3 (except the load resistor, R_L)
5) Take 10 values for the load resistance from 0-9KΩ.
6) Run the simulation by clicking on the 'Run' command and note down the current value obtained for each load resistance value.
7) Tabulate the results so obtained and draw the graph.

ERROR:- (R_L = 4KΩ)

Parameter	Hardware	Software	% Error
V_L (V)	5.15	5.15	0%
I_L (mA)	1.25	1.2910	3.1%
P_L (W)	6.25	6.66	6.15%

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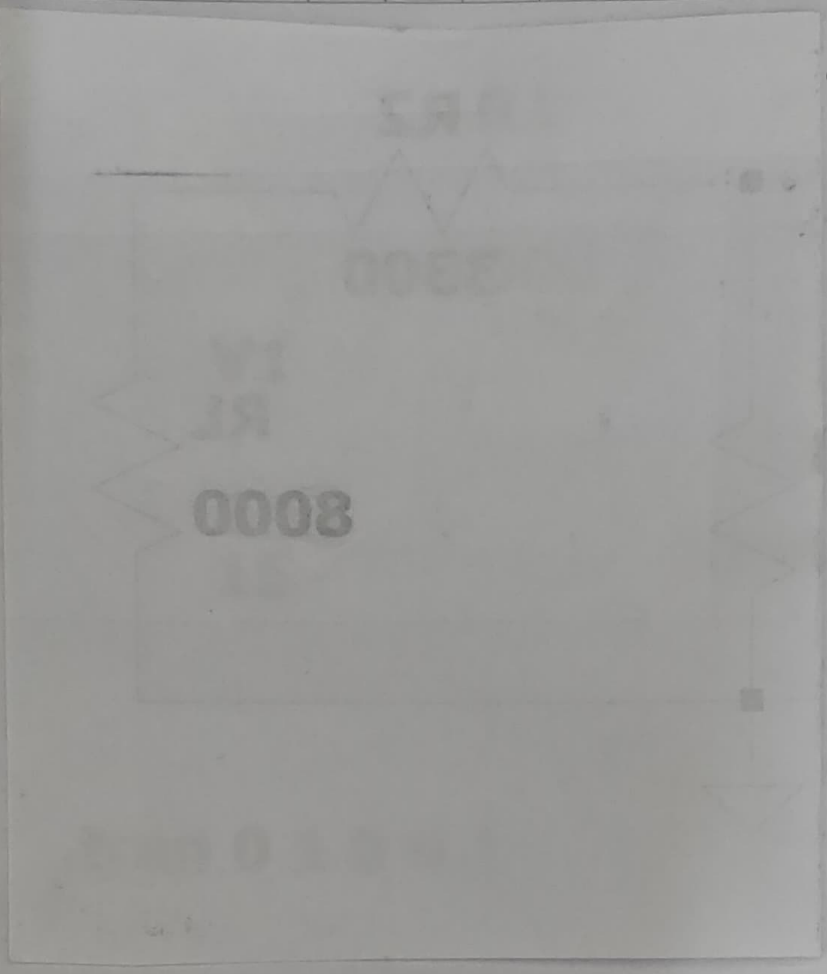

Sl. No.	R_L (KΩ)	V_L (V)	I_L (mA)	P_L (mW)
1.	0	0	2.5862	0
2.	1	2.06	2.0677	4.270
3.	2	3.43	1.7223	5.930
4.	3	4.41	1.4758	6.530
5.	(4)	5.15	1.2910	6.660
6.	5	5.72	1.1100	6.160
7.	6	6.18	1.1090	6.140
8.	7	6.55	938.5 μA	6.160
9.	8	6.86	860.3 μA	5.920
10.	9	7.13	794.1 μA	5.675

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RESULT :-

Thus, the Maximum Power Transfer Theorem has been verified using LTspice Simulation for the given circuit

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ERROR (SAMPLE):- $R_L = 4K\Omega$

Parameter	Theoretical	Experimental	% Error
V_L	5.15 V	5.15 V	0%
I_L	1.2875 mA	1.2910 mA	0.27%
P_L	6.55 W	6.660	1.6%