CYCLE – 1

1. VERIFICATION OF KIRCHOFF'S LAWS

AIM: To verify the Kirchhoff's voltage law and Kirchhoff's current law for the given circuit.

APPARATUS REQUIRED:

S.No	Name of the equipment	Range	Type	Quantity
1	RPS	0-30V	-	1N0
2	Voltmeter	0-20 V	Digital	4 NO
3	Ammeter	0-20mA	Digital	4 NO
4	Bread board	-	-	1 NO
5	Connecting wires	-	-	Required number.
6	Resistors	470 Ω		2 NO
		1kΩ		1 NO
		680Ω		1 NO

CIRCUIT DIAGRAMS:

GIVEN CIRCUIT:

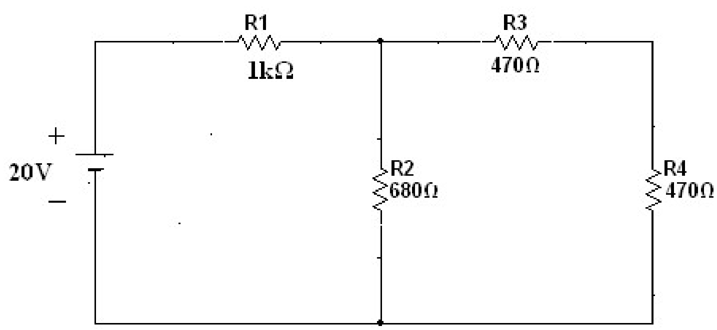


Fig (1)

1. KVL:

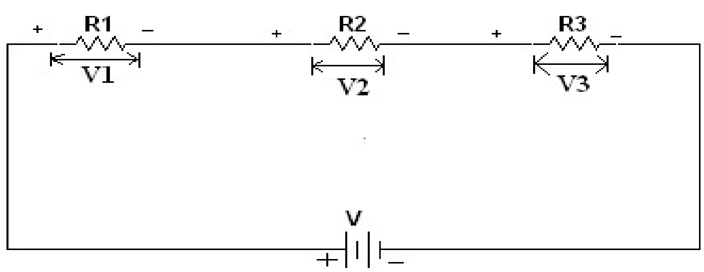
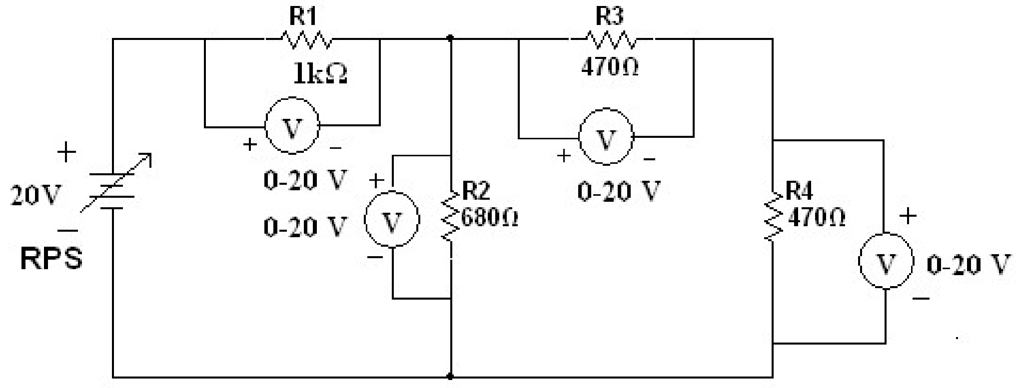


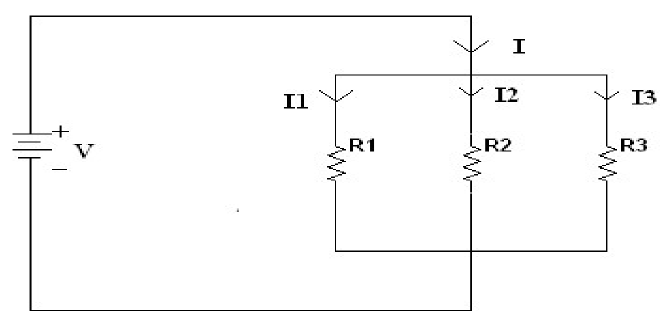
Fig (1a)

PRACTICAL CIRCUIT:



Fig(2a)

2. KCL:



Fig(1b)

PRACTICAL CIRCUIT:

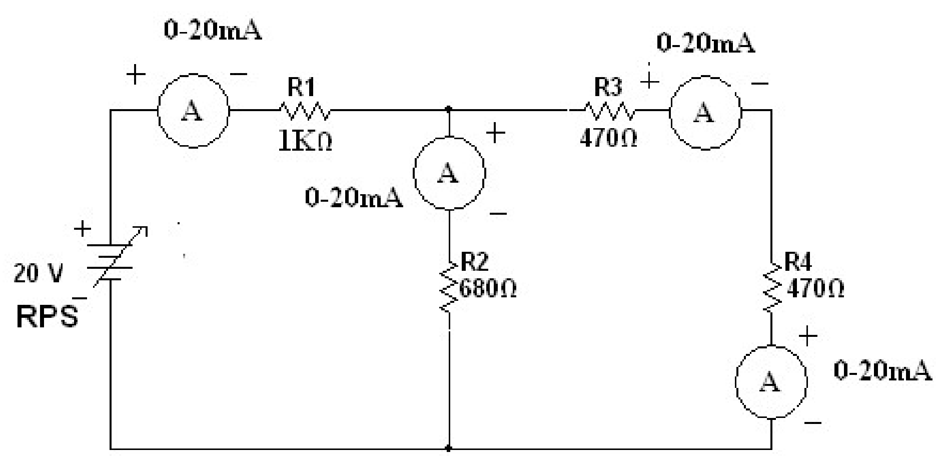


Fig (2b)

THEORY:

a) Kirchhoff's Voltage law states that the algebraic sum of the voltage around any closed path in a given circuit is always zero. In any circuit, voltage drops across the resistors always have polarities opposite to the source polarity. When the current passes through the resistor, there is a loss in energy and therefore a voltage drop. In any element, the current flows from a higher potential to lower potential. Consider the fig (1a) shown above in which there are 3 resistors are in series. According to kickoff's voltage law….

$$\mathbf{V = V_1 + V_2 + V_3}$$

b) Kirchhoff's current law states that the sum of the currents entering a node equal to the sum of the currents leaving the same node. Consider the fig (1b) shown above in which there are 3 parallel paths. According to Kirchhoff's current law...

$$\mathbf{I = I_1 + I_2 + I_3}$$

PROCEDURE:

1. Kirchhoff's Voltage law:
   1. Connect the circuit as shown in fig (2a).
   2. Measure the voltages across the resistors.
   3. Observe that the algebraic sum of voltages in a closed loop is zero.
2. Kirchhoff's current law:
   1. Connect the circuit as shown in fig (2b).
   2. Measure the currents through the resistors.
   3. Observe that the algebraic sum of the currents at a node is zero.

OBSERVATION TABLE:

KVL:

S.NO	Voltage Across Resistor	Theoretical	Practical

KCL:

S.NO	Current Through Resistor	Theoretical	Practical

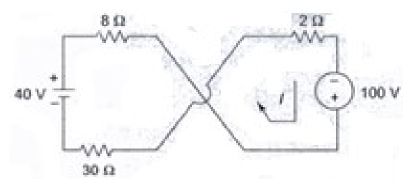
PRECAUTIONS:

1. Avoid loose connections.
2. Keep all the knobs in minimum position while switch on and off of the supply.

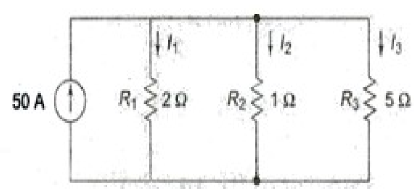
RESULT:

EXERCISE QUESTIONS:

1. In The Circuit Given In Fig Find A)The Current I B)The Voltage Across 30 Ω resistance



2. Determine The Current In All Resistors In The Circuit Shown In Fig.



VIVA QUESTIONS:

1. What is another name for KCL & KVL?
2. Define network and circuit?
3. What is the property of inductor and capacitor?

2. VERIFICATION OF THEVENIN'S THEOREM

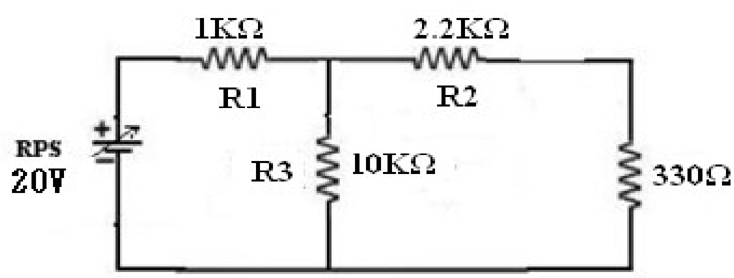
AIM: To verify Theremin's theorem for the given circuit.

APPARATUS REQUIRED:

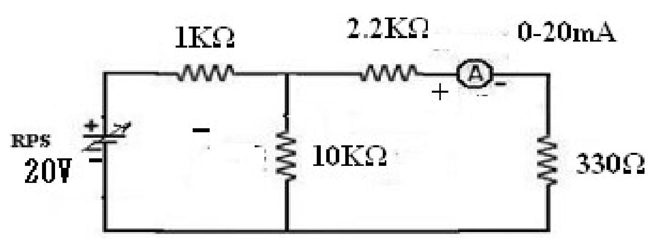
S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω,1K Ω		1 NO
		2.2Ω		1 NO
		330 Ω		1 NO
5	Breadboard	-	-	1 NO
6	DMM	-	Digital	1 NO
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

GIVEN CIRCUIT:

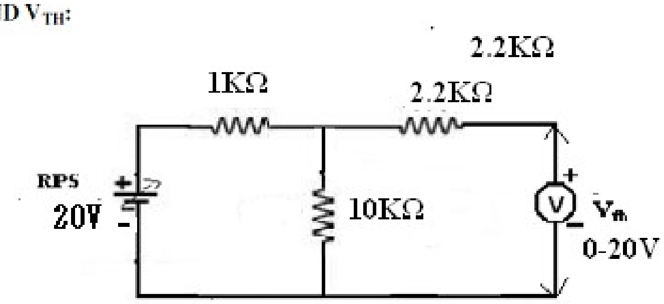


PRACTICAL CIRCUIT DIAGRAMS:
TO FIND I_L:



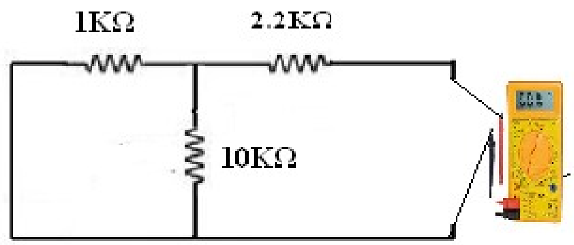
FIG(1)

TO FIND V_{TH}:



FIG(2)

TO FIND R_{th}:



fig(3)

THEORY:

THEVENIN'S THEOREM:

It states that in any lumped, linear network having more number of sources and elements the equivalent circuit across any branch can be replaced by an equivalent circuit consisting of Theremin's equivalent voltage source Vth in series with Theremin's equivalent resistance Rth. Where Vth is the open circuit voltage across (branch) the two terminals and Rth is the resistance seen from the same two terminals by replacing all other sources with internal resistances.

Thevenin's theorem:

The values of VTh and RTh are determined as mentioned in thevenin's theorem. Once the thevenin equivalent circuit is obtained, then current through any load resistance RL connected across AB is given by, $I = \frac{V_{TH}}{R_{TH}+R_L}$

Thevenin's theorem is applied to d.c. circuits as stated below.

Any network having terminals A and B can be replaced by a single source of e.m.f. V_{Th} in series with a source resistance R_{Th}

(i) The e.m.f the voltage obtained across the terminals A and B with load, if any removed i.e., it is open circuited voltage between terminals A and B.

(ii) The resistance R_{Th} is the resistance of the network measured between the terminals A and B with load removed and sources of e.m.f replaced by their internal resistances. Ideal voltage sources are replaced with short circuits and ideal current sources are replaced with open circuits.

To find V_{Th}, the load resistor 'RL' is disconnected, then $VTh = \frac{V}{R_1+R_2} X R3$

To find R_{Th},

$$R_{Th} = R2 + \frac{R_1 R_3}{R_1 + R_3}$$

Thevenin's theorem is also called as "Helmoltz theorem"

PROCEDURE:

1. Connect the circuit as per fig (1)
2. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
3. Note down the response (current, IL) through the branch of interest i.e. AB (ammeter reading).
4. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
5. Disconnect the circuit and connect as per the fig (2).
6. Adjust the output voltage of the regulated power supply to 20V.
7. Note down the voltage across the load terminals AB (Voltmeter reading) that gives Vth.
8. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
9. Disconnect the circuit and connect as per the fig (3).
10. Connect the digital multimeter(DMM) across AB terminals and it should be kept in resistance mode to measure Thevenin's resistance(R_{Th}).

THEORITICAL VALUES:

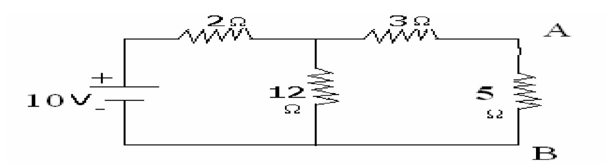
Tabulation for Thevenin's Theorem:

THEORITICAL VALUES	PRACTICAL VALUES
V_{th}= R_{th}= I_L=	V_{th}= R_{th}= I_L=

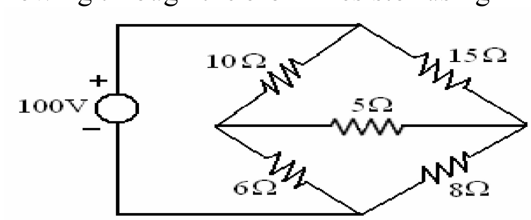
RESULT:

EXERCISE QUESTIONS:

1. Determine current through current 5 ohms resistor using Norton's theorem.



2. Determine the current flowing through the 5 ohm resistor using Thevenin's theorem



VIVA QUESTIONS:

1) The internal resistance of a source is 2 Ohms and is connected with an External Load Of 10 Ohms Resistance. What is Rth ?
2) In the above question if the voltage is 10 volts and the load is of 50 ohms What is the load current and Vth? Verify I_L?
3) If the internal resistance of a source is 5 ohms and is connected with an External Load Of 25 Ohms Resistance. What is Rth?
4) In the above question if the voltage is 20V and the load is of 50 Ohms, What is the load current and I_N ? Verify I_L ?

3. VERIFICATION OF NORTON'S THEOREM

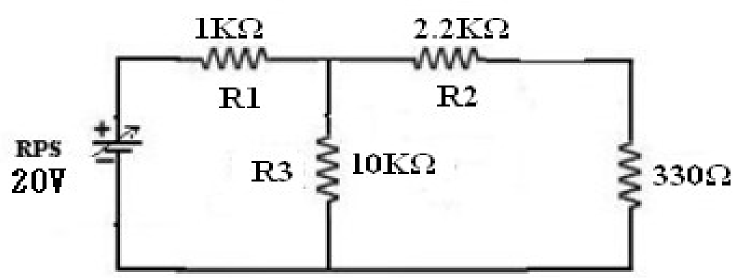
AIM: To verify Norton's theorem for the given circuit.

APPARATUS REQUIRED:

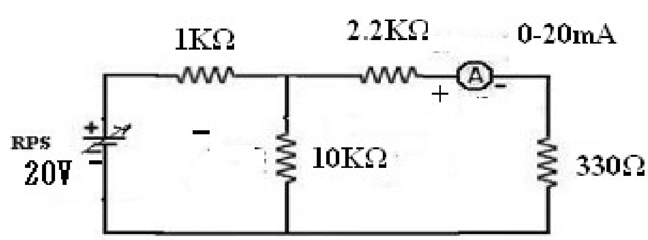
S.No	Name Of The Equipment	Range	Type	Quantity
1	Voltmeter	(0-20)V	Digital	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	10K Ω,1K Ω		1 NO
		2.2Ω		1 NO
		330 Ω		1 NO
5	Breadboard	-	-	1 NO
6	DMM	-	Digital	1 NO
7	Connecting wires			Required number

CIRCUIT DIAGRAM:

GIVEN CIRCUIT:



PRACTICAL CIRCUIT DIAGRAMS:
TO FIND I_L:



FIG(1)

TO FIND I_N:

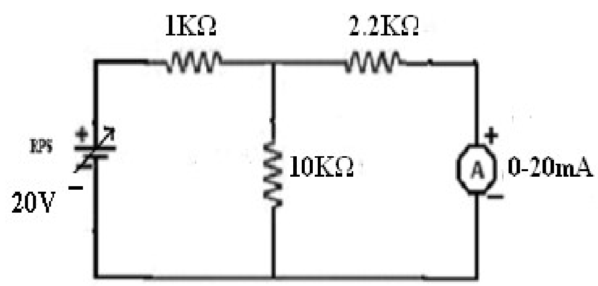
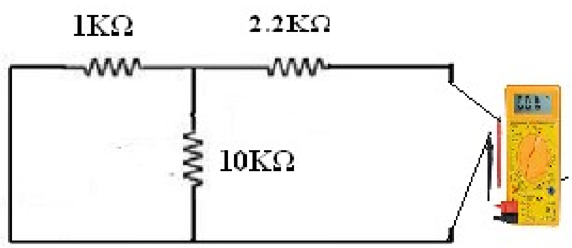


fig (2)

TO FIND R_N:



fig(3)

THEORY:

NORTON'S THEOREM:

Norton's theorem states that in a lumped, linear network the equivalent circuit across any branch is replaced with a current source in parallel a resistance. Where the current is the Norton's current which is the short circuit current though that branch and the resistance is the Norton's resistance which is the equivalent resistance across that branch by replacing all the sources sources with their internal resistances

for source current,

$$I = \frac{V}{R^1} = \frac{V(R_2 + R_3)}{R_1R_2 + R_1R_3 + R_2R_3}$$

FOR NORTON's CURRENT

$$I_N = I \times \frac{R_3}{R_3 + R_2} = \frac{VR_3}{R_1R_2 + R_1R_3 + R_2R_3}$$

Load Current through Load Resistor

$I_L = I_N \times [R_N / (R_N + R_L)]$

PROCEDURE:

1. Connect the circuit as per fig (1)
2. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
3. Note down the response (current, IL) through the branch of interest i.e. AB (ammeter reading).
4. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
5. Disconnect the circuit and connect as per the fig (2).
6. Adjust the output voltage of the regulated power supply to 20V.
7. Note down the response (current, I_N) through the branch AB (ammeter reading).
8. Reduce the output voltage of the regulated power supply to 0V and switch-off the supply.
9. Disconnect the circuit and connect as per the fig (3).
10. Connect the digital multimeter (DMM) across AB terminals and it should be kept in resistance mode to measure Norton's resistance(R_N).

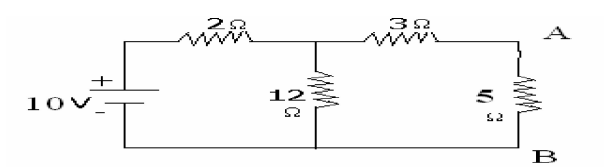
TABULATION FOR NORTON'S THEOREM:

THEORITICAL VALUES	PRACTICAL VALUES
I_N= R_N= I_L=	I_N= R_N= I_L=

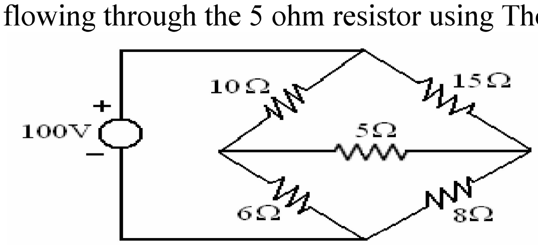
RESULT:

EXERCISE QUESTIONS:

1. Determine current through current 5 ohms resistor using Norton's theorem.



2. Determine the current flowing through the 5 ohm resistor using Thevenin's theorem



VIVA QUESTIONS:

1) The internal resistance of a source is 2 Ohms and is connected with an External Load Of 10 Ohms Resistance. What is Rth?
2) In the above question if the voltage is 10 volts and the load is of 50 ohms. What is the load current and Vth? Verify I_L?
3) If the internal resistance of a source is 5 ohms and is connected with an External Load Of 25 Ohms Resistance. What is Rth?
4) In the above question if the voltage is 20V and the load is of 50 Ohms. What is the load current and I_N ? Verify I_L ?

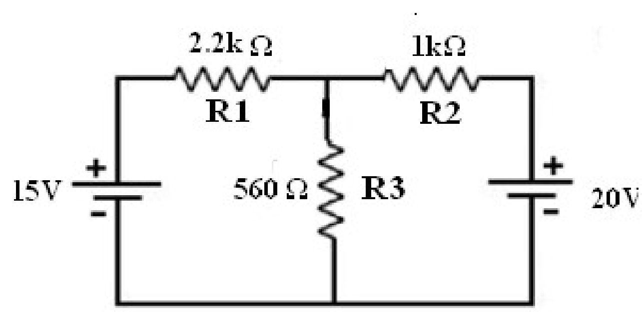
4. VERIFICATION OF SUPERPOSITION THEOREM

AIM: To verify the superposition theorem for the given circuit.

APPARATUS REQUIRED:

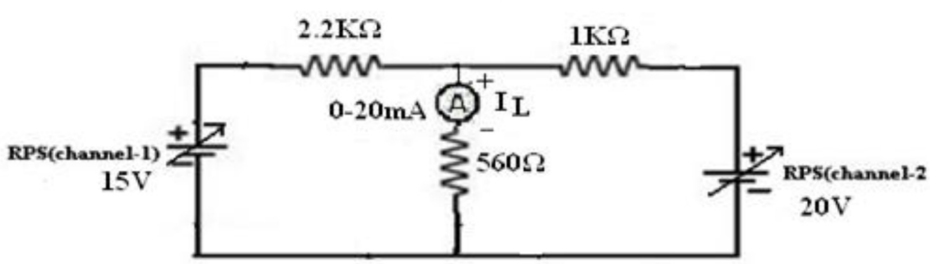
S.No	Name Of The Equipment	Range	Type	Quantity
1	Bread board	-	-	1 NO
2	Ammeter	(0-20) mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Resistors	2.2k Ω		1 NO
		1k Ω		1 NO
		560 Ω		1 NO
5	Connecting Wires	-	-	As required

CIRCUIT DIAGRAM:



PRACTICAL CIRCUITS:

When V_1 & V_2 source acting(To find I_L):-



Fig(1)

When V_1 Source Acting (To Find I_L^I)

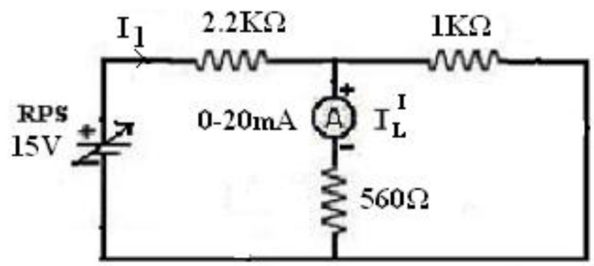


Fig (2)

WhenV_2 source acting (To find I_L^{II}):

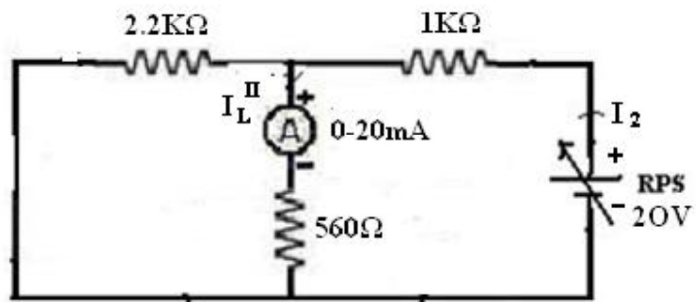


Fig (3)

THEORY:

SUPERPOSITION THEOREM:

Superposition theorem states that in a lumped ,linear, bilateral network consisting more number of sources each branch current(voltage) is the algebraic sum all currents (branch voltages), each of which is determined by considering one source at a time and removing all other sources. In removing the sources, voltage and current sources are replaced by internal resistances.

PROCEDURE:

1. Connect the circuit as per the fig (1).
2. Adjust the output voltage of sources X and Y to appropriate values (Say 15V and20V respectively).
3. Note down the current (I_L) through the 560 0hm resistor by using the ammeter.
4. Connect the circuit as per fig (2) and set the source Y (20V) to 0V.
5. Note down the current ($I_L^{1)}$ through 560ohm resistor by using ammeter.
6. Connect the circuit as per fig(3) and set the source X (15V) to 0V and source Y to 20V.
7. Note down the current (I_L^{ll}) through the 560 ohm resistor branch by using ammeter.
8. Reduce the output voltage of the sources X and Y to 0V and switch off the supply.
9. Disconnect the circuit**.**

THEORITICAL CALCULATIONS

From Fig(2)

$I_1 = V_1/(R_1 + (R_2 // R_3))$

$I_L^{1} = I_1 * R_2/(R_2 + R_3)$

From Fig(3)

$I_2 = V_2/(R_2 + (R_1 // R_3))$

$I_L^{11} = I_2 * R_1/(R_1 + R_3)$

$I_L = I_L^{1} + I_L^{11}$

TABULAR COLUMNS:

From Fig(1)

S. No	Applied voltage (V_1) Volt	Applied voltage (V_2) Volt	Current I_L (mA)

From Fig(2)

S. No	Applied voltage (V_1) Volt	Current I_L^{I} (mA)

From Fig(3)

S. No	Applied voltage (V_2) Volt	Current I_L^{II} (mA)

S.No	Load current	Theoretical Values	Practical Values
1	When Both sources are acting, I_L		
2	When only source X is acting, I_L^{I}		
3	When only source Y is acting, I_L^{II}		

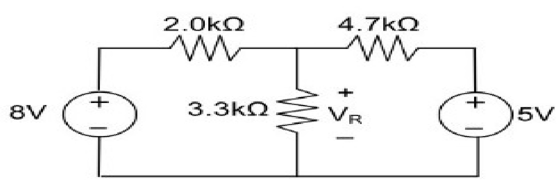
PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.

RESULT:

EXERCISE QUESTIONS:

1. Using the superposition theorem, determine the voltage drop and current across the resistor 3.3K as shown in figure below.



VIVA QUESTIONS:

1) What do you mean by Unilateral and Bilateral network? Give the limitations of Superposition Theorem?
2) What are the equivalent internal impedances for an ideal voltage source and for a Current source?
3) Transform a physical voltage source into its equivalent current source.
4) If all the 3 star connected impedance are identical and equal to ZA, then what is the Delta connected resistors

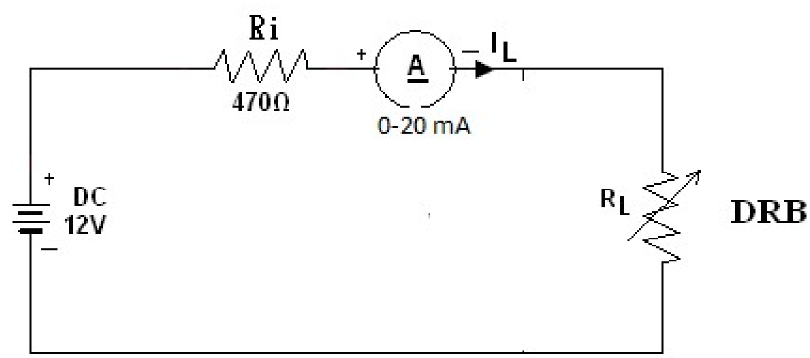
5. MAXIMUM POWER TRANSFER THEOREM

AIM: To Verify The Maximum Power Transfer Theorem For The Given Circuit.

APPARTUS REQUIRED:

SI. No	Equipment	Range	Qty
1	Bread board	-	1 NO
2	DC Voltage source.	0-30V	1 NO
3	Resistors	470 Ω	1 NO
4	Decade resistance box	0-10k Ω	1 NO
5	Ammeter	0-20mA	1 NO
6	Connecting wires	1.0.Sq.mm	As required

CIRCUIT DIAGRAM:



THEORY:

STATEMENT:

It states that the maximum power is transferred from the source to load when the load resistance is equal to the internal resistance of the source.

(or)

The maximum transformer states that "A load will receive maximum power from a linear bilateral network when its load resistance is exactly equal to the Thevenin's resistance of network, measured looking back into the terminals of network.

Consider a voltage source of V of internal resistance R_i delivering power to a load Resistance R_L

Circuit current = $\frac{V}{R_L+R_i}$

Power delivered $P = I^2 R_L$

$$= \left|\frac{V}{R_L+R_i}\right|^2 R_L$$

for maximum poewer $\frac{d(p)}{dt} = 0$

RL+Ri cannot be zero,

Ri – RL = 0

$$\boxed{R_L == Ri}$$

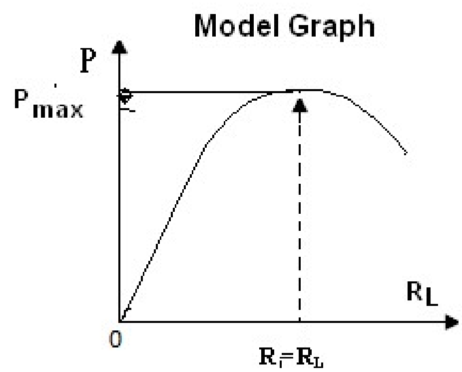
$$Pmax = \frac{V^2}{4R_L} \text{ watts}$$

PROCEDURE:

1. Connect the circuit as shown in the above figure.
2. Apply the voltage 12V from RPS.
3. Now vary the load resistance (R_L) in steps and note down the corresponding Ammeter Reading
(I_L) in milli amps and Load Voltage (V_L) volts
6. Tabulate the readings and find the power for different load resistance values.
7. Draw the graph between Power and Load Resistance.
8. After plotting the graph, the Power will be Maximum, when the Load Resistance will be equal to source Resistance

TABULAR COLUMN:

S.No	R_L	I_L(mA)	Power(P max)=I_L^2*R_L(mW)
1			
2			
3			
4			
5			
6			
7			
8			



Theoretical Calculations:-

$R = (R_i + R_L) = \ldots$ **Ω**

$I_L = V / R \quad = \ldots$ **mA**

Power = (I_L^2) $\mathbf{R_L} = \ldots$ **mW**

PRECAUTIONS:

1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.

RESULT:

VIVA QUESTIONS:

1) What is maximum power transfer theorem?
2) What is the application of this theorem?

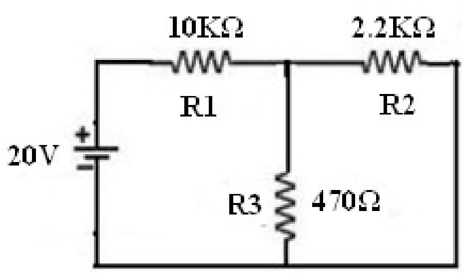
6. VERIFICATION OF RECIPROCITY THEOREM

AIM: To verify reciprocity theorem for the given circuit.

APPARATUS REQUIRED:

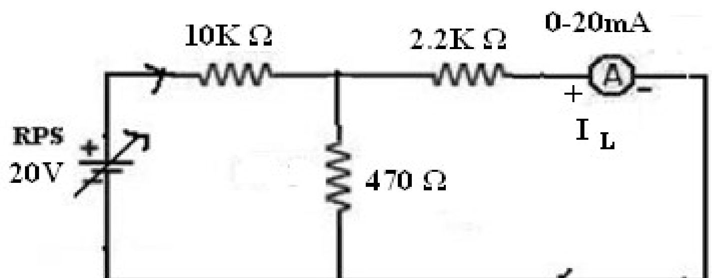
S.No	Name Of The Equipment	Range	Type	Quantity
1	Bread board	-	-	1 NO
2	Ammeter	(0-20)mA	Digital	1 NO
3	RPS	0-30V	Digital	1 NO
4	Connecting Wires	-	-	As required
5	Resistors	2.2k Ω		1 NO
		10k Ω		1 NO
		470 Ω		1 NO

CIRCUIT DIAGRAM:



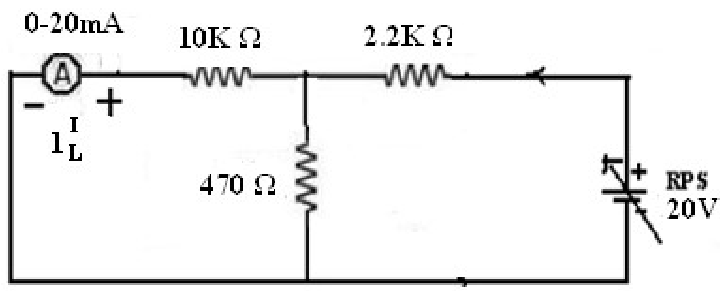
PRACTICAL CIRCUITS:

CIRCUIT-1:



fig(1)

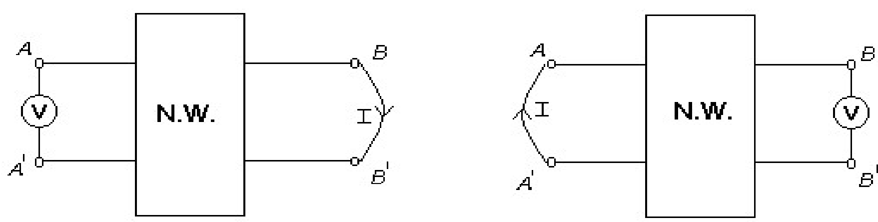
CIRCUIT-2:



fig(2)

THEORY:
STATEMENT:

In any linear, bilateral, single source network, the ratio of response to the excitation is same even though the positions of excitation and response are interchanged. This theorem permits to transfer source from one position in the circuit to another and may be stated as under



Consider the network shown in Fig. AA^I denotes input terminals and BB^I denotes output terminals. The application of voltage V across AA^I produces current I at BB^I. Now if the positions of the source and responses are interchanged, by connecting the voltage source across BB^I, the resultant current I will be at terminals AA^I. According to the reciprocity theorem, the ratio of response to excitation is the same in both cases.

PROCEDURE:
1. Connect the circuit as per the fig (1).
2. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
3. Note down the current through 2.2K Ω by using ammeter.
4. Reduce the output voltage of the RPS to 0V and switch-off the supply.
5. Disconnect the circuit and connect the circuit as per the fig (2).
6. Adjust the output voltage of the regulated power supply to an appropriate value (Say 20V).
7. Note down the current through 10K Ω resistor from ammeter.
8. Reduce the output voltage of the RPS to 0V and switch-off the supply.
9. Disconnect the circuit.

THEORITICAL CALCULATIONS :

From Fig(1)

$$I_1 = V/(R_1 + (R_2//R_3))$$

$$I_L = I_1 * R_3/(R_2 + R_3)$$

From Fig(2)

$$I_2 = V/(R_2 + (R_1//R_3))$$

$$I_L^1 = I_2 * R_3/(R_1 + R_3)$$

TABULAR COLUMNS:

From fig 1

S. No	Applied voltage (V1) Volt	Current I_L (mA)

From fig 2

S. No	Applied voltage (V2) Volt	Current I_L^I (mA)

OBSERVATION TABLE:

S.No	Parameter	Theoretical Value	Practical Value
1	$I_L/v1$		
2	$I_L^1/v2$		

PRECAUTIONS:
1. Initially keep the RPS output voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Avoid short circuit of RPS output terminals.
6. If voltmeter gives negative reading then interchange the terminals connections of a voltmeter

RESULT:

VIVA QUESTIONS:

1) What is reciprocity theorem?
2) Why it is not applicable for unilateral circuit?