REGULATION: R23

ELECTRICAL CIRCUITS LABORATORY MANUAL

LAB CODE : 23EE52

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING (AUTONOMOUS)

MYLAVARAM-521230

LIST OF EXPERIMENTS

1. Verification of Kirchhoff's circuit laws.
2. Verification of node and mesh analysis.
3. Verification of network reduction techniques.
4. Determination of cold and hot resistance of an electric lamp
5. Determination of Parameters of a choke coil.
6. Determination of self, mutual inductances, and coefficient of coupling
7. Series and parallel resonance
8. Locus diagrams of R-L (L Variable) and R-C (C Variable) series circuits
9. Verification of Superposition theorem
10. Verification of Thevenin’s and Norton’s Theorems
11. Verification of Maximum power transfer theorem
12. Verification of Compensation theorem
13. Verification of Reciprocity and Millman’s Theorems

Experiment No : 1 Date :

VERIFICATION OF KIRCHHOFF'S CIRCUIT LAWS

AIM : To Verify Kirchhoff's current and voltage laws for the given circuit.

APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	50 Ω/5 A	1
		25 Ω/5 A	1
		18 Ω/5 A	1
3.	Ammeter	(0-1) mA , MC	3
4.	Voltmeter	(0-10) V, MC	3
5.	Connecting Wires	--	Required

THEORY :

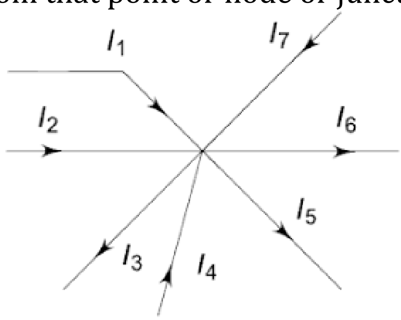
KIRCHHOFF'S CURRENT LAW (KVL)

Statement:

Kirchhoff's current law states that the sure of the currents entering into any node is equal to the sum of the currents leaving that node.

The node may be an interconnection of two or more branches. In any parallel circuit, the node is a junction point of two or more branches. The total current entering into a node is equal to the current leaving that node.

In general, sum of the currents entering any point or node or junction equal to sum of the currents leaving from that point or node or junction as shown in Fig.



$$I_1 + I_2 + I_4 + I_7 = I_3 + I_5 + I_6$$

If all of the terms on the right side are brought over to the left side, their signs change to negative and a zero is left on the right side, i.e.

$$I_1 + I_2 + I_4 + I_7 - I_3 - I_5 - I_6 = 0$$

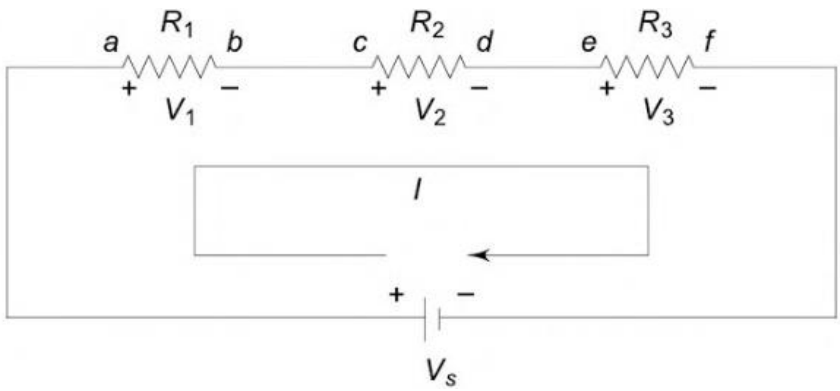
This means that the algebraic sum of all the currents meeting at a junction is equal to zero.

<u>KIRCHHOFF'S VOLTAGE LAW</u> (KVL)

Statement:

Kirchhoff's voltage law states that the algebraic sum of all branch voltages around any closed path in a circuit is always zero at all instants of time.

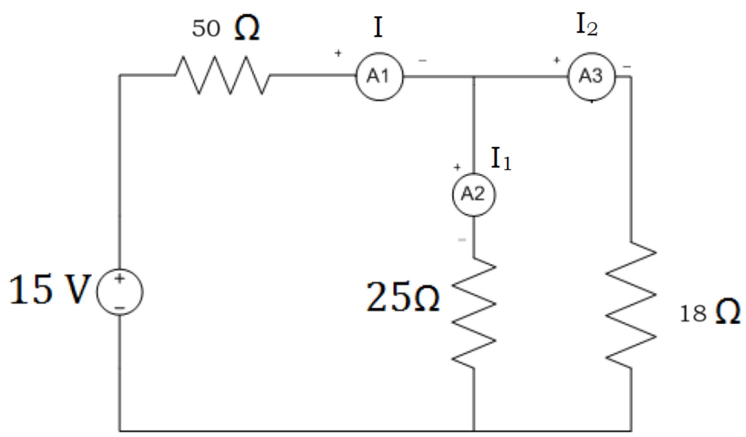
When the current passes through a resistor, there is a loss of energy and, therefore, a voltage drop. In any element, the current always flows from higher potential to lower potential. Consider the circuit in Fig. It is customary to take the direction of current I as indicated in the figure, i.e. it leaves the positive terminal of the voltage source and enters into the negative terminal.

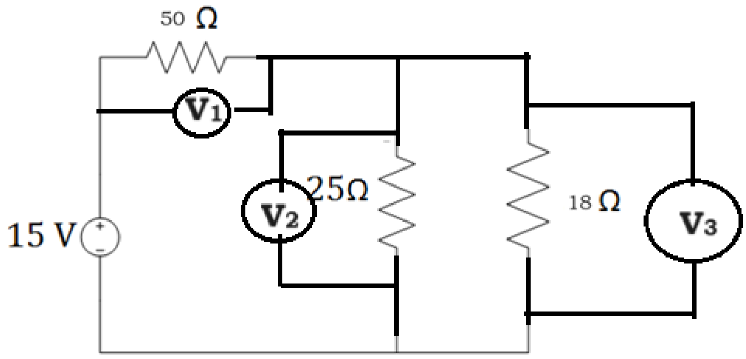


As the current passes through the circuit, the sum of the voltage drop around the loop is equal to the total voltage in that loop. Here the polarities are attributed to the resistors to indicate that the voltages at points a, c and e are more than the voltages at b, d and f, respectively, as the current passes from a to f.

$$\therefore \quad V_s = V_1 + V_2 + V_3$$

<u>CIRCUIT DIAGRAM:</u>





PROCEDURE :

1. Connect the circuit diagrams as shown in the fig. for KCL and KVL.
2. Using RPS, apply the given supply voltage.
3. For KCL, measure the ammeter readings.
4. For KVL, measure the voltmeter readings.
5. Tabulate the values of voltages and currents of KVL and KCL.
6. Verify KCL as $I=I_1+I_2$ and KVL as $V_S = V_1 + V_2$ or $V_2 - V_3=0$ Or $V_3 - V_2 = 0$.

THEORETICAL CALCULATIONS :

TABULAR COLUMNS :

PARAMETERS	KVL				KCL		
	V_S	V_1	V_2	V_3	I	I_1	I_2
THEORETICAL							
PRACTICAL							

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.
4. Measure the readings accurately without parallax error.

RESULT :

The KVL and KCL for the given circuit are verified theoretically and practically.

Viva Questions:

1) What is Current Divider Rule ?
2) What is Voltage Divider Rule?
3) What is Current?
4) Could you measure Voltage in series?
5) What is Kirchhoff‟s Current Law (KCL)?
6) Define Voltage.
7) Define Ohm’s Law for A.C ?
8) What do you mean by dependent and independent voltage sources?
9) How does a capacitor store an electrical charge?
10) Could you measure current in parallel?

Experiment No : 2 Date :

VERIFICATION OF NODE AND MESH ANALYSIS

AIM : To verify the nodal and mesh analysis for the given circuit.

APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	100 **Ω**/5 A	1
		400 **Ω**/1.7 A	1
		50 **Ω**/5 A	1
3.	Ammeter	(0-2) mA , MC	2
4.	Voltmeter	(0-10) V , MC	1
4.	Connecting Wires	--	Required

Theory:

Mesh and nodal analysis are two basic important techniques used in finding solutions for a network. The suitability of either mesh or nodal analysis to a particular problem depends mainly on the number of voltage sources or current sources. If a network has a large number of voltage sources, it is useful to use mesh analysis; as this analysis requires that all the sources in a circuit be voltage sources. Therefore, if there are any current sources in a circuit they are to be converted into equivalent voltage sources, if, on the other hand, the network has more current sources, nodal analysis is more useful.

NODAL ANALYSIS:

Nodal analysis is used for solving any electrical network, and it is defined as the mathematical method for calculating the voltage distribution between the circuit nodes. This method is also known as the node-voltage method since the node voltages are with respect to the ground. The KCL is used in nodal analysis to determine the node voltages.

MESH ANALYSIS:

A **mesh** is defined as a loop which does not contain any other loops within it. To apply mesh analysis, our first step is to check whether the circuit is planar or not and the second is to select mesh currents. Finally, writing Kirchhoff's voltage law equations in terms of unknowns and solving them leads to the final solution diagram:

Circuit Diagram:

NODAL ANALYSIS:

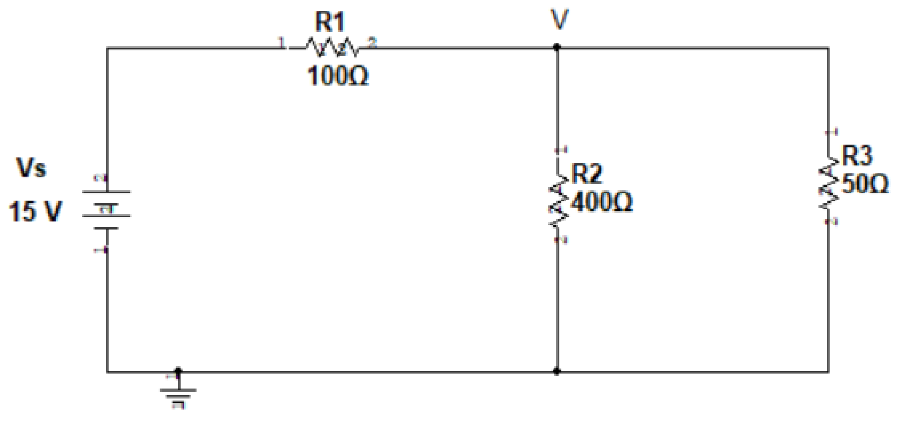


Fig-(a)

MESH ANALYSIS:

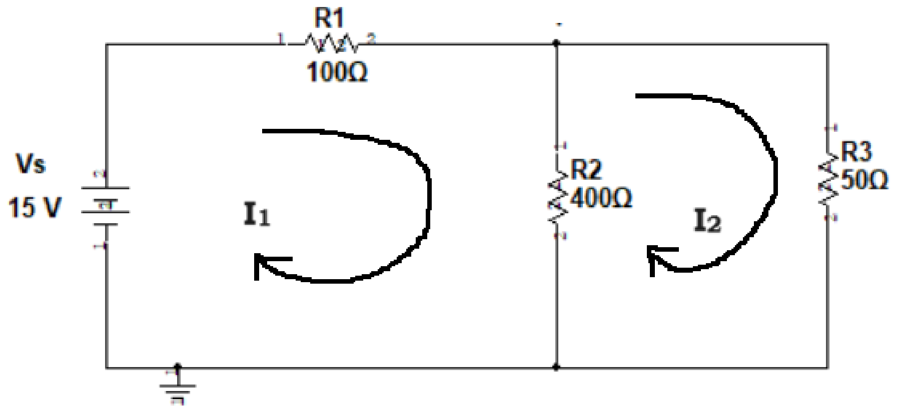


Fig-(b)

Procedure:

1. Connect the circuit diagram as shown in the fig.-(a).
2. Using Voltmeter, measure the node voltage 'V'.
3. Connect the circuit diagram as shown in the fig.-(b).
4. Using ammeter, measure the mesh currents I_1 and I_2.
5. Tabulate all measured values.

Theoretical Calculations:

Tabular column:

S.No.	Nodal Analysis			Mesh Analysis		
	Parameter	Theoretical	Practical	Parameter	Theoretical	Practical
1.	V			I_1		
2.				I_2		

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.
4. Measure the readings accurately without parallax error.

RESULT :

The nodal and mesh analysis are verified for the given circuit theoretically and practically.

Viva Questions:

1) What is mesh analysis?
2) What is nodal analysis?
3) Define mesh.
4) Define a node.
5) What is super mesh?
6) What is super node?
7) How to calculate the number of mesh equations?
8) What is a loop?
9) How to write mesh equations?
10) How to calculate the number of node equations?

Experiment No : 3 Date :

VERIFICATION OF NETWORK REDUCTION TECHNIQUES

AIM : To verify the total resistance of the circuit using series – parallel reduction technique.

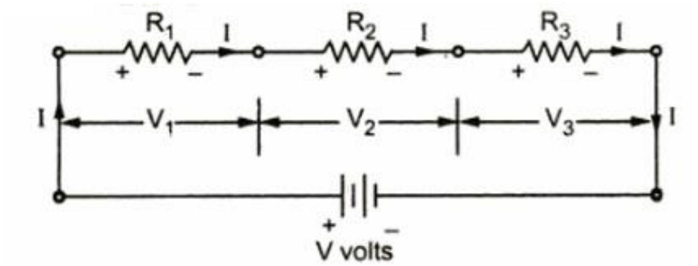
APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	360 **Ω**/1.2 A	1
		290 **Ω**/2.8 A	1
		145 **Ω**/2.8 A	1
3.	Ammeter	(0-50) mA , MC	2
4.	Connecting Wires	--	Required

THEORY:

a) Resistors in Series: [CURRENT SAME & VOLTAGE DIVISION]

Consider the resistances shown in the fig.



The resistances R_1, R_2 and R_3 are said to be in series. This combination is connected across a source of V volts. The current is flowing through all resistances and it is same indicated as 'I'.

Now let us study the **voltage distribution.**

Let V_1, V_2 and V_3 be the voltages across the terminals of resistances R_1, R_2 and R_3 respectively

Then, $V = V_1 + V_2 + V_3$

Now according to Ohm's law, $V_1 = I R_1$, $V_2 = I R_2$, $V_3 = I R_3$

Current through all of them is same i.e. I

$\therefore$ $V = I R_1 + I R_2 + I R_3 = I(R_1 + R_2 + R_3)$

$$V = I\ R_{eq}$$

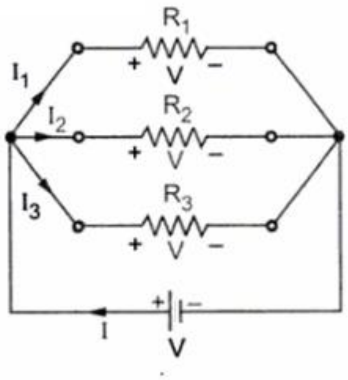
where R_{eq} = Equivalent resistance of the circuit. By comparison of two equations,

$$R_{eq} = R_1 + R_2 + R_3$$

i.e. Total or **equivalent resistance** of the series circuit is arithmetic sum of the resistances connected in series.

For n resistances in series, $\boxed{R = R_1 + R_2 + R_3 + \ldots\ldots + R_n}$

b) Resistors in parallel: [VOLTAGE SAME & CURRENT DIVISION]



Consider a parallel circuit shown in the Fig.

In the parallel connection shown, the three resistances R_1, R_2 and R_3 are connected in parallel and combination is connected across a source of voltage 'V '.

In parallel circuit current passing through each resistance is different. Let total current drawn is say ' I ' as shown. There are 3 paths for this current, one through R_1, second through R_2 and third through R_3. Depending upon the values of R_1, R_2 and R_3 the appropriate fraction of total current passes through them. These individual currents are shown as I_1, I_2 and I_3. While the voltage across the two ends of each resistances R_1, R_2 and R_3 is the same and equals the supply voltage V.

Now let us study current distribution. Apply Ohm's law to each resistance.

$$V = I_1 R_1\ ,\ V = I_2 R_2\ ,\ V = I_3 R_3$$

$$I_1 = \frac{V}{R_1}\ ,\ I_2 = \frac{V}{R_2}\ ,\ I_3 = \frac{V}{R_3}$$

$$I = I_1 + I_2 + I_3 = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$= V\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

For overall circuit if Ohm's law is applied,

$$V = I R_{eq}$$

and $$I = \frac{V}{R_{eq}}$$

where R_{eq} = Total or **equivalent resistance** of the circuit

Comparing the two equations,

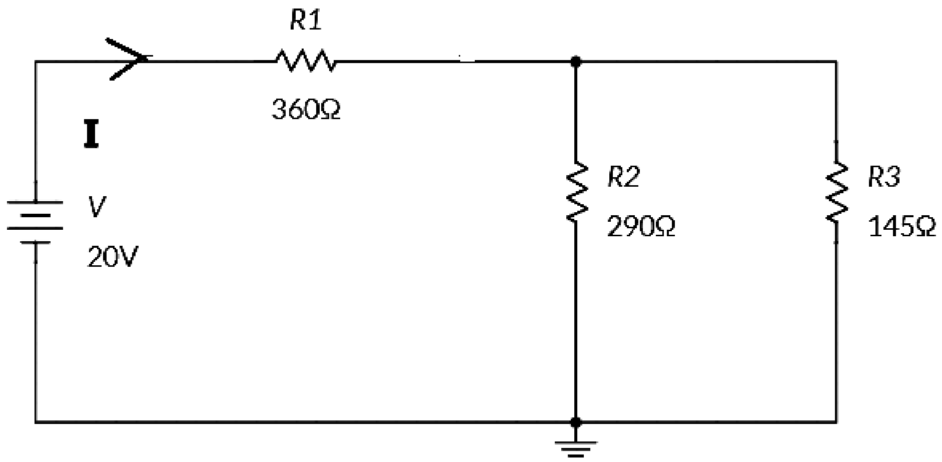
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

where R is the equivalent resistance of the parallel combination.

In general if 'n' resistances are connected in parallel,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots + \frac{1}{R_n}$$

CIRCUIT DIAGRAM:



PROCEDURE:

1) Connect the circuit diagram as shown in fig.
2) Open circuit the voltage source, measure the equivalent resistance R_{eq}.
3) Measure the total current 'I' using multimeter by replacing the source 'V'.
4) Calculate the equivalent resistance using series-parallel reduction technique.
5) Determine the total current using $I = V/R_{eq}$.
6) Verify the current by theoretically and practically and tabulate the values.

TABULAR COLUMN:

	Req (Ohm)	I(mA)
THEORETICAL		
PRACTICAL		

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.
4. Measure the readings accurately without parallax error.

RESULT :

The equivalent resistance is verified for the given circuit theoretically and practically using series – parallel reduction technique.

Viva Questions:

1) What is series connection?
2) What is parallel connection?
3) What is the formula for series connection?
4) What is the formula for parallel connection?
5) Which parameter is same in series connection?
6) Which parameter is same in parallel connection?
7) Define current division rule.
8) What is series-parallel connection?
9) Which parameter division takes place in series connection?
10) Which parameter division takes place in parallel connection?

Experiment No : 4 Date :

DETERMINATION OF COLD & HOT RESISTANCE OF AN ELECTRIC LAMP

AIM : To determine the cold and hot resistance of an electric lamp.

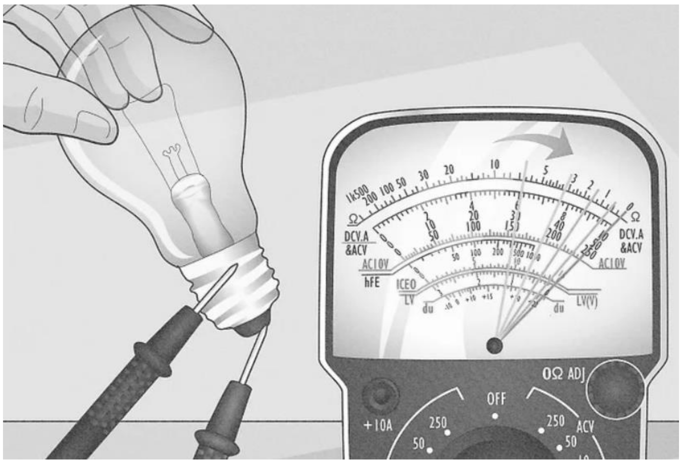
APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	1-phase Variac (Dimmerstat)	(0 – 230) V AC	1
2.	Incandescent Bulb	100 W	1
3.	Multimeter	--	1
4.	Connecting Wires	--	Required

THEORY:

Cold Resistance:

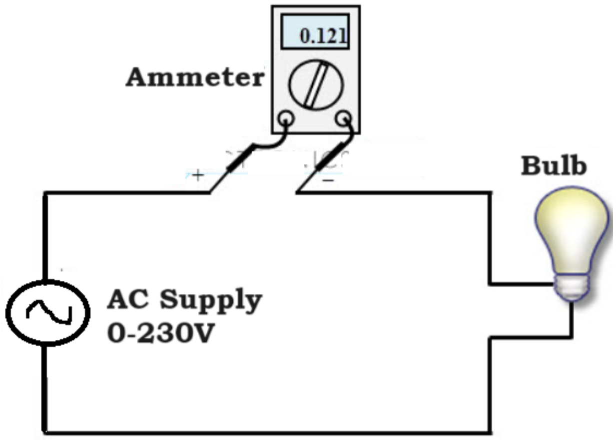
The cold resistance of a bulb is to be measured without supply voltage i.e. the bulb does not get heated. The cold resistance is measured when the ohmmeter is directly connected across the terminals of the bulb as shown in fig.



Hot Resistance:

The hot resistance is the resistance of the bulb when it is ON. When an AC supply is applied to a bulb, the heat energy is generated in the bulb. Using ammeter, the current flowing through the bulb is measured. Then, by using Ohm's law, V=IR, the hot resistance of the bulb is to be measured.

CIRCUIT DIAGRAM:



PROCEDURE:

1) Connect the multimeter across the bulb without supply.
2) Measure the cold resistance of the bulb.
3) Connect the circuit as shown in fig. to switch ON the bulb.
4) Measure the current through the bulb using ammeter.
5) Determine the hot resistance using R = V/I.
6) Tabulate the resistance values of the bulb.

TABULAR COLUMN:

	R (Ohm)
Cold Resistance	
Hot resistance	

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. Disconnect the connections properly after the completion of experiment.
3. Measure the readings accurately without parallax error.

RESULT :

The cold and hot resistance of an electric lamp are measured.

Viva Questions:

1) Define resistance?
2) How to measure cold resistance?
3) How to measure hot resistance?
4) Define Ohm’s law.
5) What is difference between DC and AC supply?
6) What is meant by hot and cold?
7) Define voltage.
8) Define current.
9) What is the unit of resistance?
10) What is the use of an ammeter?

Experiment No : 5 Date :

DETERMINATION OF PARAMETERS OF A CHOKE COIL

AIM : To determine the parameters of choke coil i.e. self-inductance, internal resistance and power factor of choke coil.

APPARATUS REQUIRED :

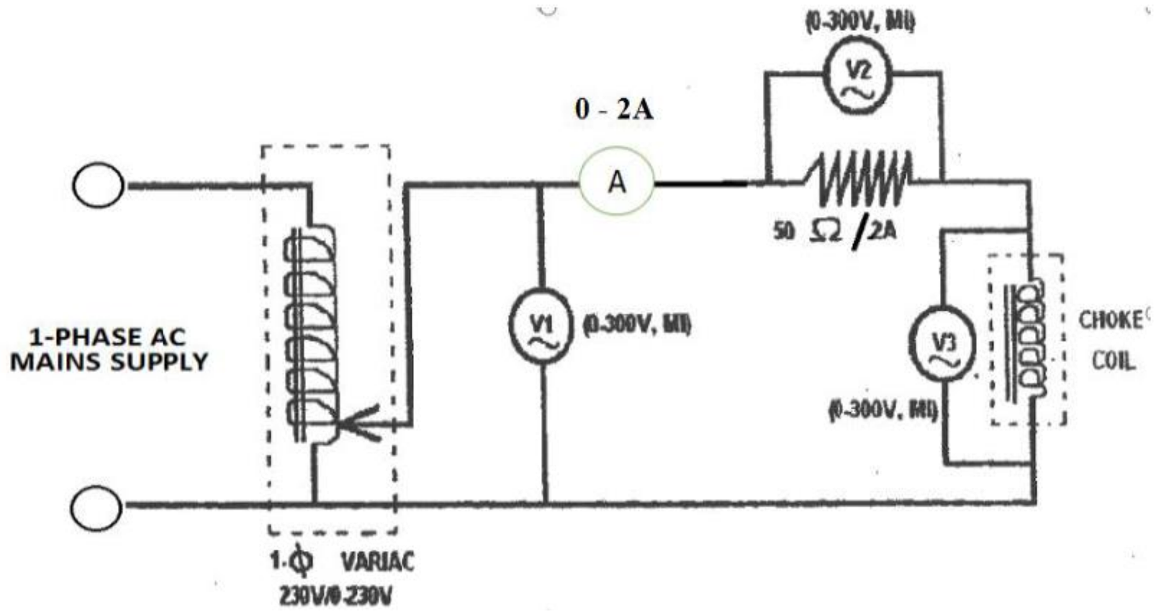
S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Single phase Variac	(0-270) V	1
2.	Rheostat	50Ω / 2A	1
3.	Voltmeter	(0-300) V, MI	3
4.	Choke coil	--	1
5.	Single lead Connecting Wires	--	Required

Theory:

Choke coil is highly inductive in nature, which is used in the applications where high voltage surge is needed for a short duration of time. It is generally used in the tube light circuit to give high voltage surge during starting and to maintain steady voltage during its operation.

An inductor which provides high impedance to alternating current with little resistance to direct current. Choke coils are often used in radio circuits and to smooth the output of a rectifying circuit. A choke is the common name given to an inductor that is used as a power supply filter element. They are typically gapped iron core units, similar in appearance to a small transformer, but with only two lead exciting the housing. The current in an inductor cannot change instantaneously; that is, inductors tend to resist any change in current flow. This property makes them good for use as filter elements, since they tend to smooth out the ripples in the rectified voltage waveform. Typically an inductor is designed to have high reactance to a particular frequency when used in signal carrying circuit. They are inductances that isolate AC frequency currents from certain areas of radio circuit. Choke coil depends upon the property of self-inductance for their operation. They are used to block alternating current while passing direct current.

CIRCUIT DIAGRAM:



PROCEDURE:

i) Connect the circuit as shown in the fig.

ii) Switch ON the supply and apply the rated voltage.

iii) Take the readings of voltmeters and tabulate the values.

iv) Calculate the parameters of choke coil.

Tabular form:

S.NO.	V1(V)	V2(V)	V3(V)	COSΦ	RL(Ω)	XL (Ω)	ZL(Ω)	L(H)

CALCULATIONS:

$$V_1^2 = V_2^2 + V_3^2 + 2\,V_2\,V_3\,\text{Cos}\,\Phi$$

$$\text{Cos}\,\Phi = (V_1^2 - V_2^2 - V_3^2) / (2\,V_2\,V_3)$$

$$R_L = Z_L\,\text{Cos}\,\Phi$$

$$X_L = Z_L\,\text{Sin}\,\Phi$$

$$Z_L = V_3 / I\ \ \Omega$$

$$L = X_L / 2\,\pi f\ \text{H}$$

PRECAUTIONS:

i) All Connections should be tight.
ii) Supply should be switched off before making or breaking connections.
iii) Take care, to see that the variable load should capable of withstanding the current rating.
iv) All meters should be kept horizontally.
v) Readings must be taken without parallax error.

RESULT:

The parameters of a choke coil are determined by using 3-voltmeter method.

Experiment No : 6 Date :

DETERMINATION OF SELF, MUTUAL INDUCTANCES AND COEFFICIENT OF COUPLING

AIM : To determination of self-Inductance, Mutual Inductances and Coefficient of coupling of a coupled coil

APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Single phase Variac	(0-270) V	1
2.	Ammeter	(0-20) A, MI	1
3.	Voltmeter	(0-300) V, MI	1
4.	Single phase Transformer	230/12 V	1
5.	Single lead Connecting Wires	--	Required

THEORY :

Self-Inductance:

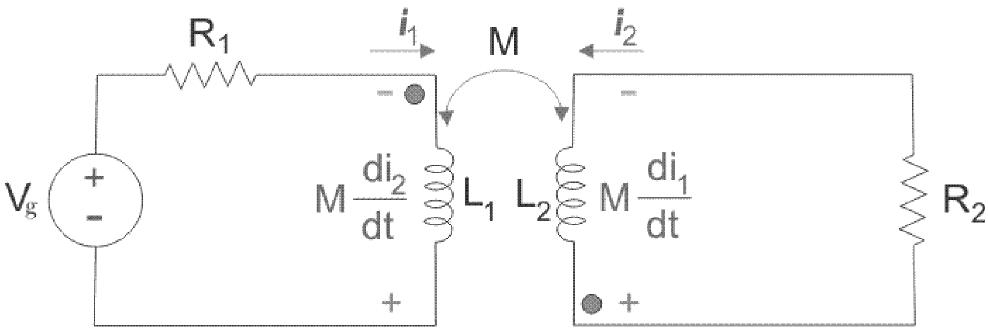
Self-inductance is the ration between the induced electromotive force (EMF) across a coil to the rate of change of current through this coil. Self-inductance is related term to self-induction phenomenon because self-induction generates self-inductance. We denote self-inductance or Co-efficient of with English letter L. Its unit is Henry (H). First, we have to know what self-induction is. Self-induction is the phenomenon by which in a coil, the change in electric current produces an induced electromotive force across this coil itself. This induced electromotive force (E) across this coil is proportional to the current changing rate. The higher the rate of change in current causes higher value of emf.

$$E \propto \frac{di}{dt} \Rightarrow E = L\frac{di}{dt}$$

$$\Rightarrow L = \frac{E}{\frac{di}{dt}} = self\ inductance$$

Mutual Inductance:

Mutual Inductance is the ratio between induced Electro Motive Force across a coil to the rate of change of current of another adjacent coil in such a way that two coils are in possibility of flux linkage. Mutual induction is a phenomenon when a coil gets induced in EMF across it due to rate of change current in adjacent coil in such a way that the flux of one coil current gets linkage of another coil. Mutual inductance is denoted as (M), it is called co-efficient of Mutual Induction between two coils.



$$\varepsilon_2 = -N_2.\frac{d\varphi_{21}}{dt}\ volt.$$

$$Again,\ \ \varepsilon_2 = -M_{21}.\frac{dl_1}{dt}\ volt.$$

Coefficient Of Coupling:
The fraction of magnetic flux produced by the current in one coil that links with the other coil is called the coefficient of coupling between the two coils. It is denoted by (k).

$$k = \frac{M}{\sqrt{L_1 L_2}}$$

<u>CIRCUIT DIAGRAMS</u>:

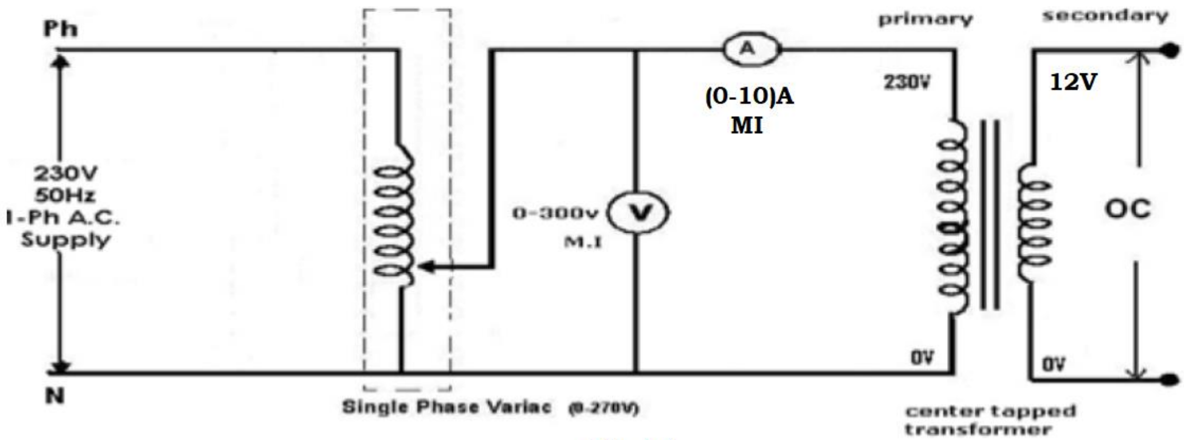


Fig.(a)

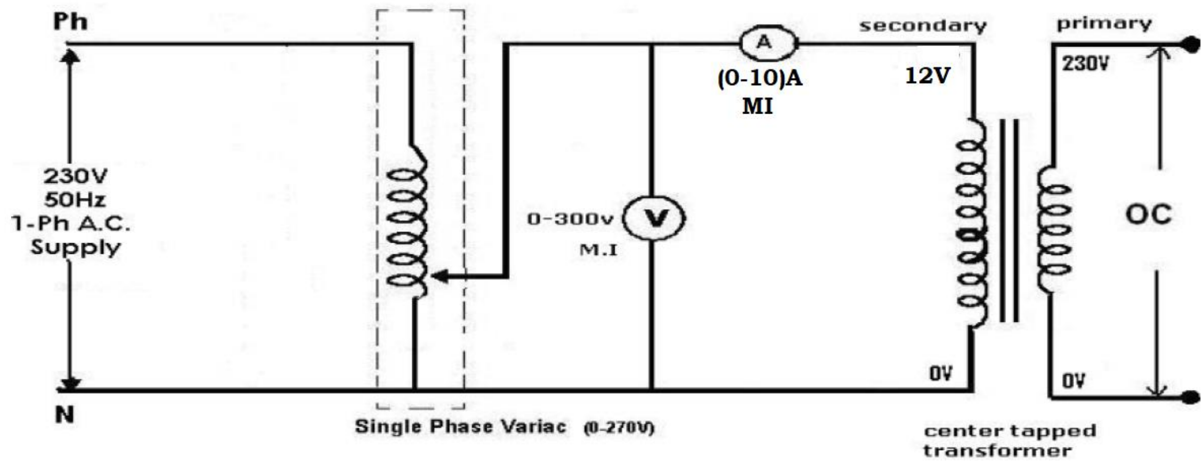


Fig.(b)

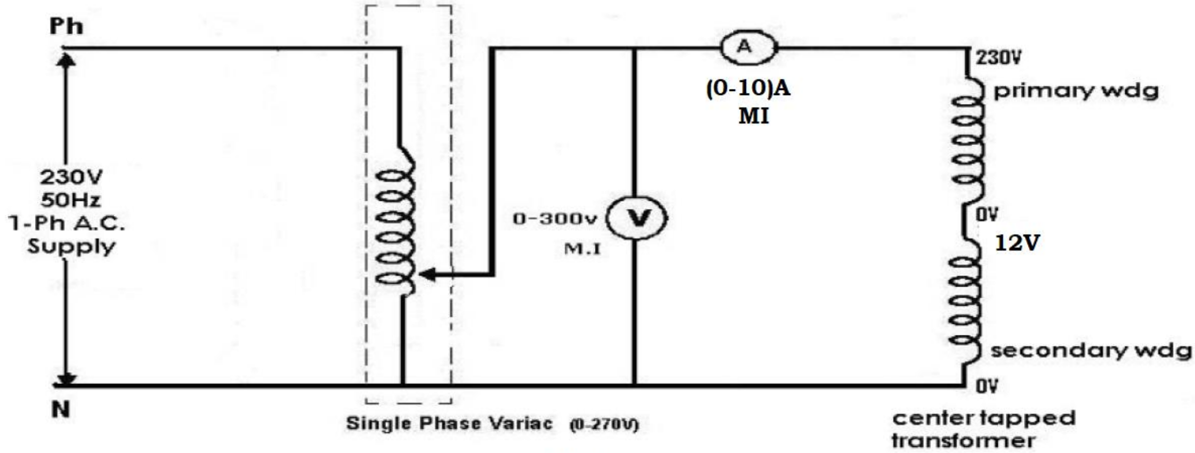


Fig.(c)

PROCEDURE :

1. Connect the circuit as shown in fig.(a) and measure the self-inductance of coil 1 i.e. L_1 by noting the voltmeter and ammeter readings.
2. Connect the circuit as shown in fig.(b) and measure the self-inductance of coil 2 i.e. L_2 by noting the voltmeter and ammeter readings.
3. Connect the circuit as shown fig.(c) and note down voltmeter (V) and ammeter (A) readings and determine equivalent inductance Leq.
4. Calculate coefficient of coupling (k).

THEORETICAL CALCULATIONS:

(Neglect winding resistance)

$L_{eq} = L_1 + L_2 \pm 2M$

Mutual Inductance $M = [(L_{eq} - (L_1 + L_2))/2]$

Coefficient of Coupling $K = M/\sqrt{(L_1 L_2)}$

Where L1 and L2 are determined as follows

Determination of L_1 : From Fig.-(a)

X_{L1} = voltmeter reading /ammeter reading

$X_{L1} = \omega L_1 = 2\Pi f L_1$

$L_1 = X_{L1}/2\Pi f$ (Henry)

Determination of L_2 : From Fig.-(b)

X_{L2} = Voltmeter reading /Ammeter reading

$X_{L2} = \omega L_2 = 2\Pi f L_2$

$L_2 = X_{L2}/2\Pi f$ (Henry)

Determination of L_{eq} : From Fig.-(c)

X_{Leq} = Voltmeter reading /Ammeter reading

$X_{Leq} = \omega L_{eq} = 2\Pi f L_{eq}$

$L_{eq} = X_{Leq}/2\Pi f$ (Henry)

TABULAR COLUMNS :

For X_{L1}:

S.NO.	VOLTMETER READING (V)	AMMETER READING (I)	X_{L1} = V/I
1.			
2.			
3.			
4.			
		Average :	

For X_{L2}:

S.NO.	VOLTMETER READING (V)	AMMETER READING (I)	X_{L2} = V/I
1.			
2.			
3.			
4.			
		Average :	

For X_{Leq}:

S.NO.	VOLTMETER READING (V)	AMMETER READING (I)	$X_{Leq} = V/I$
1.			
2.			
3.			
4.			
		Average :	

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. Properly apply the input voltage using the Variac.
3. Disconnect the connections properly after the completion of experiment.

RESULT :

The self-Inductance, Mutual Inductances and Coefficient of coupling of a coupled coil are determined.

Viva Questions:

1) Define self- inductance
2) Define mutual inductance
3) If the current in one coil becomes steady, the magnetic field is?
4) If the current in one coil is steady, what happens to the mutual inductance?
5) What is the SI unit of mutual inductance?
6) Which, among the following, is the correct expression for mutual inductance?
7) If the flux linkage in coil 1 is 3Wb-t and it has 500 turns and the current in coil 2 is 2A, calculate the mutual inductance.
8) The flux linkage in coil 1 is 3Wb-t and it has x turns and the current in coil 2 is 2A, calculate the value of x if the mutual inductance is 750H
9) Practical application of mutual inductance is ……………
10) The flux linkage in coil 1 is 3 Wb-t and it has 500 turns and the current in coil 2 is xA, calculate the value of x if the mutual inductance is 750H.

Experiment No : 7 Date :

SERIES AND PARALLEL RESONANCE

Aim: To obtain the Resonance frequency, Bandwidth and Q-factor in he given series and parallel RLC circuit.

Apparatus Required:

Sl No	Equipment	Rating	Type	Quantity
1.	Function Generator	(20HZ – 2 M.Hz, 0-30V_{P-P})		1 no
2.	Voltmeter	0 – 20 V	D.M.M	1 no
3.	Decade Resistance box			1 no
4.	Decade Inductance box			1 no
5.	Decade Capacitance box			1 no

Theory:

i) Series Resonance:

When resistor, inductor and capacitor are connected in series across a voltage supply, the circuit so obtained is called series RLC circuit. In series RLC circuit, the current flowing through all the three components i.e the resistor, inductor and capacitor remains the same.

The resonant frequency is

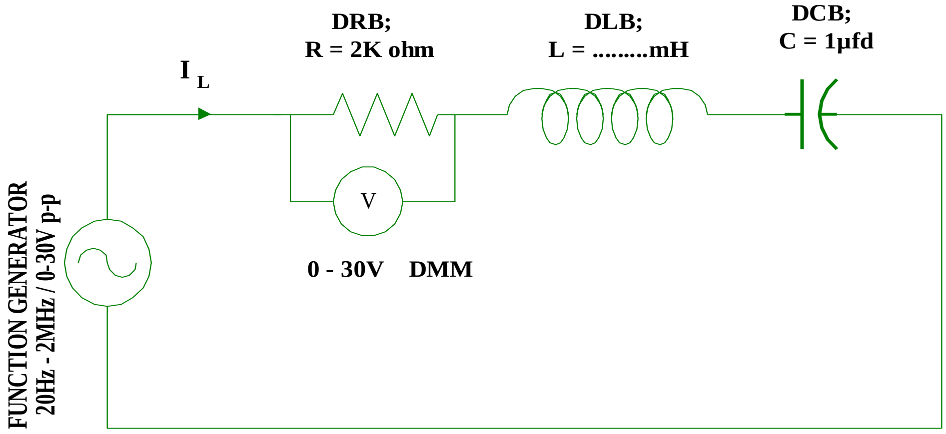
$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

ii) **Parallel Resonance:**

Consider a RLC circuit in which resistor, inductor and capacitor are connected in parallel to each other. This parallel combination is supplied by voltage supply, V_S. This parallel RLC circuit is exactly opposite to series RLC circuit. In series RLC circuit, the current flowing through all the three components i.e the resistor, inductor and capacitor remains the same, but in parallel circuit, the voltage across each element remains the same and the current gets divided in each component depending upon the impedance of each component. That is why parallel RLC circuit is said to have dual relationship with series RLC circuit.

i) Series Resonance:

Circuit Diagram:



Procedure:

1. Make the connections as per the circuit diagram
2. Choose the resonant frequency at 500 Hz
3. Set the Decade Resistance at 2KΩ
4. Set the decade Capacitance value at 1µfd
5. By using the formula calculate the value of inductance
   $F_R = 1 / (2\pi \sqrt{LC})$
6. Set the decade inductance box to the above value
7. Switch on the Digital Multi meter and adjust the setting to sinusoidal AC Volts
8. Switch on the supply of Function Generator and set the sine wave form for the Output
9. Adjust the magnitude of the output voltage to $25V_{P-P}$
10. Vary the frequency of Function Generator in convenient steps increasing from 20Hz to 2 KHz
11. For each of the frequencies set, Adjust the out put voltage of Function Generator to $25V_{P-P}$ and note down the readings of the digital Voltmeter
12. Calculate the current in series RLC circuit for each set of frequency and tabulate the Readings.

Tabular Column:

SL No:	F_S Hz	V_R (V)	I_L (A)	X_L (Ω)	X_C (Ω)	$Z = R + J (X_L - X_C)$ Ω
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Graphs:

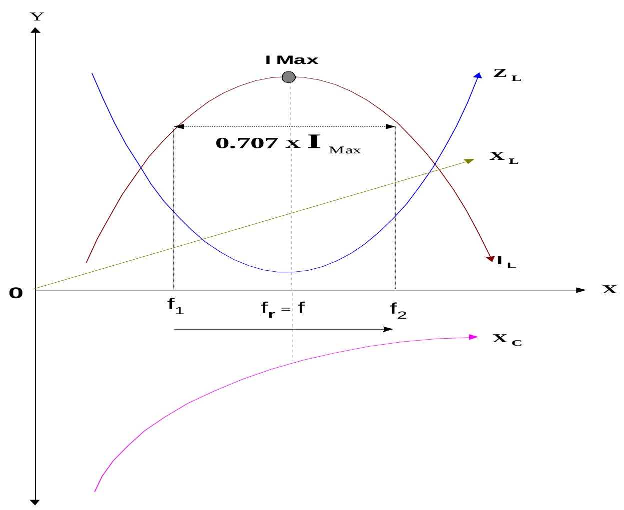
Plot Frequency **Vs** I_L

Plot Frequency **Vs** X_L

Plot Frequency **Vs** X_C

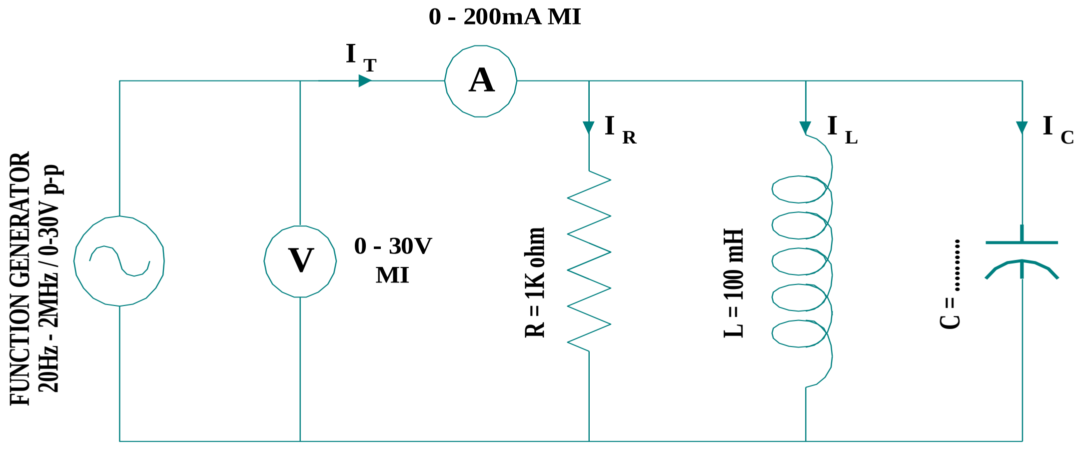
Plot Frequency **Vs** Z

Expected Graphs:



ii) Parallel Resonance:

Circuit Diagram:



Procedure:

1) Make the connections as per the circuit diagram.
2) Choose the Resonance frequency at 1KHz.
3) Set the decade Inductance value at 100mH
4) Calculate the value of the capacitance using the formulae $f_r = 1 / (2 \Pi \sqrt{L C})$.
5) Set the dial of decade Capacitance box to the above value
6) Set the decade Resistance box to 1kΩ.
7) Switch on the digital multi meter and adjust the settings on the panel to AC Volts.
8) Switch on the Function Generator and set sine wave form for the O/p. Adjust the magnitude of the output voltage to $25V_{P-P}$.
9) Vary the frequency of the AF oscillator in steps from 20hz-2khz.For each of the Frequency set, Adjust the output voltage to $25V_{P-P}$ and note down the reading of digital Multi ammeter as I_T.

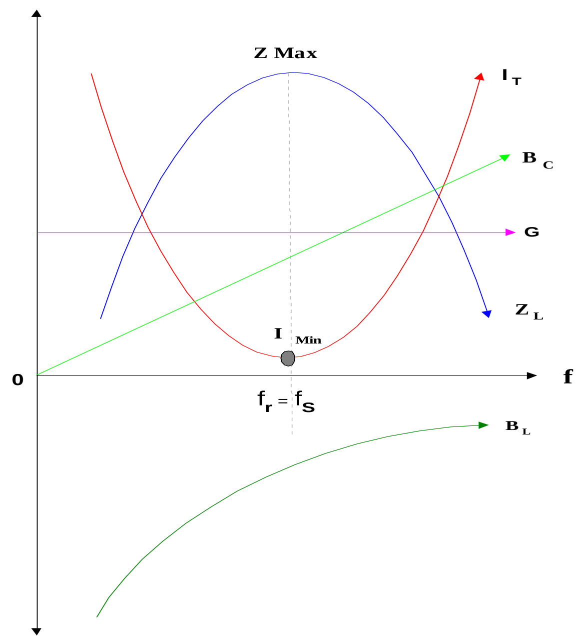
Tabular Column:

Sl No:	F_S in Hz	I_T (mA)	$B_L = \frac{1}{2 \Pi f L}$ (Mho)	$B_C = 2 \Pi f C$ (Mho)	G = 1 / R (Mho)	Y =	Z =
1.							
2.							
3.							
4.							

Graphs:

1. Plot the graph f Vs I_T
2. Plot the graph f Vs B_L
3. Plot the graph f Vs B_C
4. Plot the graph F Vs Z

Expected Graphs:



Precautions:

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.
4. Measure the readings accurately without parallax error.

Result:

The resonant frequency is verified for series and parallel resonance circuits.

Viva Questions:

1) In a series RLC circuit, the phase difference between the Vc and Vr is equal to………
2) In a series RLC circuit, the phase difference between the Vc and V_L is equal to………
3) In a series RLC circuit, the phase difference between the V_L and Vr is equal to………
4) In a series RLC circuit, the phase difference between the I and Vr is equal to………...
5) In a series RLC circuit, the phase difference between the I and Vc is equal to………..
6) In a series RLC circuit, the phase difference between the I and $V_L$is equal to…………
7) The I in the capacitor leads the voltage in a series RLC circuit …. resonant frequency.
8) The current in the inductor ….. the voltage in a series RLC circuit above the resonant frequency.
9) The current in the capacitor …………… the voltage in a series RLC circuit below the resonant frequency.
10) Why it is called as resonant circuit?

Experiment No : 8 Date :

LOCUS DIAGRAMS OF R-L (L VARIABLE) AND R-C (C VARIABLE) SERIES CIRCUITS

AIM: To draw the locus diagram of series RL and RC circuit as R is fixed, L and C are variable.

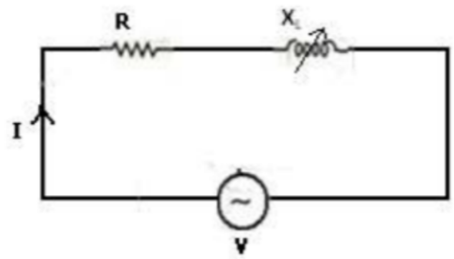
APPARATUS:

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Function Generator	(20HZ – 2 M.Hz, 0-30V_{P-P})	1
2.	Resistance	100 **Ω**/5 A	1
3.	Inductance	Variable	1
4.	Capacitance	Variable	1
5.	Ammeter	(0-10) mA , MI	1
6.	Voltmeter	(0-30) V, MI	1
7.	Connecting Wires	--	Required

THEORY:

Locus diagrams are useful in determining the behaviour or response of an RL/RC circuit, when one of its parameters is varied while the frequency and voltage are kept constant. The magnitude and phase of the current vector in the circuit depend upon the values of R and L or C and frequency at the fixed source voltage. The path travelled by the tip of the current vector when the parameters R and L or C are varied while frequency and voltage are kept constant is called the locus diagram.

When X_L is varied :



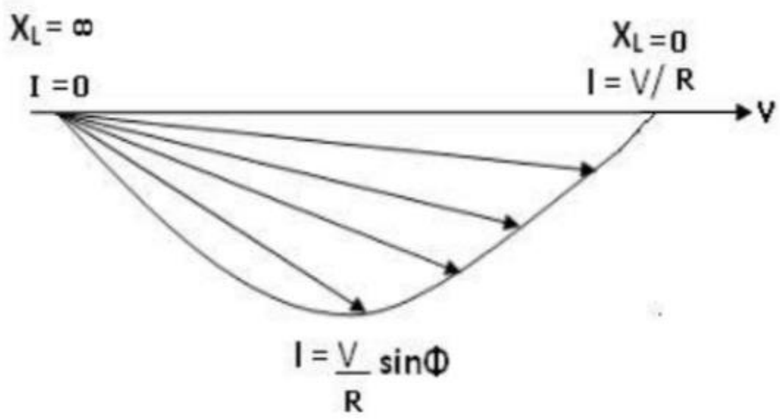
When $X_L = 0$, current is maximum and is given by $\frac{V}{R}$ and is in phase with V. The power factor is unity

When X_L = to infinity, the current is zero, the power factor is zero and $Ø = 90^0$

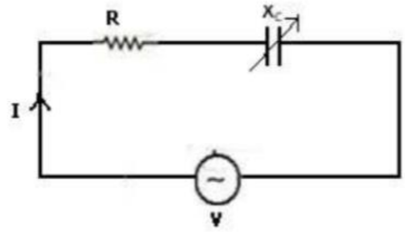
For any other value of \`R\`, the current lags the voltage by an angle $Ø = \frac{X_L}{R}$

∴ The general expression for current is $I = \frac{V}{\sqrt{R^2+X_L{}^2}} = \frac{V}{R}\frac{R}{R} = \frac{V}{R}\frac{R}{Z} = \frac{V}{R}\cos Ø$

The equation of a circle in the polar form where $\frac{V}{R}$ is the diameter of the circle



Where X_c is varied :



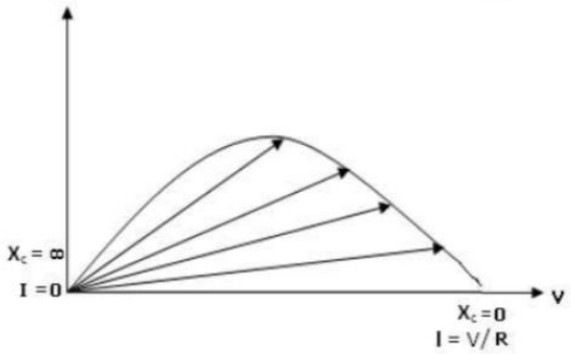
When $X_c = 0$, current is maximum & is given by $I_{max} = \frac{V}{R}$, which is in phase with V. Power factor is unity and $\emptyset = 0$

When $X_c = \infty$, the current is zero. Power factor is 0 & $\emptyset = 90^0$, for any other value of X_c , the current leads the voltage by an angle $\emptyset = tan^{-1}\frac{X_c}{R}$

The general equation for the current is

$$I = \frac{V}{Z} = \frac{V}{Z}\frac{R}{R} = \frac{V}{R}X\frac{R}{Z} = \frac{V}{R}\,cos\emptyset$$

The equation $I = \frac{V}{R}\,cos\emptyset$ is the equation of the circle in polar form, where $\frac{V}{R}$ is the diameter of the circle.



PROCEDURE:

i) Using function generator, apply the sinewave with 20V peak to peak voltage and frequency is 1KHz.

ii) Connect the circuit as shown in the fig.

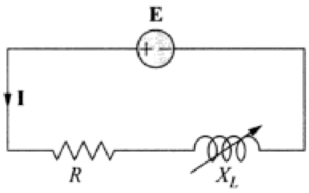
iii) Vary the inductance or capacitance in steps and note down the ammeter and voltmeter readings.

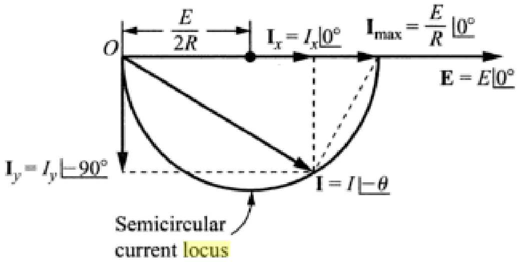
iv) Calculate the phase angle using

$$\emptyset = \tan^{-1}\frac{X_L}{R} \quad \text{or} \quad \emptyset = \tan^{-1}\frac{X_C}{R}$$

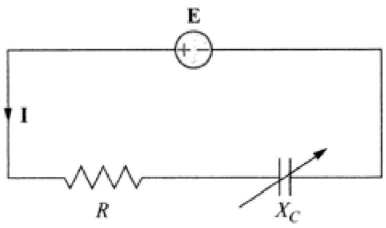
v) Plot the locus diagram using the values.

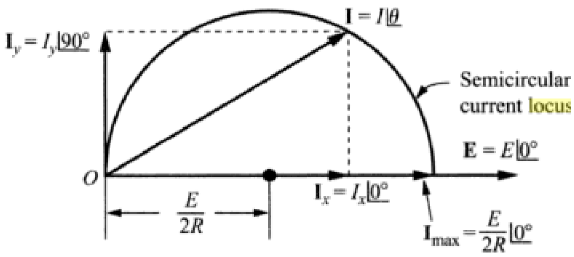
SERIES RL : (L is variable)





SERIES RC : (C is variable)





TABULAR FORM:

S.NO.	SERIES RL (L is Variable)					SERIES RC (C is Variable)			
	L(H)	V(V)	I(mA)	$\emptyset = \tan^{-1}\frac{X_L}{R}$		C(F)	V(V)	I(mA)	$\emptyset = \tan^{-1}\frac{X_C}{R}$
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									

PRECAUTIONS:

i) Avoid loose connections.

ii) Measure the readings without parallax error.

RESULT:

The locus diagrams of series RL(L is variable) and RC(C is variable) are drawn on the graph sheet.

Experiment No : 9 Date :

VERIFICATION OF SUPERPOSITION THEOREM

AIM : To verify the superposition theorem by determining the current flowing through the resistance R.

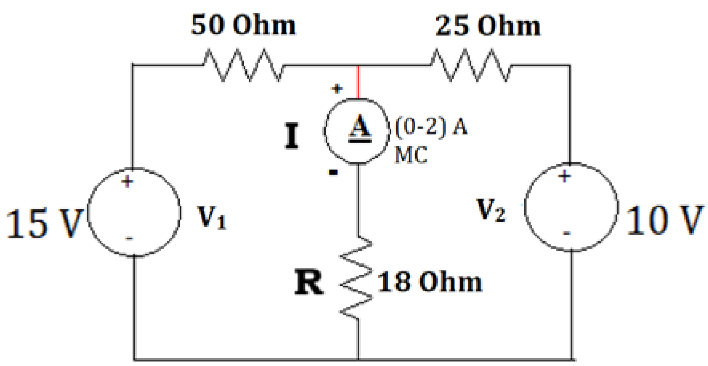
APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	50 **Ω**/5 A	1
		25 **Ω**/5 A	1
		18 **Ω**/5 A	1
3.	Ammeter	(0-2) A , MC	1
4.	Connecting Wires	--	Required

THEORY :

The superposition theorem states that in any linear network containing two or more sources, the response in any element is equal to the algebraic sum of the responses caused by individual sources acting alone, while the other sources are non-operative; that is, while considering the effect of individual sources, other ideal voltage sources and ideal current sources in the network are replaced by short circuit and open circuit across their terminals respectively. This theorem is valid only for linear systems.

CIRCUIT DIAGRAM :



(a)

PROCEDURE :

1. Connect the circuit as shown in the Circuit diagram (a).
2. Switch ON the supply voltage (DC) and apply V_1 and V_2.
3. Note down the Ammeter reading as I.
4. Make V_1= 0 and apply V_2, note down the ammeter reading as I_1.
5. Make V_2= 0 and apply V_1, note down the ammeter reading as I_2.
6. Verify the condition $I = I_1 + I_2$

THEORETICAL CALCULATIONS :

TABULAR COLUMNS :

S.NO.	Parameter	V_1 = 15V, V_2 = 10V	V_1 = 0V, V_2 = 10V	V_1 = 15V, V_2 = 0V
1.	Current through 18 Ohm (Theoretical)			
2.	Current through 18 Ohm (Practical)			

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.
4. Measure the readings accurately without parallax error.

RESULT :

The superposition theorem is verified for the given circuit theoretically and practically.

Experiment No : 10 Date :

VERIFICATION OF THEVENIN'S AND NORTON'S THEOREMS

i) THEVENIN'S THEOREM:

AIM : To verify the Thevenin's equivalent circuit across the load resistance R_L.

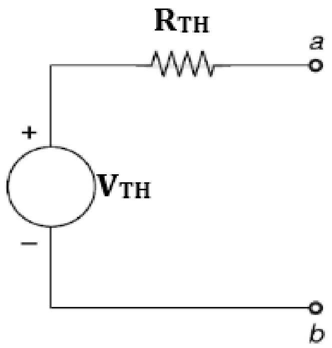
APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	400 **Ω**/1.7 A	1
		290 **Ω**/2.8 A	1
		50 **Ω**/5 A	1
3.	Ammeter	(0-50) mA , MC	1
	Voltmeter	(0-30) V , MC	1
4.	Connecting Wires	--	Required

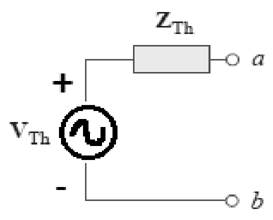
THEORY :

Thevenin's theorem states that any two terminal linear networks having a number of voltage-current sources and resistances(impedances) can be replaced by a simple equivalent circuit consisting of a single voltage source in series with a resistance(impedance), where the value of the voltage source is equal to the open circuit voltage across the two terminals of the network, and resistance is equal to the equivalent resistance measured between the terminals with all the energy sources are replaced by their internal resistances.

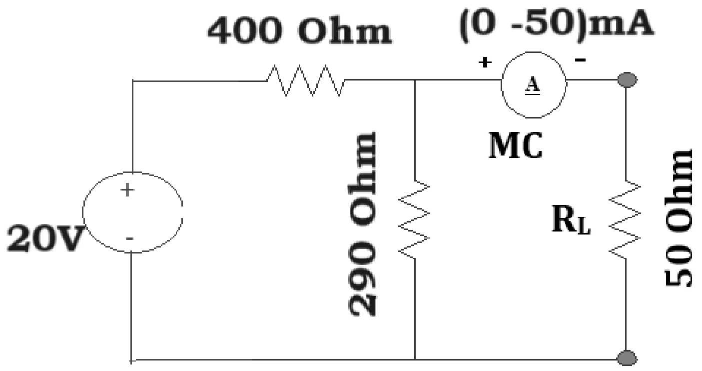
According to Thevenin's theorem, The Thevenin's equivalent circuit can be shown in the following circuit.



(or)



CIRCUIT DIAGRAM :



PROCEDURE :

1. Connect the circuit as shown in the Circuit diagram
2. Switch ON the supply voltage and apply the voltage as 20V.
3. Note down the Ammeter reading as I.
4. Open the load resistance terminals and measure the voltage (V_{Th}) across the open circuited terminals.
5. Short the voltage source and measure the Thevenin's resistance (R_{Th}) across the open circuited terminals.
6. Connect the Thevenin's equivalent circuit by connecting the load resistance across it.
7. Measure the load current (I_L) through the load resistance (R_L).
8. Verify $I = I_L$.

THEORETICAL CALCULATIONS :

TABULAR COLUMNS :

Parameter	Theoretical	Practical
V_{Th} (V)		
R_{Th} (Ω)		
I_L (A)		

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.

RESULT :

The Thevenin's theorem is verified for the given circuit theoretically and practically.

ii) NORTON'S THEOREM:

AIM : To verify the Norton's equivalent circuit across the load resistance R_L.

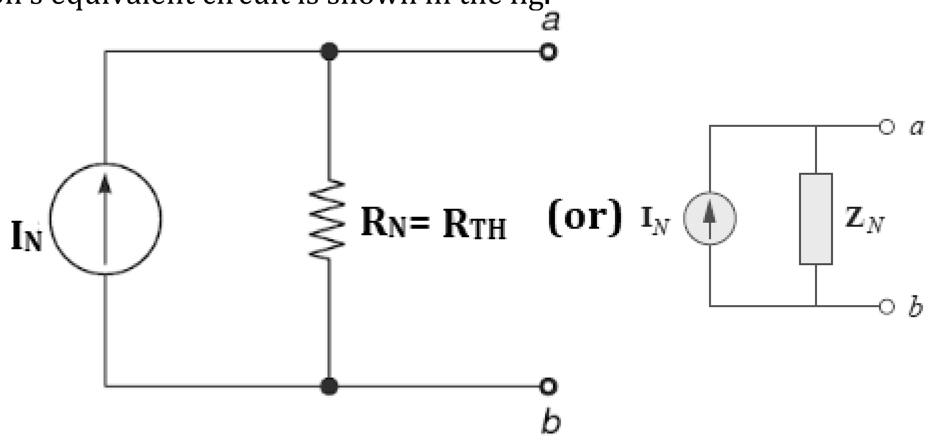
APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	400 Ω/1.7 A	1
		290 Ω/2.8 A	1
		50 Ω/5 A	1
3.	Ammeter	(0-50) mA , MC	1
4.	Connecting Wires	--	Required

THEORY :

Norton's theorem states that any two terminal linear networks with voltage-current sources and resistances (impedances) can be replaced by an equivalent circuit consisting of a current source in parallel with a resistance (impedance). The value of current source is the short circuit current (Norton's current) between the two terminals of the network and resistance (Norton's resistance or impedance) is the equivalent resistance (impedance) measured between the terminals of the network with all energy sources are replaced by their internal resistances.

The Norton's equivalent circuit is shown in the fig.



PROCEDURE :

1. Connect the circuit as shown in the Circuit diagram
2. Short the load resistance terminals and measure the current (I_N) through the short circuited terminals by connecting an ammeter.
3. Open the load terminals and short the voltage source.
5. Measure the Norton's resistance (R_N) across the open circuited terminals.
6. Draw the Norton's equivalent circuit by connecting the load resistance across it.

THEORETICAL CALCULATIONS :

TABULAR COLUMNS :

Parameter	Theoretical	Practical
I_N (A)		
R_N (Ω)		

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.

RESULT :

The Norton's theorem is verified for the given circuit theoretically and practically.

VIVA QUESTIONS:

1) State and explain Thevenin's theorem.
2) State and explain Norton's theorem.
3) Limitations of Thevenin's theorem.
4) Limitations of Norton theorem.
5) Explain about Thevenin's resistance.
6) Explain about Norton resistance.
7) Advantages about Norton theorem over Thevenin.
8) Limitations of Thevenin's theorem
9) Limitations of Noton's theorem
10) Explain which one is the best method for a given circuit.

Experiment No : 11 Date :

VERIFICATION OF MAXIMUM POWER TRANSFER THEOREM

AIM : To verify the maximum power transfer theorem for the given circuit

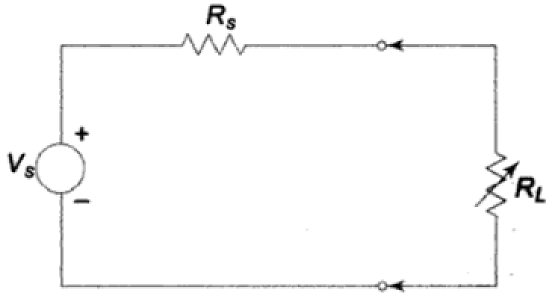
APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	50 **Ω**/5 A	1
		25 **Ω**/5 A	1
3.	Ammeter	(0-2) A , MC	1
4.	Voltmeter	(0-30) V , MC	1
5.	Connecting Wires	--	Required

THEORY :

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 source resistance.

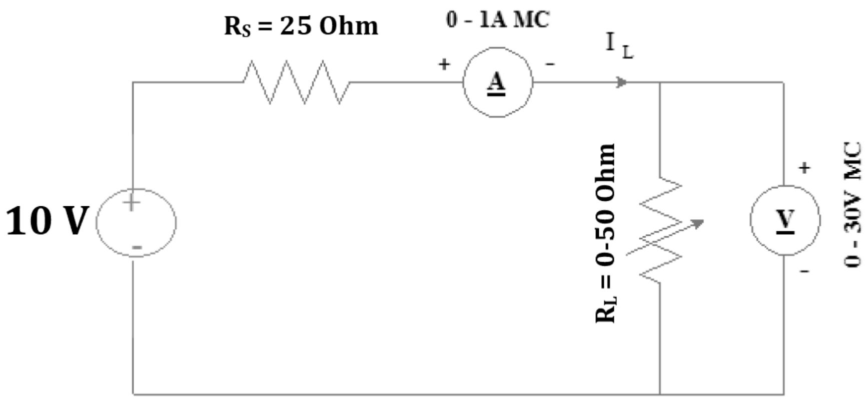
In Fig., assume that the load resistance is variable.



Maximum Power delivered to the load resistance,

$$P_{max} = \frac{V_S^2}{4R_S}$$

CIRCUIT DIAGRAM :



PROCEDURE :

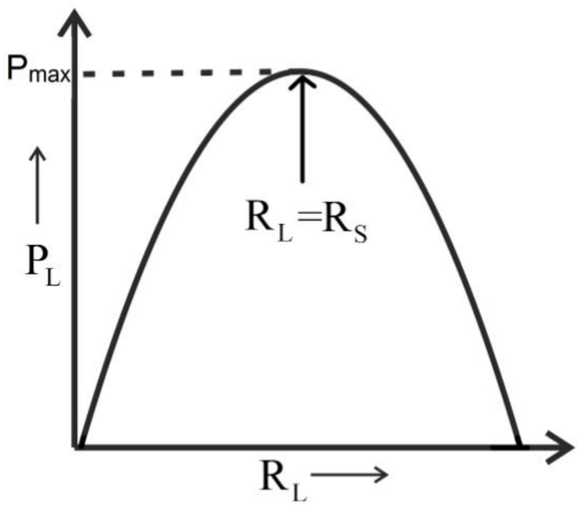
1. Connect the circuit as shown in the Circuit diagram.
2. Switch ON the supply voltage and apply the given voltage.
3. Vary the load resistance (R_L) from 0 to maximum value in steps and note down the readings of volt meter (V_L) and ammeter (I_L).
4. Calculate the power (P_L) consumed by R_L at each step.
5. Tabulate the readings.
6. Draw the graph between Load resistance (R_L) and Power (P_L).

THEORETICAL CALCULATIONS :

TABULAR COLUMNS :

DC EXCITATION			
R_L (Ω)	V_L (V)	I_L (A)	$P_L = V_L I_L$ (W)
5			
10			
15			
20			
25			
30			
35			
40			
45			
50			

MODEL GRAPH:



PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.

RESULT :

The maximum power transfer theorem is verified with DC excitation theoretically and practically.

VIVA QUESTIONS:

1) State and explain Super position theorem.
2) State and explain Maximum power transfer theorem.
3) Limitations of Super position theorem.
4) Limitations of Maximum power transfer theorem.
5) Define Super node.
6) Define Super mush.
7) Advantages about Maximum power transfer theorem.
8) If the source impedance is complex, then the condition for MPT is?
9) Advantages about Super position theorem
10) In Superposition theorem, while considering a source, all other current sources are?

Experiment No : 12 Date :

VERIFICATION OF COMPENSATION THEOREMS

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

APPARATUS REQUIRED :

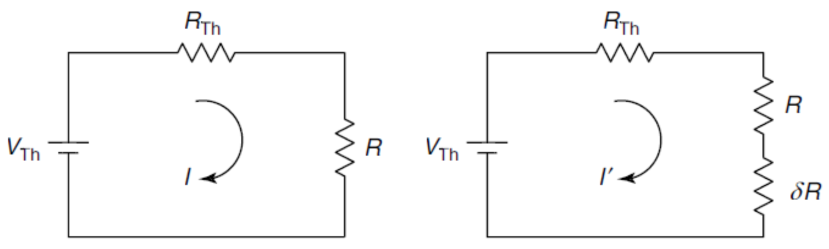
S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	400 **Ω**/1.7 A	1
		100 **Ω**/5 A	1
		145 **Ω**/5 A	1
3.	Ammeter	(0-2) A , MC	1
5.	Connecting Wires	--	Required

THEORY :

Statement:

It states that 'in any linear bilateral active network, if any branch carrying a current 'I' has its resistance R changed by an amount δR, the resulting changes that occur in the other branches are the same as those which would have been produced by an opposing voltage source of value Vc(IδR) introduced into the modified branch.'

Explanation Consider a network shown in Fig.(a), having load resistance *R*.



$$I = \frac{V_{Th}}{R_{Th} + R}$$

If the load resistance R be changed to $R + \delta R$ as shown in Fig.(b) then the current flowing in the circuit is

$$I' = \frac{V_{Th}}{R_{Th} + R + \delta R}$$

The change in the current is $\delta I = I' - I = \dfrac{V_{Th}}{R_{Th} + R + \delta R} - \dfrac{V_{Th}}{R_{Th} + R}$

$$= -\frac{V_{Th}\ \delta R}{(R_{Th} + R + \delta R)\,(R_{Th} + R)}$$

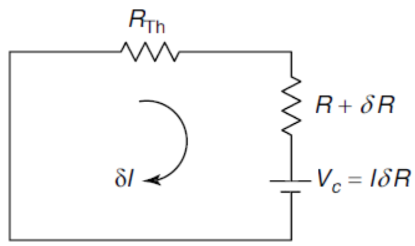
$$= -\frac{V_{Th}}{R_{Th} + R}\,\frac{\delta R}{R_{Th} + R + \delta R}$$

$$= -\frac{I\ \delta R}{R_{Th} + R + \delta R}$$

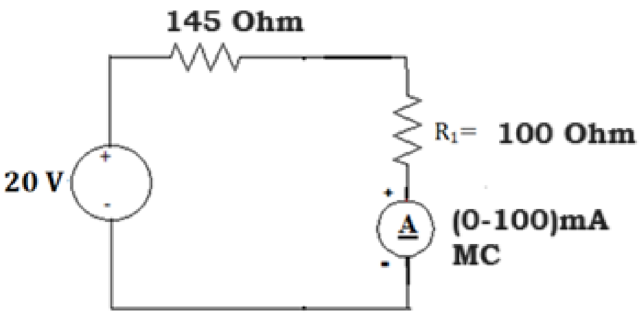
$$= -\frac{V_c}{R_{Th} + R + \delta R}$$

where $V_c = I\ \delta R$ and is called the *compensation voltage*.

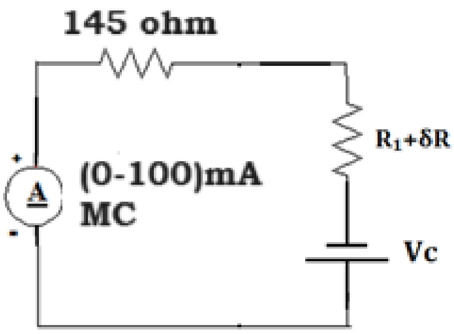
δI has the same direction as I. This shows that the change in current δI due to a change in any branch in a linear network can be calculated by determining the current in that branch in a network obtained from the original network by removing all the independent sources and placing a voltage source called compensation source in series with the branch whose value is $V_c = I\ \delta R$, whose I is the current through the branch before its resistance is changed and δR is the change in resistance.



<u>CIRCUIT DIAGRAM</u> :



(a)



(b)

PROCEDURE :

1. Connect the circuit as shown in the fig(a).
2. Measure the current using Ammeter as I.
3. Now replace 25**Ω** rheostat with R_2=400**Ω** rheostat and measure the current as I'.
4. Calculate **δ**I = I'−I .
5. Calculate **δ**R=R_2−R_1 and Vc = I(**δ**R)
6. Connect the circuit diagram as shown in the fig(b).
7. Measure the current using Ammeter as **δ**I'.
8. Verify **δ**I= **δ**I'.

THEORETICAL CALCULATIONS :

TABULAR COLUMNS :

Parameter	I	I'	**δ**I	Vc	**δ**I'
Theoretical					
Practical					

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.

RESULT :

The compensation theorem is verified for the given circuit theoretically and practically.

VIVA QUESTIONS:

1) To what type of the circuit, the reciprocity theorem applicable?
2) What is transfer resistance in reciprocity theorem?
3) Is reciprocity theorem applicable to ac?
4) What are mutually transferable in the reciprocity theorem?
5) Is reciprocity theorem applicable to the circuit having capacitor or inductor?
6) State Compensation Theorem.
7) What is meant by the compensation emf?
8) Mention the application of compensation Theorem.
9) If the compensation voltage is 8 Volts and the value of resistance in the branch is changed from 2 ohms to 4 ohms then determine the current in that branch before modification.
10) What are the advantages of compensating theorem?

Experiment No : 13 Date :

VERIFICATION OF RECIPROCITY & MILLMAN'S THEOREMS

i) RECIPROCITY THEOREM:

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

APPARATUS REQUIRED :

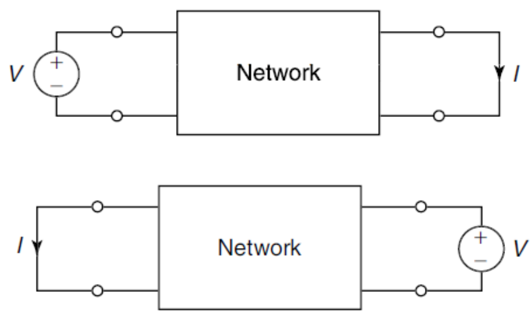
S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	50 **Ω**/5 A	1
		25 **Ω**/5 A	1
		100 **Ω**/5 A	1
3.	Ammeter	(0-2) A, MC	1
5.	Connecting Wires	--	Required

THEORY :

Statement:

It states that 'in a linear, bilateral, active, single source network, the ratio of excitation to response remains same when the positions of excitation and response are interchanged.'

In other words, it may be stated as 'if a single voltage source Va in the branch 'a' produces a current I_b in the branch 'b' then if the voltage source Va is removed and inserted in the branch 'b', it will produce a current I_b in branch 'a''.

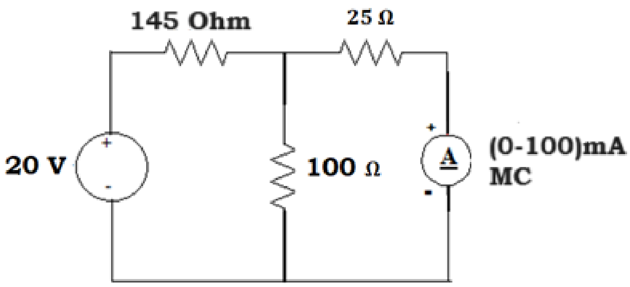


Explanation Consider a network shown in Fig.

When the voltage source *V* is applied at the port 1, it produces a current *I* at the port 2. If the positions of the excitation (source) and response are interchanged, i.e., if the voltage source is applied at the port 2 then it produces a current *I* at the port 1.

The limitation of this theorem is that it is applicable only to a single-source network. This theorem is not applicable in the network which has a dependent source. This is applicable only in linear and bilateral networks. In the reciprocity theorem, position of any passive element (R, L, C) do not change. Only the excitation and response are interchanged.

CIRCUIT DIAGRAM :



PROCEDURE :

1. Connect the circuit as shown in the Circuit diagram.
2. Switch ON the supply voltage and apply 20 V.
3. Note down the Ammeter reading as I_1.
4. Now interchange voltage source and ammeter.
5. Note down the Ammeter reading as I_2.
6. Verify $I_1 = I_2$.

THEORETICAL CALCULATIONS :

TABULAR COLUMNS :

S.NO.	Step	Current, I (A)
1.	Before Interchanging	
2.	After Interchanging	

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.

RESULT :

The reciprocity theorem is verified theoretically and practically.

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

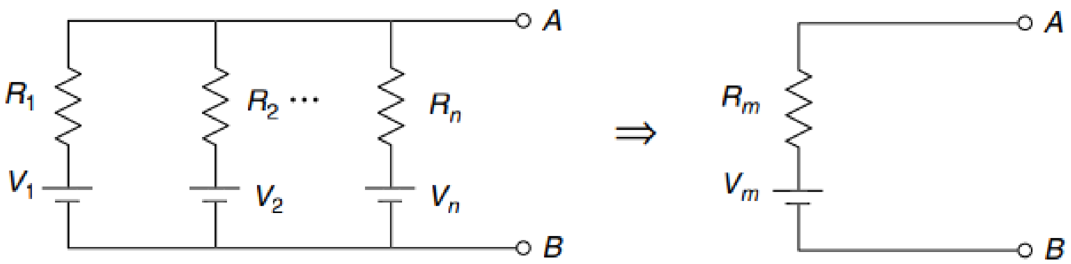
APPARATUS REQUIRED :

S.NO.	NAME OF THE EQUIPMENT	RANGE	QUANTITY
1.	Regulated Power Supply (RPS)	(0 – 30) V	1
2.	Rheostat	50 Ω/5 A	1
		25 Ω/5 A	1
		100 Ω/5 A	1
3.	Ammeter	(0-2) A , MC	1
5.	Connecting Wires	--	Required

THEORY :

Statement:

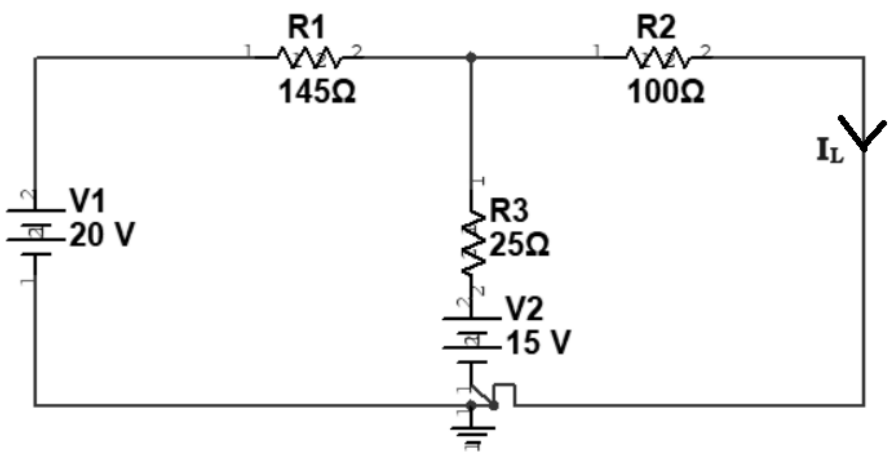
It states that 'if there are n voltage sources V_1, V_2 ,...,V_n with internal resistances R_1,R_2 ,..., R_n respectively connected in parallel then these voltage sources can be replaced by a single voltage source V_m and a single series resistance R_m' as shown in the fig.



where $$V_m = \frac{V_1G_1 + V_2G_2 + \ldots + V_nG_n}{G_1 + G_2 + \ldots + G_n}$$

$$R_m = \frac{1}{G_m} = \frac{1}{G_1 + G_2 + \ldots + G_n}$$

CIRCUIT DIAGRAM :



PROCEDURE :

1. Connect the circuit as shown in the Circuit diagram (a).
2. Measure the current using Ammeter as I_1.
3. Calculate Vm and Rm.
4. Connect the circuit as shown in the fig.(b).
5. Measure the current using Ammeter as I_2.
6. Verify the theorem by $I_1 = I_2$

THEORETICAL CALCULATIONS :

TABULAR COLUMNS :

DC EXCITATION:

S.NO.	Parameter	I_1	I_2
1.	Theoretical		
2.	Practical		

PRECAUTIONS :

1. Check the connections before switching ON the supply.
2. The terminals of the rheostat should be properly connected.
3. Disconnect the connections properly after the completion of experiment.

RESULT :

The Millman's theorem is verified for the given circuit theoretically and practically.

VIVA QUESTIONS:

1) State Millman's Theorem?
2) When the Millman's Theorem is found necessary in circuit analysis?
3) Write the formula to find Millman's voltage.
4) Write the formula to find equivalent resistance.
5) List the applications of millman's theorem.
6) Is it possible to apply both theorems to AC as well as DC circuit?
7) Is Millman's is applicable for unilateral and bilateral networks?
8) Which condition is required to apply the Milliman's theorem for the circuit?
9) Draw the equivalent circuit.
10) What is the connection of Vm and Rm?