DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Manual for ECE217 Networks lab

SIR C.R.REDDY COLLEGE OF ENGINEERING
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SIR C.R.REDDY COLLEGE OF ENGINEERING:: ELURU-7
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

ECE 217 NETWROKS *LABORATORY*
(2/4 ECE, I Semester)

1 Verification of ohm's law and Kirchhoff's laws

2 Verification of Superposition Theorem

3 Verification of Thevenin's Theorem

4 Verification of Maximum power Transfer Theorem

5 Verification of Reciprocity Theorem

6 Series R-L-C resonance & Parallel resonance

7 Two port networks

8 Time response of RL & RC circuits

9 Parameters of an Iron core Inductor

10 Calibration of Energy meter

11 Measurement of power in 3-Φ circuit

12 Series RLC vector diagram

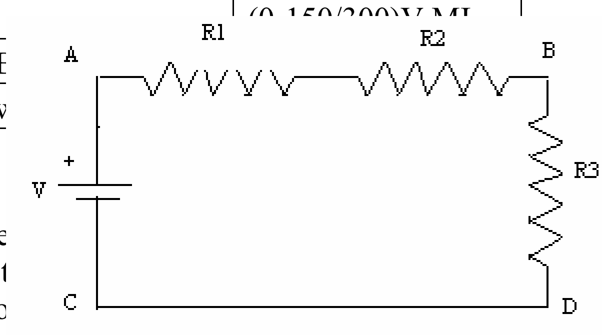
Exp. No : 1

OHM'S LAW &KIRCHHOFF'S LAWS

Aim:- To verify ohm's law and Kirchhoff's voltage law and current law.

Apparatus:-

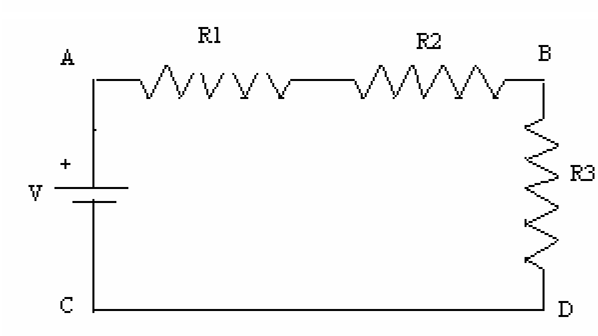
S.No	Description	Rating	Qty
1	1-Φ Dimmerstat	230/0-270V,8A	1
2	Incandescent lamp	25W 40W 60W	1 1 1
3	Ammeter	(0-1A)MI (0-3A)MI	3 1
4	Voltmeter	(0-150/300)V MI	4
5	Connecting E		1
6	Connecting v		-



Theory:-

a) Kirchhoffs Voltage

According to t … braic sum of emfs acting in that circuit c … ement of the circuit.



In mesh ABCD, $V=I(R_1+R_2+R_3)$

b) Kirchhoff's Current Law:

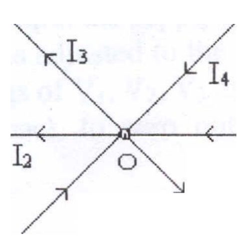
According-to this law, in any network of wires carrying currents, the algebraic sum of all the currents meeting at a node is zero or the sum of all the incoming currents is equal to the sum of outgoing currents away from that node.

Let I_1, I_2, I_3, I_4, I_5 I_6 be the currents at node O. I_1, I_4, I_5 are the currents entering the node O and I_2, I_3, I_6 are the currents leaving the node O. Then according to Kirchhoff's law,

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

i.e $I_1+I_4+I_5=I_2+I_3+I_6$

c) Filament Lamp:-



Ohm's Law:- At constant temperature the potential difference between two terminals of a conductor is proportional to the current flowing though the conductor.

V is proportional to I

V=I.R

Where R is the Resistance between those two terminals

R= V/I

The resistance of the filament lamp is determined by finding the current at different at voltages.

The filament lamp does not follow the ohms law because the lamp works at different temperatures.

The resistance at a temperature $t^o c$

$R_t=R_o[1+\alpha_0 t]$

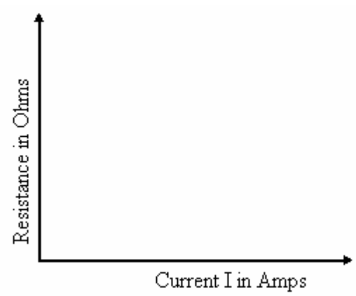
Where R_o=Resistance at $0^o c$.

α_o= temperature coefficient of resistance at $0^o c$

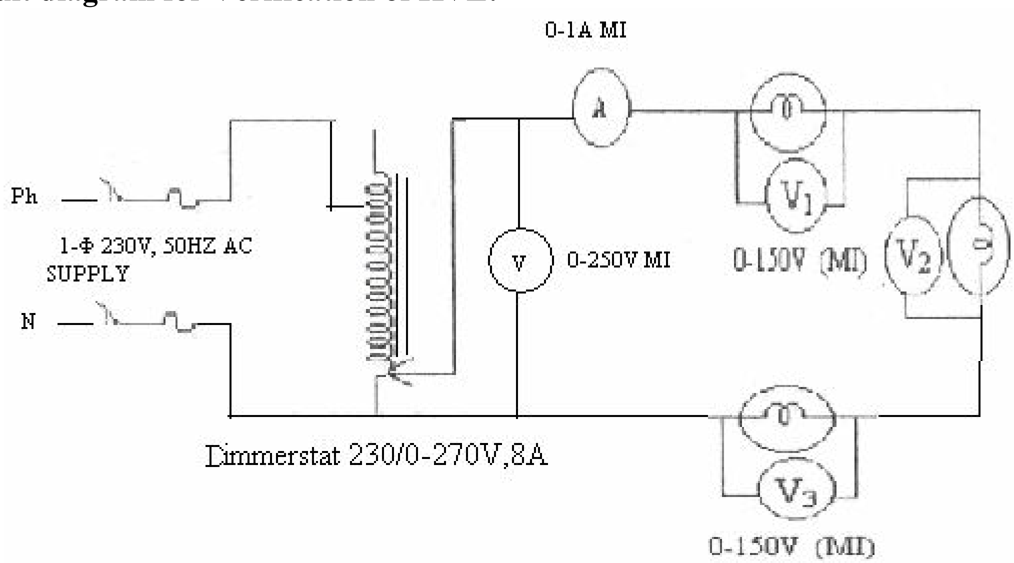
The graph between resistance and current is not linear.

The resistance of the filament lamp when the current flowing through the lamp is zero is called as cold resistance. i.e the resistance at room temperature.

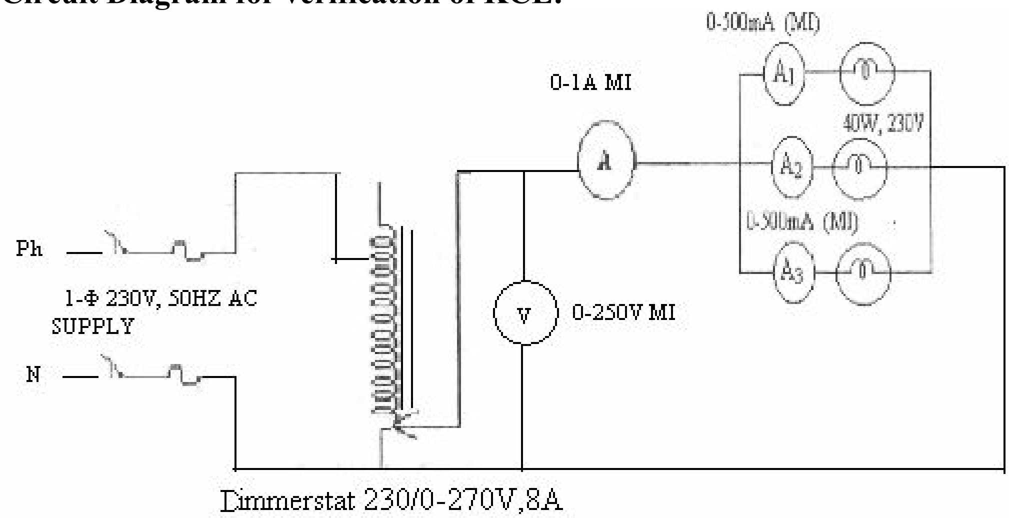
Graph:-



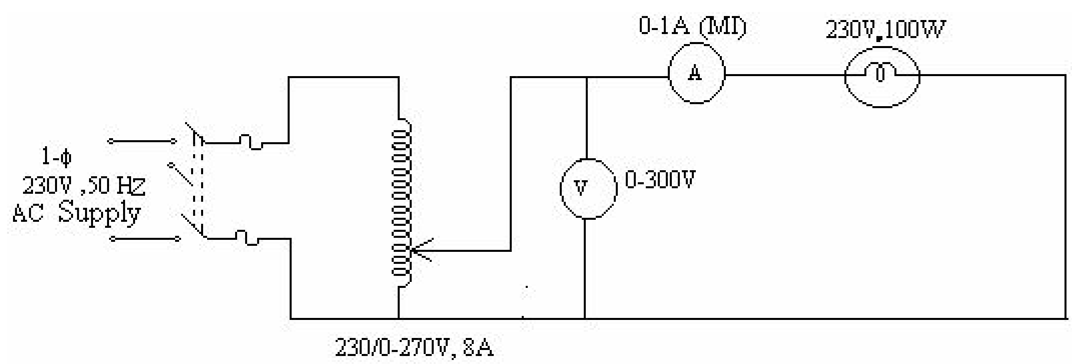
Circuit diagram for Verification of KVL:



Circuit Diagram for verification of KCL:-



Circuit diagram for measurement of resistance of a filament lamp



Procedure:-

a) <u>Kirchhoff's Voltage Law:</u>

1. The connections are made as shown in the circuit diagram.
2. With the dimmer stat at zero output the supply switch is closed.
3, The output of the dimmers tat is adjusted to the voltage in steps as given in the tabular column and the readings of V I, V 2, V 3 are noted for each step,
4. The dimmerstat is brought back to zero output and the supply switch is opened.

b) <u>Kirchhoff's 's Current Law:</u>

1. The connections are made as shown in the circuit diagram.
2. With the Dimmerstat at zero output the supply switch is closed.
3. The output of the dimmer stat is adjusted to the voltage in steps as given in the tabular column and all the ammeter readings are noted for each step.
4. The Dimmerstat is brought back to zero output and the supply switch is opened

c) measurement of resistance of a filament lamp

1. The connections are made as shown in the circuit diagram.
2. With the Dimmerstat at zero output the supply switch is closed.
3. The Dimmerstat is varied in steps as given in the tabular column and the respective Ammeter readings are noted.
4. The Dimmerstat is brought back to zero output and the supply switch is opened

Tabular Column for Verification of KVL:

Sl.No	Applied voltage V in volts	V_1 in volts	V2 in volts	V3 in volts	V = VI+V2+V3
1	50				
2	100				
3	150				
4	200				
5	230				

Tabular Column for Verification of KCL:

Sl.No	Applied voltage V in volts	$I_i$in Amps	I_2in Amps	$I_{3\,i}$in Amps	$I=I_1+I_2+I_3$
1	50				
2	100				
3	150				
4	200				
5	230				

Tabular column for measurement of resistance of a filament lamp:-

Sl.No.	V in Volts	I in Amps	R in Ohms	W in Watts
1.	50			
2.	100			
3.	150			
4.	200			
5.	230			

Specimen calculations:-

KVL & KCL:-

V = VI+V2+V3 (for KVL)

$I = I_1+I_2+I_3$ (for KCL)

Resistance of a filament lamp:-

$R = \frac{V}{I}$ **;** $W = I^2R$

Viva Questions:-

1. Why tungsten is used as filament in incandescent lamp ?
2. Melting point of a Tungsten -----
3. What are the types of filaments that are used in filament lamps?
4. Why gas is filled inside the filament lamp.
5. What is difference between AC and DC resistance
6. What is a linear circuit?
7. What is the heating effect of a electric current.
8. Define ohm's law.
9. Define Kirchhoff's Voltage law.
10. Define Kirchhoff's Current law.
11. Filament of a lamp is made of ---------
12. Give the Voltage Division Rule.
13. If one of the resistance in a parallel circuit is removed , what happence to the total resistance.
14. The series circuit consists of five equal resistances and dissipates 10 watts of power. Then power dissipated in each resistance?
15. The power dissipation in each of three parallel branches is 1W. What is the total

Power dissipation of the circuit?

16.

Precautions:-

1) Do not touch bare conductors when supply is ON
2) Switch off all the measuring devices when NOT in USE.
3) Ensure that dimmerstat is in minimum position before switching ON the supply and before switching OFF the supply.
4) Ensure that there is no short circuit across the supply or any device, before switching ON the supply.
5) Check for prager polarity of meters.

Result:-

Exp. No : 2

VERIFICATION OF SUPERPOSITION THEOREM

Aim : To verify Superposition theorem.

Apparatus :

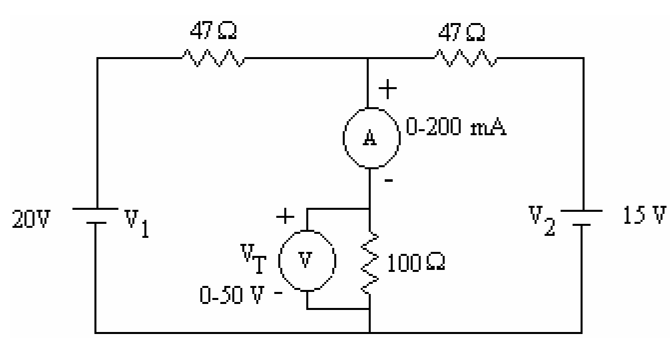
Sl.No.	Description	Rating	Qty.
1.	Dual DC power supply	0 - 30V, 2A	1
2.	Digital DC Milli ammeter	0 – 200mA	1
3.	Digital DC voltmeter	0 – 20V	1
4.	Superposition theorem circuit board	---	1
5.	Connecting wires	---	---

Theory:

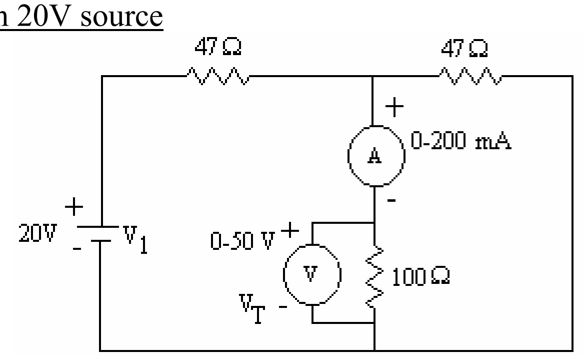
Any linear network containing multiple sources, the response in any element is equal to the algebraic sum of responses due to individual sources.
This theorem is applicable only in linear circuits, i.e., circuits consisting of resistance or impedance in which ohms law is valid. Superposition theorem can be applied to a circuit containing current sources and even to circuits containing both current and voltage sources. The above theorem is applied when the current in any particular branch of network containing number of voltage sources and current sources is to be determined.

Circuit diagram:

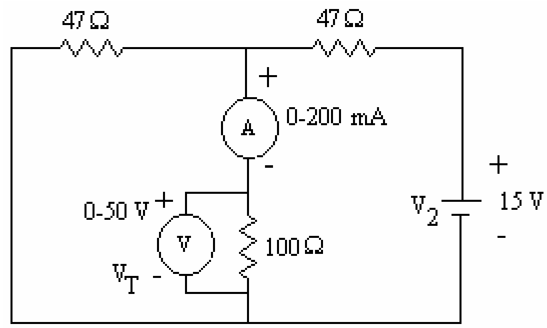
a) For the circuit with two sources



b) For the circuit with 20V source



c) For the circuit with 15V source



Procedure :

a) For the circuit with two sources

1. The connections are made as shown in the circuit diagram - a.
2. With the voltage knobs of the Dual DC power supply at their minimum positions the power supply is switched ON.
3. The voltage V_1 is adjusted to 20V, the voltage V_2 is adjusted to 15V and the reading of the Milliammeter is noted.
4. The voltage knobs are brought back to their minimum positions and the power supply is switched OFF.

b) For the circuit with 20V source

1. The connections are made as shown in the circuit diagram - b.
2. With the voltage knobs of the Dual DC power supply at their minimum positions the power supply is switched ON.
3. The voltage V_1 is adjusted to 20V and the reading of the Milliammeter is noted.
4. The voltage knobs are brought back to their minimum positions and the power supply is switched OFF.

c) For the circuit with 15V source

1. The connections are made as shown in the circuit diagram - c.
2. With the voltage knobs of the Dual DC power supply at their minimum positions the power supply is switched ON.
3. The voltage V_2 is adjusted to 15V and the reading of the Milliammeter is noted.
4. The voltage knobs are brought back to their minimum positions and the power supply is switched OFF.

Tabular Column :

Sl.No.	Condition of the circuit	V_1 in Volts	V_2 in Volts	V_T in Volts	I in mA
1.	With Two voltage sources				
2.	With 20 V source only				
3.	With 15 V source only				

Theoretical Calculations:

Applying mesh analysis for circuit diagram – a, we get,

$$147I_1-100I_2 = 20$$

$$-100I_1+147I_2= 15$$

Solving for I_1 and I_2, we get,

$I_1= 0.12404$ A ; $I_2= - 0.0176$ A ;

The current in the 100Ω branch is

$$I_1 - I_2 = 0.1417 \text{ A}$$

Applying mesh analysis for circuit diagram - b, we get,

$$147I_1-100I_2 = 20$$

$$-100I_1+147I_2= 0$$

Solving for I_1 and I_2, we get

$I_1= 0.2533$ A ; $I_2= 0.1723$ A;

The current I_x in the 100Ω branch is $I_1 - I_2 = 0.081$ A

Applying mesh analysis for circuit diagram - c, we get,

$$147I_1-100I_2 = 0$$

$$-100I_1+147I_2= 15$$

Solving for I_1 and I_2, we get,

$I_1= 0.1292$ A ; $I_2= 0.1899$ A;

The current I_y in the 100Ω branch is $-I_1+I_2 = 0.0607$ A

Finally $I_x+I_y = 0.1417$ A = The current due to the two sources.

Viva Questions:

1. Super position theorem is valid for ------
2. When applying super position theorem to any circuit ideal voltage source is replaced by --- and ideal current source is replaced by -----
3. Give the statement of superposition theorem.
4. Give the limitations of super position theorem.
5. When the superposition theorem is applied to the circuits consisting of dependent sources, how the dependent sources act
6. Superposition theorem is essentially based on the concept of?

Precautions:

1. Don't touch bare conductors when supply is ON
2. Wear shoes in laboratory to avoid shocks
3. Switch off the all the measuring devices when NOT in USE.
4. Ensure that there is no short circuit across the supply or any device, before switching on the supply.
5. Ensure that the current knob of the dc power supply is in maximum position before switching on the supply.

Expt.3

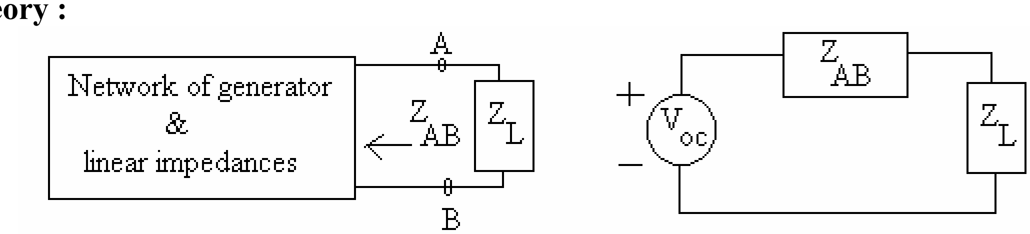
THEVENIN'S THEOREM

Aim: To verify Thevenin's Theorem.

Apparatus :

Sl.No.	Description	Range	Qty.
1.	DC power supply	0-30V, 2A	1
2.	Digital DC Milliammeter	0-200mA	1
3.	Digital DC Voltmeter	0-20V	1
4.	Thevenin's theorem circuit board	---	1
5.	Potentiometer	500 Ω	1
6.	Connecting wires	---	---

Theory :

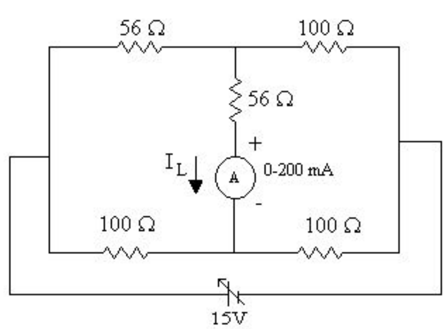


Consider a generator network consisting of generator & linear impedances as shown in figure. Z_L is the load impedance connected across terminals A & B. According to Thevenin s theorem this network can be replaced by an emf V_{oc} in series with an impedance Z_{AB} as shown in figure. V_{oc} is the open circuit voltage i.e, the voltage measured at terminals A & B when Z_L is removed.

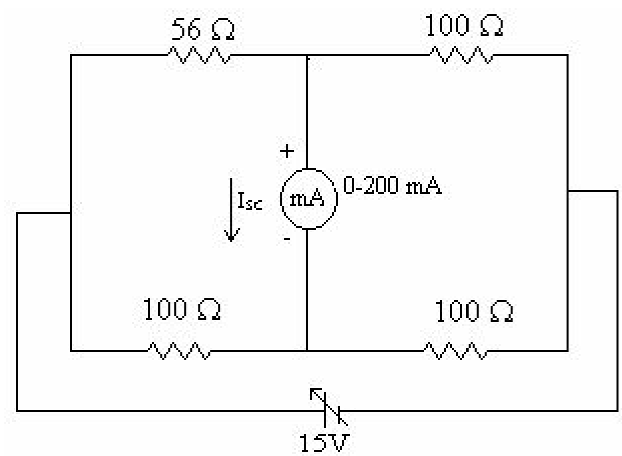
Z_{AB} is the impedance looking into terminals A & B with load Z_C removed with all generators replaced by their internal impedances. The only restriction on this theorem is that network is not magnetically coupled to external circuits.

Circuit diagram :

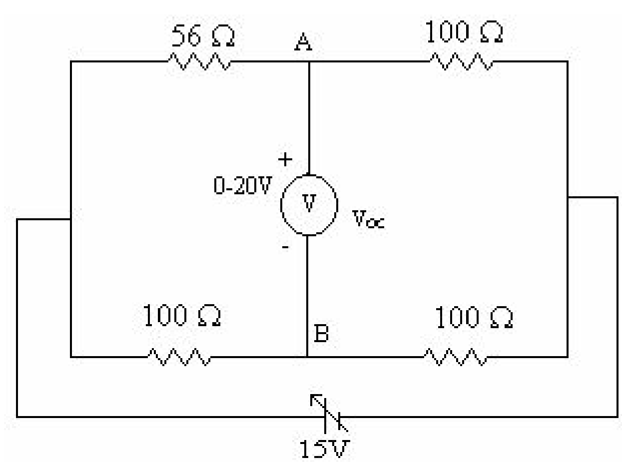
a) <u>For measurement of Load current</u>



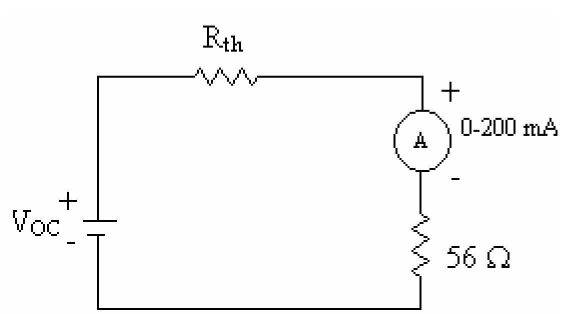
b) **For measurement of Short circuit current**



c) **For measurement of Open circuit voltage**



d) For verification of Thevenin's Theorem



Procedure :

a) ***For measurement of Load current***

1. ***The connections are made as shown in the circuit diagram - a.***
2. With the voltage knobs of the DC power supply at their minimum positions the power supply is switched ON.
3. The voltage knobs are varied gradually such that the output voltage is adjusted to 15 Volts and the ammeter reading is noted.
4. The voltage knobs are brought back to their minimum positions and the DC power supply is switched OFF.

b) For measurement of Short circuit current

1. The connections are made as shown in the circuit diagram - b.
2. Step No's 2 to 4 of part – a, are repeated.

c) For measurement of Open circuit voltage

1. The connections are made as shown in the circuit diagram - c.
2. With the voltage knobs of the DC power supply at their minimum positions the power supply is switched ON.
3. The voltage knobs are varied gradually such that the output voltage is adjusted to 15 Volts and the voltmeter reading is noted.
4. The voltage knobs are brought back to their minimum positions and the DC power supply is switched OFF.

d) For verification of Thevenin's Theorem

1. The value of R_{Th} which is calculated from the above readings is fixed using a potentiometer and connected into the circuit as shown in the circuit diagram - d.
2. The output of DC power supply is adjusted to the measured value of V_{OC} from the earlier setup and the ammeter reading is noted.
3. The voltage knobs are brought back to their minimum positions and the DC power supply is switched OFF.

Tabular Column :

Sl.No.	Circuit diagram	Quantity to be measured	Meter Reading
1.	A	Load current	I_L = Amps
2.	B	Short circuit current	I_{SC} = Amps
3.	C	Open circuit voltage	V_{OC} = Volts
4.	D	Load current	I_L = Amps

Theoretical Calculations :

a) For circuit (a):

Applying KVL for Circuit(a),

$$212I_1 - 56I_2 - 100I_3 = 0$$
$$-56I_1 + 256I_2 - 100I_3 = 0$$
$$-100I_1 - 100I_2 + 200I_3 = 15$$

Solving I_1, I_2, I_3 We get,

$I_1 = 0.1057$ A; $I_2 = 0.0908$ A ;

The current I through 56 Ω resistor is,

$I_L = I_1 - I_2 = 0.1057 - 0.0908 = 0.0149$ A;

b) For circuit (b):

Equivalent resistance $R_e = \dfrac{56 \times 100}{(100+56)} + \dfrac{100 \times 100}{(100+200)}$

$$= 85.89\Omega$$

Therefore $I = \dfrac{15}{85.89} = 0.1746\text{A}$

Current through 56Ω resistance is $I_{56} = \dfrac{0.1746 \times 100}{156} = 0.11194\text{A}.$

Current through 100Ω resistance is $I_{100} = \dfrac{0.1746}{2} = 0.0873\text{A}.$

Therefore $I_{sc} = I_{56} - I_{100} = 0.11196 - 0.0873 = 0.02464\text{A}$

c) For Circuit (c)

$$V_A = 15 - \frac{15}{156} \times 100 = 9.615V$$

$$V_B = 15 - \frac{15}{200} \times 100 = 7.5\ V$$

$$V_{OC} = V_A - V_B = 2.115\text{V}$$

d) For circuit(d)

$$R_{TH}=\frac{V_{OC}}{I_{SC}}=\frac{2.115}{0.02464}=85.85\Omega$$

$$I_L=\frac{V_{TH}}{R_{TH}+R_L}=\frac{2.115}{85.85+56}=0.0149A$$

Viva Questions:

1) While applying thevenin's theorem, thevenin's voltage is equal to-----
2) Thevenin's impedance is -----
3) Norton's equivalent form in any complex impedance circuit consists of ----
4) What is the main application of thevenin's theorem?

Precautions:

1. Don't touch bare conductors when supply is ON
2. Wear shoes in laboratory to avoid shocks
3. Switch off the all the measuring devices when NOT in USE.
4. Ensure that there is no short circuit across the supply or any device, before switching on the supply.
5. Ensure that the current knob of the dc power supply is in maximum position before switching on the supply.
6. Check for proper polarity of meters.

Expt.4

MAXIMUM POWER TRANSFER THEOREM

Aim : To verify Maximum power transfer theorem.

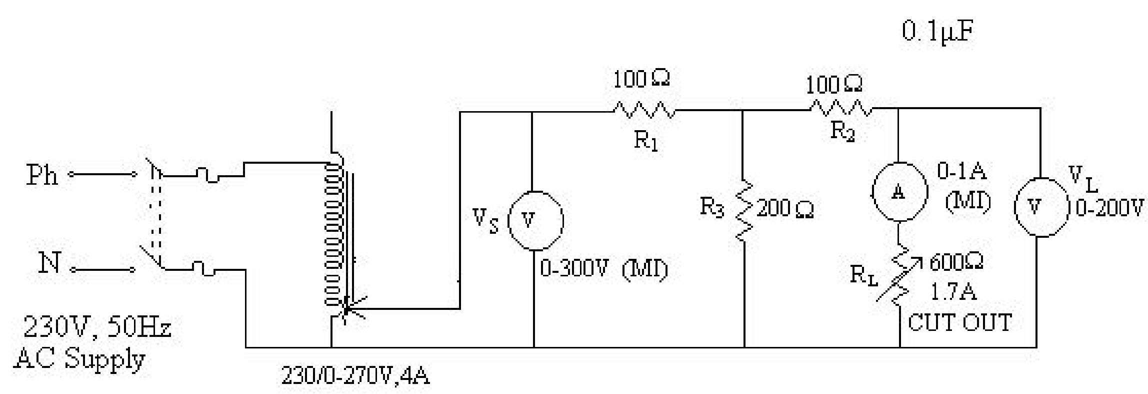
Apparatus :

Sl.No.	Description	Range	Qty.
1.	1-ϕ Dimmerstat	230/0-270V, 8A	1
2.	Rheostat	600 Ω, 1.7A	4
3.	Ammeter	0-1A (MI)	1
4.	Multimeter	---	2
5.	Connecting wires	---	---

Theory :

Many circuits basically consist of sources, supplying voltage, current and power to the load; for example, a radio speaker system, or a microphone supplying the input signals to voltage pre-amplifiers. Sometime it is necessary to transfer maximum voltage, current or power from source to the load. The Maximum Power Transfer Theorem states that maximum power is delivered from a source to load when the load resistance is equal to the source resistance. This theorem can also be applied to complex impedance circuits. If source impedance is complex then maximum power is transferred from source to load when load impedance is equal to complex conjugate of source impedance.

Circuit diagram :



Procedure :

1. The connections are made as shown in the circuit diagram.
2. With the dimmerstat at zero output and the rheostat R_L in CUTOUT position the supply switch is closed.
3. The output of the dimmerstat is adjusted such that V_s reads 220V.
4. The rheostat R_L is gradually CUTIN in steps such that the current is decreased in steps of 0.05A and the voltmeter reading V_L is noted.
5. The dimmerstat is brought back to zero output and the supply switch is opened.

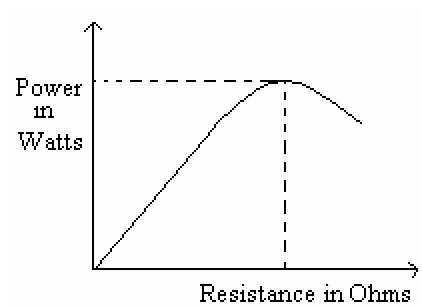
Tabular column :

Sl.No.	**V_S** in Volts	**I_L** *in Amps*	**V_L** in Volts	**R_L** in Ohms	**W** in Watts

Specimen Calculation :

$$R_L = \frac{V_L}{I_L} \qquad W = I_L^2 R_L$$

Nature of Graph :



Theoretical Calculations:

The equivalent resistance as seen from the load end of the circuit when the AC supply is short-circuited is: -

$$R_S = \frac{R_1 R_3}{R_1 + R_3} + R_2 \;; \qquad R_S = \frac{100 \times 200}{300} + 100 \;; \qquad R_S = 166.67\ \Omega$$

The open circuit voltage V_{oc} is found by keeping the output open circuited (i.e., RL is disconnected)

$$V_{OC} = \frac{V_S \text{ x } R_3}{R_1 + R_3} \;; \qquad V_{OC} = \frac{220 \times 200}{300}; \qquad V_{OC} = 146.67\ V$$

The maximum power $P = \frac{{V_{OC}}^2}{4R_L}$; $P = \frac{(146.67)^2}{4 \times 166.67} = 32.267\ W$

Viva Questions:

1 Condition for Maximum power transferred to a load in a DC circuit ----
2. In a complex impedance circuit, the maximum power transfer occurs when the load impedance is equal to-------
3. Maximum power transfer occurs at what % of its efficiency?
4. Applications of maximum power transfer theorem.
5. What is the valve of maximum power transferred to the load (R_L).When E is generator EMF and R_i is internal resistance.

Precautions:

1 Do not touch bare conductors when supply is ON
2 Switch off the all the measuring devices when NOT in USE.
3 Ensure that dimmerstat is in minimum position before switching ON the supply and before switching OFF the supply.
4 Ensure that there is no short circuit across the supply or any device, before switching ON the supply.
5 Check for proper polarity of meters.

Expt.5

RECIPROCITY THEOREM

Aim : To verify reciprocity theorem.

Apparatus :

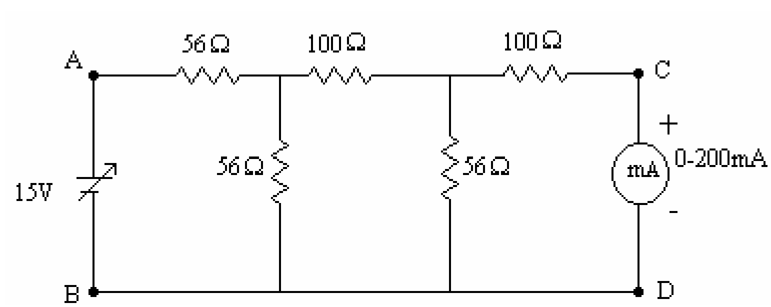
Sl.No.	Description	Rating	Qty.
1.	DC power supply	0-30V, 2A	1
2.	Digital DC Milliammeter	0-200mA	1
3.	Reciprocity theorem circuit board	---	1
4.	Connecting wires	---	---

Theory:

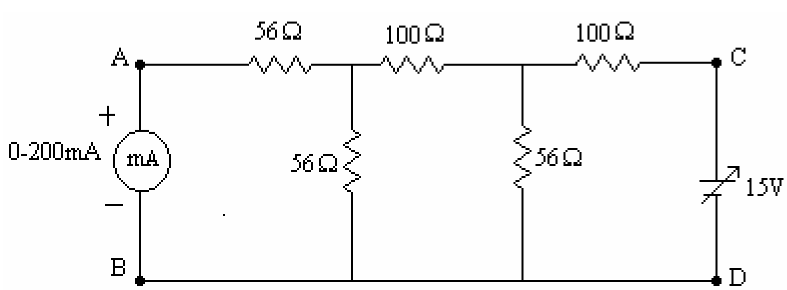
According to this theorem if we apply input to a circuit, which consist of resistors, inductors, capacitors and transformers, including coupled circuits, the ratio of response in any element to the input is constant even when the position of input and output are interchanged.

Circuit diagram :

a) *With source across AB*



b) With source across CD



Procedure :

1. The connections are made as shown in the circuit diagram - a.
2. With the voltage knobs of the DC power supply at minimum positions the power supply is switched ON.
3. The voltage knobs are varied, the output is adjusted to 15 V and the Milliammeter reading is noted.
4. The voltage knobs are brought back to their minimum positions and the power supply is switched OFF.
5. Step No's - 1 to 4 are repeated for circuit diagram - b also.

Tabular Column :

Sl.No.	**Condition of the Circuit**	**V** in Volts	**I** in mA	**Ratio** in Ohms
1.	Source across AB	15		
		20		
		30		
2.	Source across CD	15		
		20		
		30		

Specimen Calculation :

$$\text{Ratio} = \frac{V}{I}$$

Theoretical Calculations :

The mesh equations for Circuit diagram – a, are :

$$112I_1 - 56I_2 = 15$$
$$-56I_1 + 212I_2 - 56I_3 = 0$$
$$-56I_2 + 156I_3 = 0$$

Solving the above equations for the value of I_3, We get,

$$I_3 = 0.0164 \text{ A.}$$

The mesh equations for Circuit diagram – b, are :

$$112I_1 - 56I_2 = 0$$
$$-56I_1 + 212I_2 - 56I_3 = 0$$
$$-56I_2 + 156I_3 = 15$$

Solving the above equations for the value of I_1,
We get,

$$I_1 = 0.0164 \text{ A.}$$

Viva Questions:

1) Reciprocity theorem is applicable to -----
2) Condition for a reciprocal network in terms of ABCD parameters.
3) Condition for a reciprocal network in terms of Z parameters.
4) Give the Statement of Reciprocity theorem.

Precautions:

1 Don't touch bare conductors when supply is ON
2 Wear shoes in laboratory to avoid shocks
3 Switch off the all the measuring devices when NOT in USE.
4 Ensure that there is no short circuit across the supply or any device, before switching on the supply.
5 Ensure that the current knob of the dc power supply is in maximum position before switching on the supply.
6 Check for proper polarity of meters.

Expt.6

R-L-C SERIES RESONANCE & R-L-C PARALLEL RESONANCE

Aim : To plot a resonance curve and calculate the resonant frequency.

Apparatus :

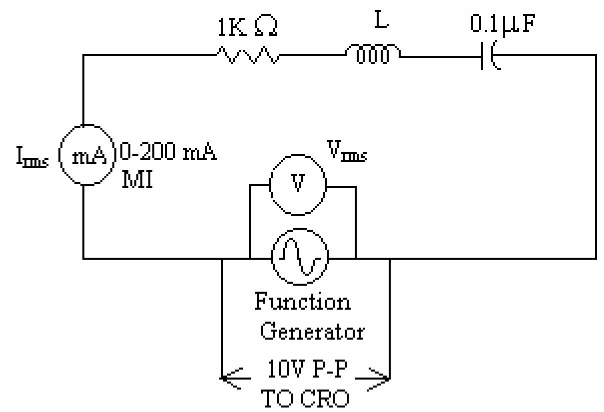
Sl.No.	Description	Range	Qty
1.	Inductor (DIB)	---	1
2.	Capacitor (DCB)	0.1 µ f	1
3.	Resistance (DRB)	1k Ω	1
4.	Ammeter	0-50 mA (MI)	1
5.	Multimeter	---	1
6.	Function generator	---	1
7.	C.R.O	---	1
8.	Connecting wires	---	---

Theory :

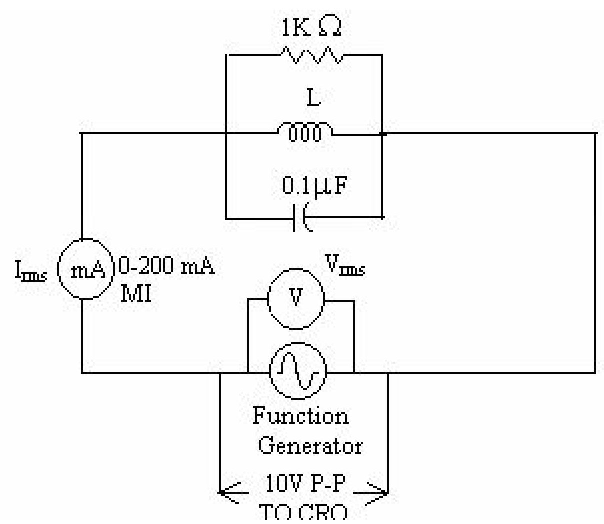
An a.c voltage of rms value V when applied to an R-L-C circuit establishes an rms current I given by

$I = V / Z$ where $Z = \sqrt{R^2 + (X_C - X_L)^2}$ .In this experiment $X_C > X_L$ the effect of $X_C > X_L$ is a leading power factor, since the current I leads V by an angle ϕ, where $\phi = \tan^{-1}\left(\frac{X_C - X_L}{R}\right)$. In an inductor copper loss takes place due to the resistance of its coil and core loss takes place in the magnetic core (in case of iron core inductor). In the capacitor losses takes place in di-electric media used for making it. The losses taking place in the magnetic core of the inductor or di-electric media of the capacitor are usually known. The copper losses are taken into account when the resistance of the coil is connected in series with inductance. The importance of R in the R-L-C series circuit is that, when X_L=X_C due to the variable inductor or variable capacitor or due to varying frequency the current is limited only by R.

Circuit diagram for R-L-C series resonance :



Circuit diagram for R-L-C parallel resonance :



Procedure :

1. The connections are made as shown in the circuit diagram.
2. With the amplitude knob of the Function generator at minimum position, frequency at 100 Hz, the Function generator is switched ON.
3. The frequency is varied in steps as given in the tabular column and for each step by maintaining the output voltage constant at 10V peak to peak the voltmeter and Milliammeter readings are noted for each step.
4. The frequency is brought back to 100 Hz the amplitude knob is brought back to its minimum position and the Function generator is switched OFF.

Tabular Column for series resonance :

Sl.No.	Frequency in Hz	V(peak-peak) in Volts	V(rms) In volts	I in mA	Z in Ohms

Tabular Column for parallel resonance:

Sl.No.	Frequency in Hz	V(peak-peak) in Volts	V(rms) In volts	I in mA	Z in Ohms

Specimen Calculation :

For series resonance:-

We have in an R L C circuit $I = \dfrac{V}{R + j\left(\omega_L - \dfrac{1}{\omega_C}\right)}$; $Z = \dfrac{V}{I}$,

At resonance as, $X_L = X_C$, We have, $Z = R$, Then, $I = \dfrac{V}{R}$

For parallel resonance:-

Current I= VxY

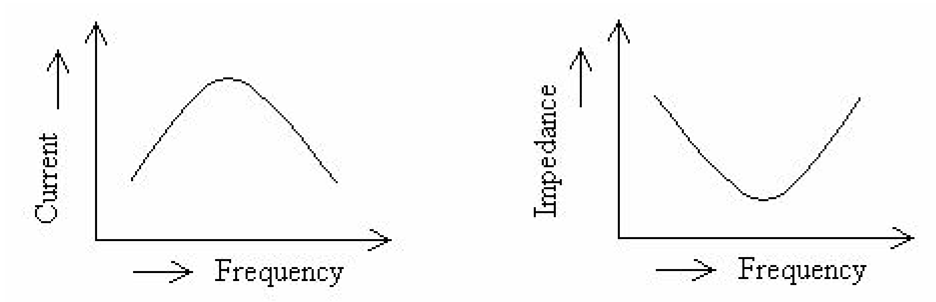
Admitance $Y = G + J(B_L - B_C)$

At resonance $B_L = B_C$

Current I= VxG

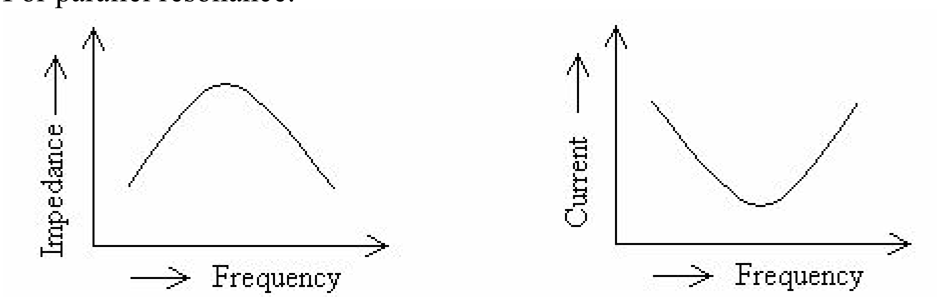
Nature of graph :

For series resonance:



Frequency VS Current   Frequency VS Impedance

For parallel resonance:



Frequency VS Impedance   Frequency VS Current

Viva Questions :

1. Give the dynamic impedance in parallel resonant RLC circuit
2. What is the condition for series resonance?
3. Give the formula for Resonant frequency of RLC series circuit.
4. At resonance RLC series circuit act as a-----
5. Below resonance frequency RLC series circuit act as a----
6. Above resonance frequency RLC series circuit act as a----
7. What is band width?
8. What is the power factor of the circuit at resonance------
9. Why current is maximum at resonance in RLC series circuit?
10. Why impedance is minimum at resonance in RLC series circuit.
11. At resonance voltage drop across inductor is equal to voltage drop across capacitor why?
12. What is current value at lower and upper cut off frequency in RLC series circuit in terms of maximum value?
13. If $X_L > X_c$, RLC series circuit act as a-----
14. If $X_L < X_c$ RLC circuit act as a-----
15. Define Q –factor
16. What is the power factor of a parallel resonant circuit?
17. Series and parallel resonant circuits magnifies------
18. What is the relation between apparent power(S), true power (P) & reactive power (Q).

19. What is the phase angle between line voltage and phase voltage in a balanced star connected system
20. what is the power factor of RLC series circuit at lower cut off and upper cut off frequency
21. What are the units for susceptance
22. Insulation for all electrical equipment is designed for -----value.
23. The form factor for DC supply voltage is always-----
24. In a series resonant circuit the impedance above and below resonant frequency is---&---
25. Give the expression for quality factor in series RLC circuit
26. What is meant by selectivity?
27. Give the relation between bandwidth & quality factor
28. What is meant by magnification?
29. Give the other name for parallel resonant circuit

Precautions :

1) Don't touch bare conductors when supply is ON
2) Wear shoes in laboratory to avoid Electric shocks
3) Switch off the all the measuring devices when NOT in USE.
4) Check for proper polarity of meters.
5) Ensure that there is no short circuit across the supply or any device, before switching on the supply.

Expt.7

TWO PORT NETWORK

Aim:- To find out Z-parameters, Y parameters, A B C D parameters and h parameters

Apparatus :-

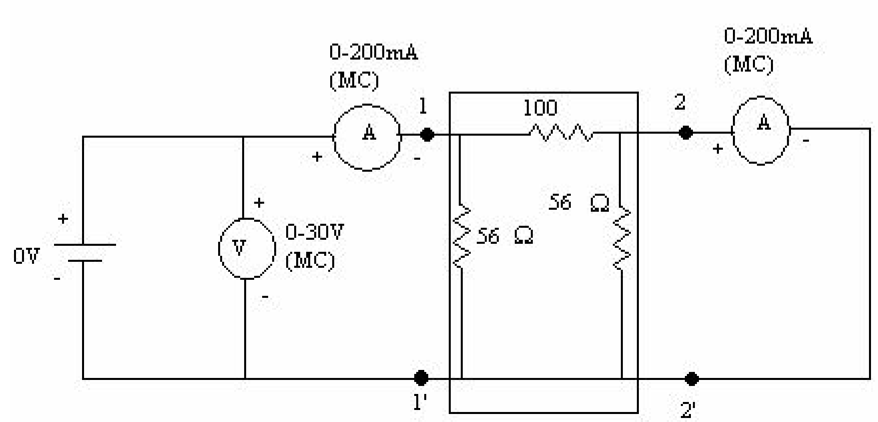
Sl.No	Description	Rating	Qty
1	DC power supply	0-30V, 2A	1
2	Digital DC milli ammeter	0-200 mA	2
3	Digital DC voltmeter	0-20V	2
4	Two port N/W circuit board	-------	1
5	Connecting wires	-------	-

Theory:- A part is normally referred to a pair of terminals of a network through which we can have access to network either for connecting a sources or for measuring, an O/P the network having only two pairs of terminals, through which it is accessible is called a two port network. The port at which the response is calculated in designated as O/P terminals of the another terminal pair at which excitation is calculated is designated as I/P terminals. The voltage of current at I/P terminals i.e port are V_1& I_1. out of the 4 variables V_1, V_2, I_1, I_2 only two are independent of the other two are expressed in terms of these independent variables in terms of network parameters. The various network parameters are Z,Y,A,B,C,D,h.

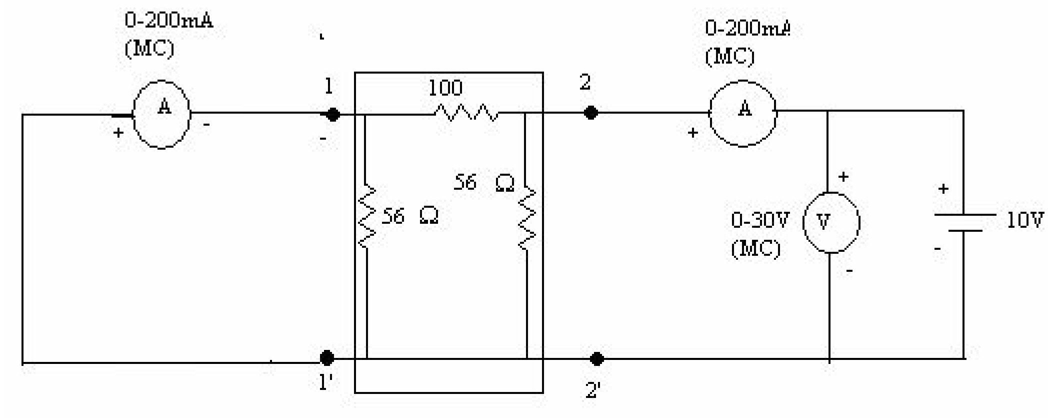
Procedure:-

1. The connections are made as shown in circuit diagram (a)
2. With the voltage knobs of the DC power supply at their minimum position the power supply is switched ON.
3. The voltage knobs are varied such that the output of the power supply will be 10V and all the meter readings are noted.
4. The voltage knob are brought back to their minimum positions and the power supply is switched OFF
5. Step no's 1 to 4 are repeated for circuit diagram (b) and also for circuit diagram (c)

Circuit diagram:



Fig(a) port 2-2’ short circuited



Fib(b) port 1-1’ short circuited

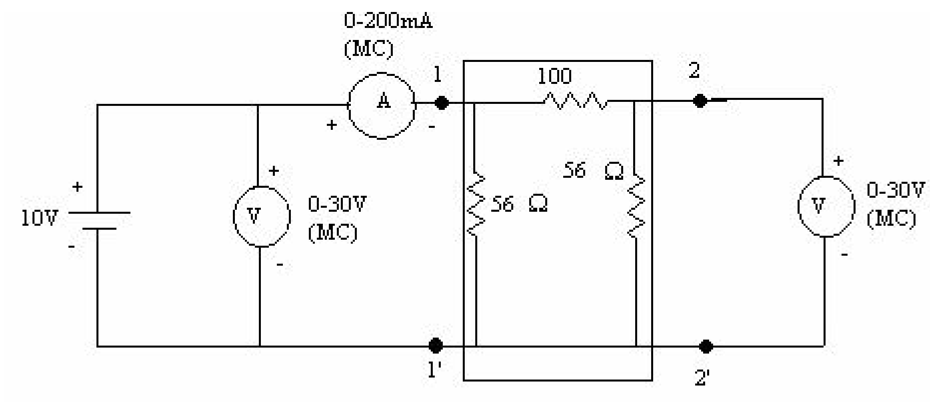
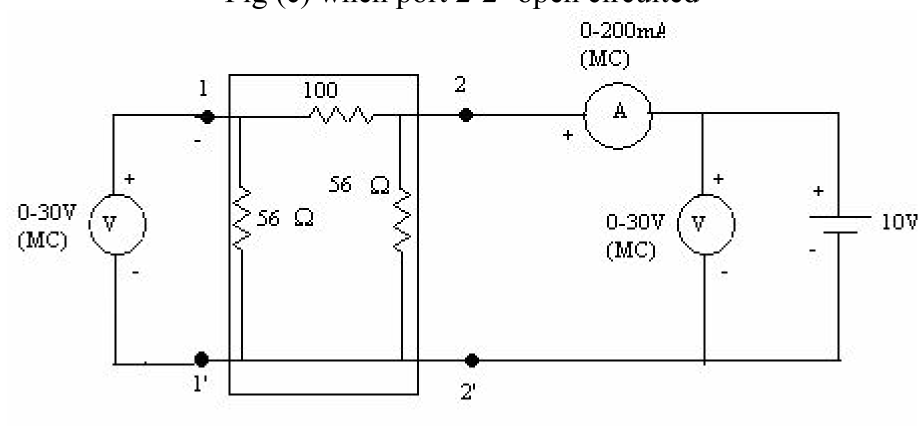


Fig (c) when port 2-2’ open circuited



Fig(d) when port 1-1’ open circuited

Tabular column:-

S.No	Name	V_1 in Volts	I_1 in Amps	V_2 in volts	I_2 in Amps
1	Port 2-2’ shortcircuited				
2	Port 1-1’ shortcircuited				
3	Port 2-2’ opencircuited				
4	Port 1-1’ opencircuited				

Specimen calculations;-

Z-parameters:-

$V_1=Z_{11}I_1+Z_{12}I_2;$

$V_2=Z_{21}I_1+Z_{22}I_2;$

When port 2-2' open circuited:

$Z_{11}=\frac{V_1}{I_1} \mid I_2=0;$ $Z_{21}=\frac{V_2}{I_2} \mid I_2=0$

When port 1-1' open circuited:

$Z_{12}=\frac{V_1}{I_2} \mid I_1=0;$ $Z_{22}=\frac{V_2}{I_2} \mid I_1=0$

Y-parameters:-

$I_1=Y_{11}V_1+Y_{12}V_2$

$I_2=Y_{21}V_1+Y_{22}V_2$

When port 2-2' short circuited:

$Y_{11}=\frac{I_1}{V_2} \mid V_2=0$ $Y_{21}=\frac{I_2}{V_1} \mid V_2=0$

When port 1-1' short circuited:

$Y_{12}=\frac{I_1}{V_2} \mid V_1=0$ $Y_{22}=\frac{I_2}{V_2} \mid V_1=0$

A B C D Parameters:

$V_1=AV_2-BI_2$

$I_1=CV_2-DI_2$

When port 2-2' open circuited

$A=\frac{V_1}{V_2} \mid I_2=0;$ $C=\frac{I_1}{V_2} \mid I_2=0$

When port 2-2' short circuited:

$B=\frac{-V_1}{I_2} \mid V_2=0$ $D=\frac{-I_1}{I_2} \mid V_2=0$

A,D are dimension less quantities

h-Parameters:-

$V_1=h_{11}I_1+h_{12}V_2$

$I_2=h_{21}I_1+h_{22}V_2$

When port 2-2' short circuited:

$h_{11} = \frac{V_1}{I_1} | V_2 = 0$ $h_{21} = \frac{I_2}{I_1} | V_2 = 0$

When port 1-1' open circuited:

$h_{12} = \frac{V_1}{V_2} | I_1 = 0$; $h_{22} = \frac{I_2}{V_2} | I_1 = 0$

Viva questions:-

1. Give an example for lumped element & distributed element
2. Give an example for bilateral element
3. Define electric network
4. Give the classification of Network elements
5. Define active element
6. Define passive element
7. What are unilateral elements?
8. What are bilateral elements
9. Give examples of active elements
10. Give examples of passive elements
11. Give examples of unilateral elements
12. Give examples of bilateral elements
13. What are linear elements?
14. What are non-linear elements
15. What are lumped elements?
16. What are distributed elements?
17. Give examples for LUMPED parameters.
18. Give examples for Distributed parameters.

Precautions:-

1) Don't touch bare conductors when supply is ON
2) Wear shoes in laboratory to avoid Electric shocks
3) Switch off the all the measuring devices when NOT in USE.
4) Check for proper polarity of meters.
5) Ensure that there is no short circuit across the supply or any device, before switching on the supply.

Result:- The Z,Y, A B C D &h parameters are calculated.

Expt.8

TIME RESPONSE OF RL & RC CIRCUITS

Aim:- To find the time constant series R_L & R_C circuits

Apparatus :-

Sl.No	Description	Rating	Qty
1	Resistors	1KΩ 100Ω	1 1
2	Capacitor	0.1µf	1
3	Inductor	10mH	1
4	CRO		1
5	Function generator		1
6	Connecting wires		

Theory:-

In a network containing energy storage elements with change in excitation, the currents & voltages change from one stable to other is called transient state. The storage elements deliver their energy to the resistances, hence the response change with time gets saturated after some time, and is referred to as the transient response.

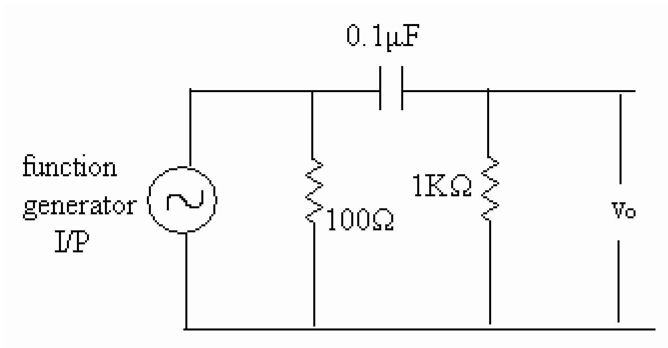
Consider a circuit consisting of resistance and inductance as shown in fig. the inductor in the circuit is initially unchanged, and is in series with a resistor. When the switch is closed we find the complete solution for the current, the solution of the circuit is $i = \frac{V}{R}\left[1 - e^{-RT/2}\right]$.

Consider a circuit consisting of resistance and capacitor as shown in fig. the capacitor in the circuit is initially unchanged, and is in series with a resistor. When the switch is closed we find the complete solution for the current. The solution of the circuit is $i = \frac{V}{R} e^{-t/RC}$

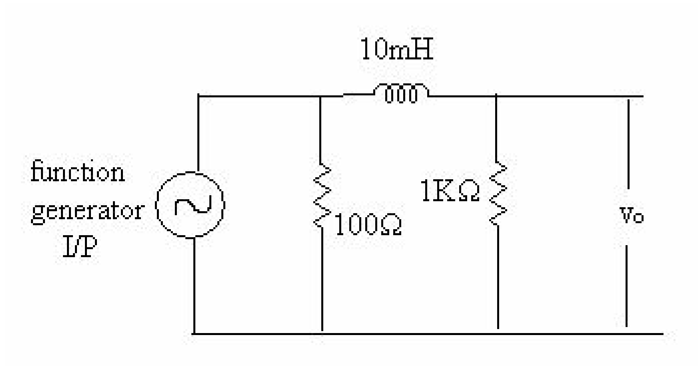
Tabular column:-

R_1 (Ω)	R_2 (Ω)	C in f	L in H	Theoritical time constant	Practical time constant

Circuit diagram:-



Series RC circuit



Series RL circuit

Procedure:-

1. Connect the circuit as shown in fig
2. Apply 1KHZ, 1V peak to peak square wave signal as I/P
3. connect the I/P signal to channel 1 and the O/P to channel 2 of CRO value.

Specimen calculations:-

t=L/R, L= t=RC, C=

Viva Questions:-

1) What is transient?
2) Why transients occur in electric circuits?
3) What is free and forced response?
4) Define time constant of RL circuit?
5) Define time constant of RC circuit?
6) The time duration from the instant of switching till the attainment of steadystate is called-----------?
7) The response of a circuit due to -------- alone is called natural response
8) In circuits excited by DC source at steady state-------- behave as short circuit------ And --------- behave as open circuit?
9) In electrical circuits transient currents are associated with
10) In transient circuit analysis, complementary function gives ------response.

Precautions:-

1) Don’t touch bare conductors when supply is ON
2) Wear shoes in laboratory to avoid Electric shocks
3) Switch off the all the measuring devices when NOT in USE.
4) Check for proper polarity of meters.
5) Ensure that there is no short circuit across the supply or any device, before switching on the supply.

Expt.9

PARAMETERS OF AN IRON CORE INDUCTOR

Aim : To determine the resistance and inductance of an iron-core inductor.

Apparatus :

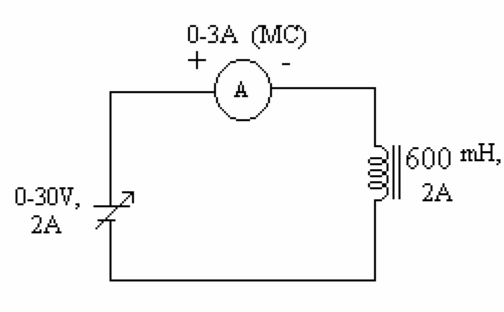
Sl.No.	Description	**Rating**	**Qty.**
1.	Iron core inductor	250 mH, 2A	1
2.	1-ϕ Dimmerstat	230/0-270V, 4A	1
3.	D.C power supply	0-30V, 2A	1
4.	Ammeter	0-3A (MC) 0-3A (MI)	1 1
5.	Voltmeter	0-250V (MI)	1
6.	Wattmeter	1/2A, 300V, 60W, LPF	1
7.	Connecting wires	---	---

Theory:-

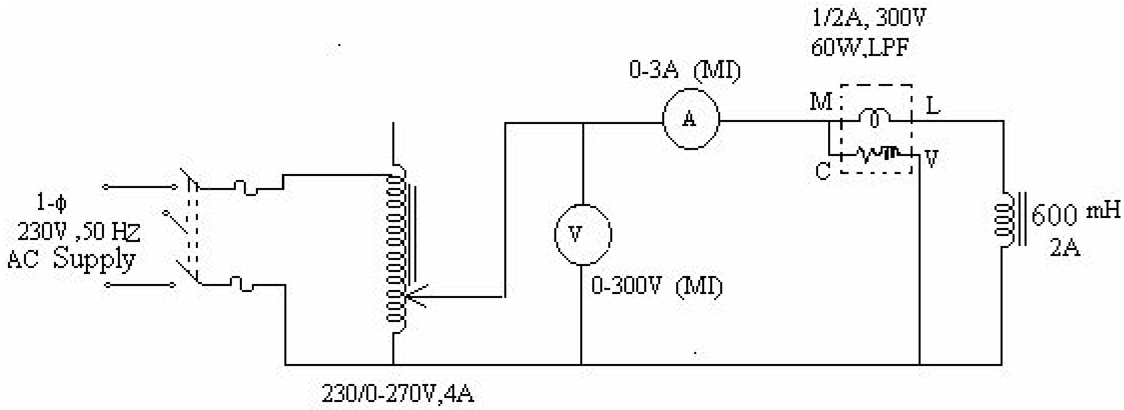
The property of a substance which opposes the flow of current through it is called resistance. The parameters of an iron core are resistance and inductance. In order to find the resistance, choke coil is connected to the DC supply. The choke coil consists of resistance and inductance. Resistance can be calculated and it can be measured in this experiment resistance can only be calculated. The units of resistance is ohms. The impedance can be determined by connecting it to the AC supply inductance also can be calculated. By knowing about resistance and impedance we can determine the value of inductive reactance. From its value we can calculate the value of impedance of given frequency. Resistance, impedance, reactance has same units ohms. Because these all have same characteristics i.e opposition of flow of current it. Reactance cannot be measured. In case of impedance as it is a combination of reactance and resistance it can apply only be calculated, but not be measured.

Circuit diagram :

a) For calculating DC resistance



b) For calculating all the parameters of the Inductor



Procedure :

a) <u>For calculating DC resistance</u>

1. The connections are made as shown in the circuit diagram - a.
2. With the voltage knobs of the D.C.Power supply at minimum positions the power supply is switched ON.
3. The voltage is varied in steps as given in the tabular column and the respective currents are noted.
4. The voltage knobs are brought back to their minimum positions and the power supply is switched OFF.

b) <u>For calculating all the parameters of the Inductor</u>

1. The connections are made as shown in the circuit diagram - b.
2. With the Dimmerstat at zero output the supply switch is closed.
3. The Dimmerstat is varied in steps such that the output voltage is adjusted to the values given in the tabular column and for each step the readings of all the meters are noted.
4. The Dimmerstat is brought back to zero output and the supply switch is opened.

Tabular column (1):

Sl.No.	**V** *in Volts*	**I** *in Amps*	**R** *in Ohms*
1.	2		
2.	4		
3.	6		
4.	8		

Tabular column (2):

Sl.No.	V in Volts	I in Amps	W in Watts	Z in Ohms	R in Ohms	X_L in Ohms	L in Henry	p.f
1	50							
2	100							
3	150							
4	200							
5	230							

Specimen calculation :

$$Z = \frac{V}{I}\ ; \qquad R = \frac{W}{I^2}; \qquad X_L = \sqrt{Z^2 - R^2}\ ; \qquad L = \frac{X_L}{2\pi f}; \qquad \text{Cos}\phi = \frac{R}{Z};$$

Viva Questions :

1. What is meant by true power?
2. What is apparent power?
3. What is power factor?
4. What is the power factor of pure resistive circuit?
5. Power factor of '0' indicates what?
6 In RC circuit power dissipation is due to which component.
7 R.M.S value of sine wave indicates what?
8 Define R.M.S value?
9 Give the relation between R.M.S value and peak value of a sinusoidal waveform
10 Define peak factor?
11 Give the peak factor of the sinusoidal wave form?
12 Define form factor of sinusoidal wave form?
13 Define impedance?
14 Give phase relation in a pure inductor?
15 Give phase relation in a pure capacitor?
16. What is the impedance of pure capacitor?
17. What is the average value of a sine wave over a full cycle?
18. A sine wave voltage is applied across a capacitor, when the frequency of 'v' is

increased?
19. A sine wave voltage is applied across a inductor, when the frequency of ‘v’ is increased?
20. For the same peak value, which wave will have highest RMS value?
21. The form factor of D.C voltage is?
22. The power consumed in a circuit element will be least when the phase difference between V&I is?
23. Give the importance of impedance diagram?
24. What are compound circuits?
25. When the resistance of an RC circuit is greater than X[c], Φ between applied
26. voltage and the total current is closer to?
27. When frequency of applied voltage in a series RC circuit is increases, what happens to X[c]?
28. Give the phasor diagram of series RL circuit?
29. Give the phasor diagram of series RC circuit?
30. What is the phase angle between capacitor current and the applied voltage in a parallel RC circuit

Precautions :

1) Don’t touch bare conductors when supply is ON
2) Wear shoes in laboratory to avoid Electric shocks
3) Switch off the all the measuring devices when NOT in USE.
4) Check for proper polarity of meters.
5) Ensure that there is no short circuit across the supply or any device, before switching on the supply.

Expt.10

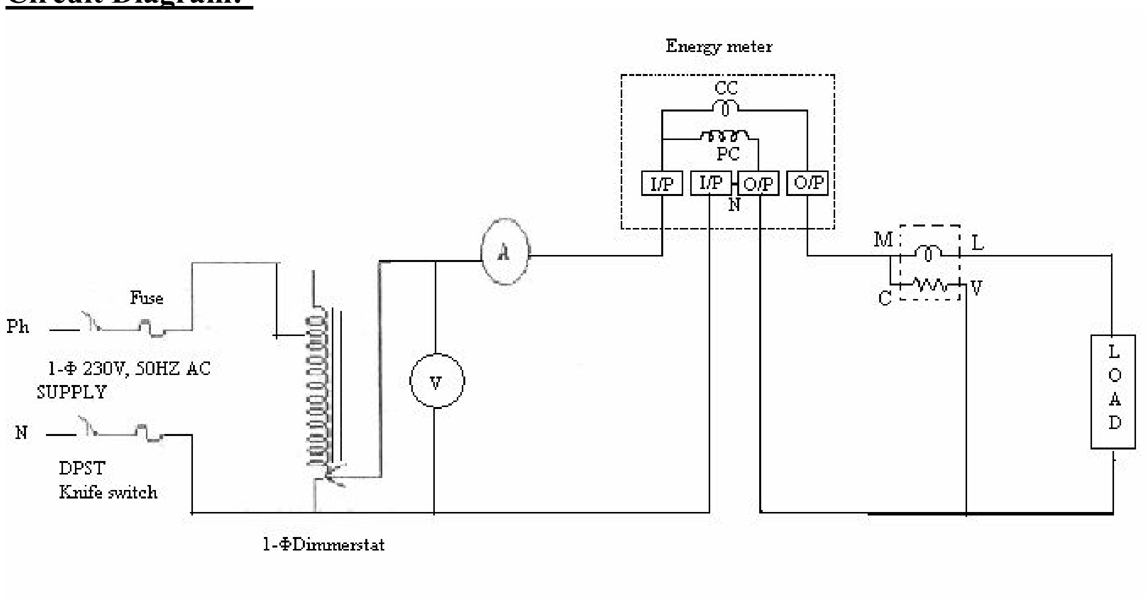
ENERGY METER CALIBRATION

Aim:- To calibrate the given single phase energy meter

Apparatus:-

S.no	Name	Range	Qty
1	Voltmeter	0-250-MI	1
2	Ammeter	O-lOA	1
3	Single phase energy meter	230V,10A, 50HZ	1
4	Wattmeter	300V/10A	1
5	Stopwatch		1

Circuit Diagram:-



Procedure:-
1. Connect the circuit as shown in the circuit diagram.
2. Apply the rated voltage of230 V.
3. Vary the load such that Y4 of it's rated current flows in the ammeter.
4. Notedown the readings of Voltmeter, Ammeter and Wattmeter.
5. Notedown the time required for 5 revolutions in the Energy meter.
6. Vary the load to 'is, 2/3, full load current.
7. For every load noted own the Voltmeter, Ammeter and Wattmeter readings; and notedown time required for 5 revolutions.

Tabular column:-

S.no	Load	Voltage	Current	Power	CosΦ=W/VI	Time in sec for 5 revolutions(t)

Specimen calculations:-

Meter constant = 1200 rev/1Kwh

No.of units consumed for 5 rev.Er= $\frac{1}{1200} x5$ kwh

No.of units consumed actually for 5 rev. E_a= $\frac{w}{1000} x \frac{time(t)}{60x60}$

% error = $\frac{E_r - E}{E_a} x100$

Viva Questions:

1) What is the functioning of shading band in energy meter?
2) In energy meter driving torque is produced due to?
3) What is formula for braking torque in energy meter?
4) What is the condition for steady state speed of energy meter disc?
5) What is ment by creeping?
6) How do you prevent the creeping?
7) What are the units for power?
8) What are the units for energy?

Precautions:

1. Don't touch bare conductors when supply is ON
2. Don't Switch on the supply unless the circuit is approved by any Staffmember. 3. Wear shoes in laboratory to avoid Electric shocks
4. Switch off the all the measuring devices when NOT in USE.
5. Check for proper polarity of meters.
6. Ensure that there is no short circuit across the supply or any device, before switching on the supply.

Expt.11

POWER MEASUREMENT IN A 3-Φ BALANCED A.C CIRCUIT USING TWO WATT METER METHOD

AIM:

To measure the 3-Φ power using two watt meter method in a balanced A.C circuit.

APPARATUS REQUIRED:

S.NO	APPARATUS REQUIRED	RANGE	QUANTITY
1.	Ammeter	(0 – 10) A (M.I)	1
2.	Volt meter	(0 – 600) V (M.I)	1
3.	Watt meter	600V/10A (UPF)	2
4.	3-Φ load	-	-
5.	Connecting wires	-	-

THEORY:

The connections of the two current coils in series with the load in the two phases and the two pressure coils are connected between two phases and third phase respectively. I_f the current coil carrier I_R and I_B and the pressure coil are V_{YR} and V_{YB} .

In terms of instantaneous currents i_R, i_Y, i_B and instantaneous voltages v_R, v_Y, v_B. The instantaneous total power is given by

$$P = V_R I_R + V_Y I_Y + V_B I_B \quad \text{——— (1)}$$

In case of y connected without neutral, we have

$$I_R + I_Y + I_B = 0$$

$$I_Y = -(I_R + I_B) \quad \text{——— (2)}$$

Substitute equation (2) in equation (1)

$$P = V_R I_R + V_Y(-I_R - I_B) + V_B I_B$$

$$= V_R I_R - V_Y I_R - V_Y I_B + V_B I_B$$

$$= I_R(V_R - V_Y) + I_B(V_B - V_Y)$$

$$P = V_{YR} I_R + V_{YB} I_B$$

NOTE: The watt meters read only the average power.

Wattmeter number 1: i.e.

W_1 ___ Current coil carries I_R

___ Pressure coil carries V_{YR}

Wattmeter number 2: i.e.

W_1 ___ Current coil carries I_B

___ Pressure coil carries V_{YB}

Therefore, $P = W_1 + W_2$

$$P = V_{YR}\, I_R \cos\Phi_1 + V_{YB}\, I_B \cos\Phi_2 \quad \text{\_\_\_\_\_\_\_\_} (3)$$

Thus, the total average power for a 3-Φ circuit is obtained by adding two reading of watt meter W_1 and W_2.

In equation (3) $\cos\Phi_1$ and $\cos\Phi_2$ are the phase angles between V_{YR} and I_R and between V_{YB} and I_B.

In terms of instantaneous currents I_R, I_Y, I_B and instantaneous voltages V_R, V_Y, V_B. The instantaneous total power is given by

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Close the supply (TPST) switch.
3. The load is applied in steps and for each step meter readings are noted.
4. Repeat step 3 until the rated current of load is reached.
5. Load is removed in steps and switch is opened.
6. Calculate and verify the total power.

TABULAR COLUMN:

S.NO	V_1(Volts)	W_1(Watts)	W_2(Watts)	W_1+W_2	I_L(Amps)	$\sqrt{3}\, V_L I_L \cos\Phi$

MODEL CALCULATIONS:

Voltage across load (V_L) = V

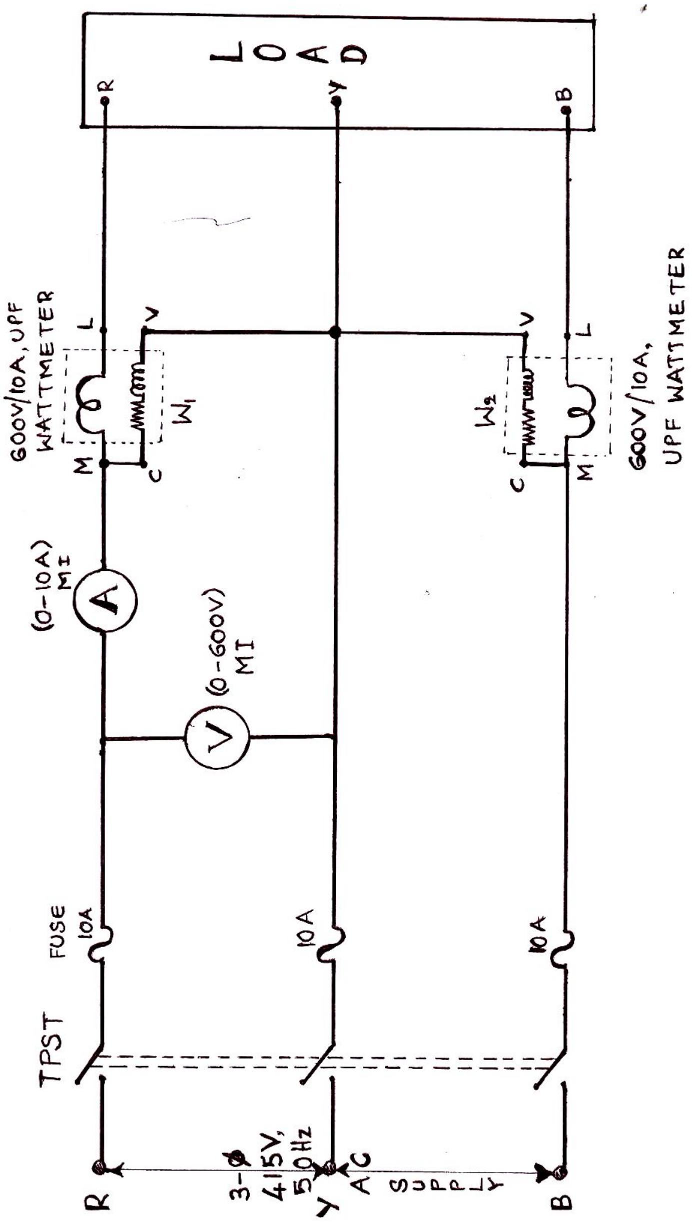
Load current (I_L) = A

Watt meter reading W_1 = Watts

W_2 = Watts

W_1+W_2 = Watts

Total power = $\sqrt{3}\, V_L I_L \cos\Phi$ Watts


LOAD
R
Y
B
600V/10A, UPF WATTMETER
W1
W2
600V/10A, UPF WATTMETER
M
L
C
V
(0-10A) MI
(0-600V) MI
FUSE 10A
10A
10A
TPST
3-φ 415V, 50Hz AC SUPPLY

Viva Voce Questions:-

1) Can wattmeter measures the reactive power?
2) What are the different methods for finding three phase power?
3) What type of load is used in this experiment?
4) Define Active power?
5) Define reactive power?
6) Define apparent power?
7) Define Form factor?
8) Define Peak factor?
9) What is the relation between voltage and current in a pure resistor?
10) What is the relation between voltage and current in a pure Inductor?
11) What is the relation between voltage and current in a pure capacitor?
12) Define frequency?
13) What is electric power?
14) Why we are using (0-600V) voltmeter in this experiment?
15) What type of wattmeter is used in this experiment?

Precautions:

1. Don't touch bare conductors when supply is ON
2. Don't Switch on the supply unless the circuit is approved by any Staffmember. 3. Wear shoes in laboratory to avoid Electric shocks
4. Switch off the all the measuring devices when NOT in USE.
5. Check for proper polarity of meters.
6. Ensure that there is no short circuit across the supply or any device, before switching on the supply

Expt.12

SERIES RLC VECTOR DIAGRAM

Aim:- To draw the vector diagram of a series RLC circuit.

Apparatus:-

S.no	Description	Range	Qty
1	Rheostat	200Ω, 1.7A	1
2	Inductor	600mH, 2A	1
3	Capacitor	100μF, 350V	1
4	1-Φ dimmerstat	230/0-270V, 8A	1
5	Ammeter	0-1A (MI)	1
6	Multimeter	-	1
7	Connecting wires	-	-

Theory:-

An ac voltage of rms value V when applied to an RLC series circuit establishes an rms current I given by

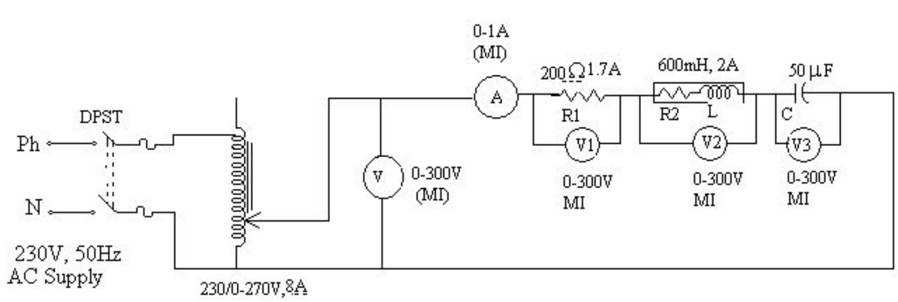
$$I=V/Z \quad \text{Where } Z=\sqrt{R^2+(X_C-X_L)^2}\ .\ \Phi=\tan^{-1}\left(\frac{X_C-X_L}{R}\right)$$

Where Φ is the angle between voltage and current i.e phase angle. When $X_L > X_C$ the circuit behaves as inductive and the current lags the voltage by an angle Φ. When $X_C > X_L$ the circuit behaves as capacitive the current leads the voltage by an angle Φ.

Procedure:-

1. The connections are made as shown in the circuit diagram.
2. With the dimmerstat at zero output the supply switch is closed.
3. The dimmerstat is varied in steps such that the output voltage is adjusted to the values given in the tabular column and for each step the voltage across R, voltage across L and Voltage across C as well as current are noted.
4. The dimmerstat is brought back to zero output and the supply switch is opened.

Circuit diagram:-



Tabular column:-

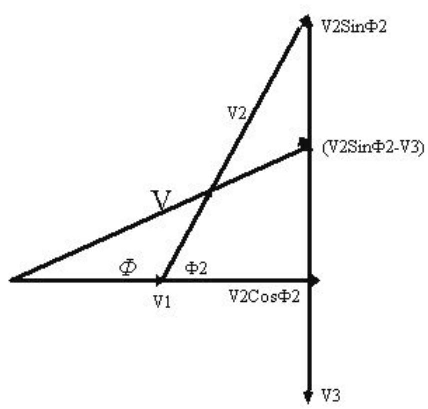
S.No	V in Volts	I in Amps	V_1 in Volts	V_2 in Volts	V_3 in Volts	V_3-V_2 in Volts	Calculated V in Volts	Φ in Degrees	CosΦ

Specimen calculations:-

$V = \sqrt{(V_1 + V_2 Cos\Phi_2)^2 + (V_2 Sin\Phi_2 - V_3)^2}$ `Φ

$\Phi_2 = Tan^{-1}\left(\frac{X_L}{R_2}\right)$ Phase angle $\Phi = Tan^{-1}\left(\frac{X_L - X_C}{R_1 + R_2}\right) = tan^{-1}\left(\frac{V_2 Sin\Phi_2 - V}{(V_1 + V_2 Cos\Phi_2)}\right)$

Vector diagram:-



Viva Questions:-

1. The power consumed in a circuit element will be least when the phase difference between V&I is?
2. When frequency of applied voltage in a series RC circuit is increases, what happens to X[c]?
3. Give the phasor diagram of series RL circuit?
4. Give the phasor diagram of series RC circuit?
5. What is the phase angle between capacitor current and the applied voltage in a parallel RC circuit

Precautions:

1. Don't touch bare conductors when supply is ON
2. Don't Switch on the supply unless the circuit is approved by any Staffmember. 3. Wear shoes in laboratory to avoid Electric shocks

4. Switch off the all the measuring devices when NOT in USE.
5. Check for proper polarity of meters.
6. Ensure that there is no short circuit across the supply or any device, before switching on the supply