

## LIST OF EXPERIMENT

1. Study of various Indicating Instruments
2. Measurement of the high resistance by using loss of charge method
3. Measurement of medium resistance by ammeter voltmeter method
4. To experimentally measure resistance using Wheatstone bridge equipment
5. To measure the value of unknown low resistance using Kelvin's double bridge.
6. Measurement of earth resistance by using earth tester
7. To measure the power in an inductive circuit, Eg: transformer, by 3-voltmeter method.
8. To calibrate the 1 $\Phi$  induction type energy meter and to plot the curves b/w
  - a) % error Vs load current.
  - b) % Correction Vs load current.
9. To measure power drawn by 3-phase inductive load using two watt meters
10. Measurements using Instrument Transformers.

## **EXPERIMENT-1**

**AIM:-** To Study of various Indicating Instruments.

### **THEORY:**

1. Function of Electrical Instruments
2. Indicating Instruments

These are the instruments which indicate the instantaneous value of quantity being measured at the time it is being measured. The indication is in the form of pointer Deflection (analogue instrument) or digital readout (digital instrument). In analogue instruments, a pointer moving over a graduated scale directly gives the value of the electrical quantity being measured. Ammeters, voltmeters and wattmeters are example of such instruments.

For example when an ammeter is connected in the circuit, the pointer of the meter directly indicates the value of current flowing in the circuit at that time.

In most indicating instruments, three distinct forces are essential for the satisfactory indicating of the pointer on a dial. These forces are:

1. A deflecting (or operating) torque
2. A controlling (or restoring) torque
3. A damping torque

### **DEFLECTING TORQUE (TD): -**

It is the torque which deflects the pointer on a calibrated scale according to the electrical quantity passing through the instrument. This deflecting torque causes the moving system, and hence the pointer attached to it, to move from its zero position, i.e. Its position when the instrument is disconnected from the supply. The deflecting torque can be produced by utilizing any of the effects mentioned earlier. Thus the deflecting system of an instrument converts the electric current or potential into a mechanical force called deflecting torque.

## **CONTROLLING TORQUE (TC): -**

It is the torque which controls the movement of the pointer on a particular scale according to the quantity of electricity passing through it. The controlling forces are required to control the deflection or rotation and bring the pointer to zero position when there is no force, or stop the rotation of the disc when there is no power. Without such a torque, the pointer would swing over to the maximum deflected position irrespective of the magnitude of current or voltage being measured.

The functions of the controlling system are;

- (1) To produce a force equal and opposite to the deflecting torque at the final steady position of the pointer definite for a particular magnitude of current. In the absence of a controlling torque, the pointer will shoot (swing) beyond the final steady position for any magnitude of current and thus the deflection will be indefinite.
- (2) To bring the moving system back to zero when the force causing the instrument moving system to deflect is removed. In the absence of a controlling torque the pointer will not come back to zero when current is removed.

In indicating instruments, the controlling torque, also called restoring or balancing torque, is obtained by one of the following two methods:

1. Spring control
2. Gravity control

## **DAMPING TORQUE: -**

It is the torque which avoids the vibration of the pointer on a particular range of scale, such a damping or stabilizing force is necessary to bring the pointer to rest quickly, otherwise, due to inertia of the moving system, the pointer will oscillate about its final deflected position for quite some time before coming to rest in the steady position

When a deflecting torque is applied to the moving system, it deflects and it should come to rest at a position where the deflecting force is balanced by the controlling

torque. The deflecting and controlling forces are produced by systems which have inertia and, therefore the moving system cannot immediately settle at its final position but overshoots or swings ahead of it. Consider fig 1.4 suppose 0 is the equilibrium or final steady position. Because of inertia the moving system moves to position „a“. Now for any position „a“ beyond the equilibrium position the controlling torque is more than the deflecting torque and hence the moving system swings back. Due to inertia it cannot settle at „0“ but swings to a position say „b“ behind the equilibrium position. At „b“, the deflecting torque is more than the controlling force and hence the moving system again swings ahead. The pointer thus oscillate about its final steady (equilibrium) position with decreasing amplitude till its kinetic energy (on account of inertia) is dissipated in friction and therefore, it will settle down at its final steady position. If extra force are not provided to “damp” these oscillations, the moving system will take a considerable time to settle to the final position and hence time consumed in taking readings will be very large. Therefore, damping forces are necessary so that the moving system comes to its equilibrium position rapidly and smoothly without any oscillations.

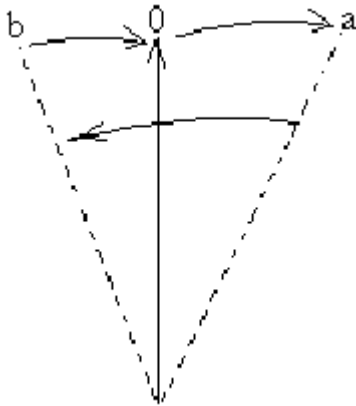


Fig. 1.4 Oscillations of pointer

There are three types of damping:

1. Air – friction damping
2. Fluid – friction damping
3. Eddy – current damping

Ammeters are employed for measuring current in a circuit and connected in series with the circuit. As ammeter is connected in series, the voltage drop across ammeter terminals should be as low as possible. This requires that the resistance of the ammeter should be as low as possible. The current coil of Ammeter has low current carrying capacity whereas the current to be measured may be quite high. For this reason a low resistance is connected in parallel to the current coil.

#### **a) VOLTMETER**

Voltmeters are employed to measure the potential difference across any two points of the circuit these are connected in the parallel to the circuit. The resistance of voltmeter is kept very high by connecting a high resistance in series of the voltmeter with the current coil of the instrument. The actual voltage drop across the current coil of the voltmeter is only a fraction of the total voltage applied across the voltmeter which is to be measured. There are three types of ammeters and voltmeters generally used :

- Moving coil type
- Moving iron type
- Electronic Voltmeter

#### **b) WATTMETER**

The measurement of real power in AC circuits is done by using an instrument using Wattmeter. The real power in AC circuits is given by expression

$$P = VI \cos\phi$$

Where,  $\cos\phi$  is power factor.

A wattmeter is comprises of two coils namely current coil and pressure coil. The current coil is connected in series with the load and the pressure coil is connected

across the load. Wattmeter are available in dual range for voltages as well as for current .g. 5/10A,000/400V.In order to note down the correct reading a multiplying factor is used. These multiplying factors are according to the range of instrument.

**RESULT:**

Various types of Indicating Instruments are studied.

EX, NIIST, BPL

## EXPERIMENT-2

**AIM:-** Measurement of the high resistance by using loss of charge method.

**APPARATUS REQUIRED:**

S.N.	NAME	SPECIFICATION	QTY
1.	Power supply	0-30V (D.C.)	1
2.	Resister	100KΩ	1
3.	Capacitor	10micro farad	1
4.	Voltmeter	0-30V	1
5.	Ammeter	0-200 mA	1
6.	Multimeter	-----	1

**THEORY:-**

In this method the resistance which is measured is connected in parallel with the capacitor C and the electronic voltmeter V. The capacitor is the charged up to some suitable voltage by means of the battery having the voltage V and is then allowed to discharge through the resistance. The terminal voltage is observed over the considerable period of the time during discharge.

The voltage across the capacitor at any instant t after the application of voltage is

$$V = v \exp (-t/CR) \text{ or } V/v = \exp (-t/CR)$$

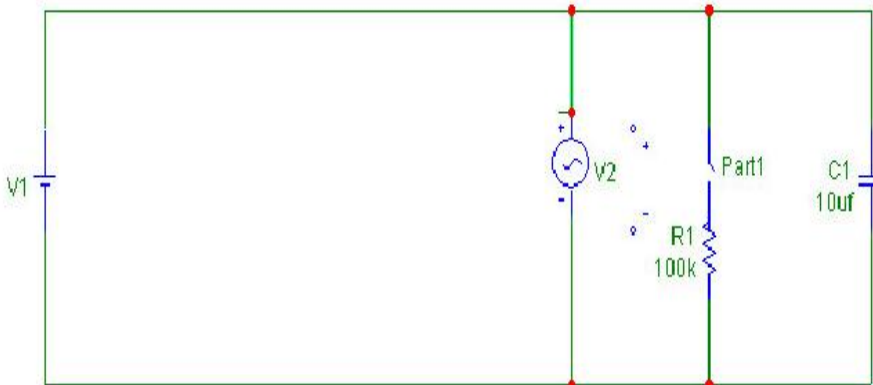
Or Insulation resistance  $R = \frac{t}{C \log_e V/v}$

$$= \frac{0.4343 t}{C \log_{10} V/v} \dots\dots\dots(3.1)$$

From equation (3.1) it follow that if V,v,C and t are known the value of R can be comuted.

If the resistance are very large the time for an appreciable fall in voltage is very large and thus this process may become time consuming.

### Circuit Diagram:-



### PROCEDURE:-

- 1) Connections is make as per the circuit diagram.
- 2) Close the switch s and keep s2 open the capacitor charge by own leakage method.
- 3) New open reading and voltmeter .as its own resistance.
- 4) Note down the reading of the voltmeter Vs equal interval of the time

### OBSERVATION TABLE:-

S. NO.	Time (sec)	V(without R)	V(with R)	Log <sub>10</sub> (V/v) without R	Log <sub>10</sub> (V/v) with R

**RESULT:-** High resistance of the resistance is calculated by using loss of charge method.

### EXPERIMENT-3

**AIM:** - Measurement of medium resistance by ammeter voltmeter method.

**APPARATUS REQUIRED:-**

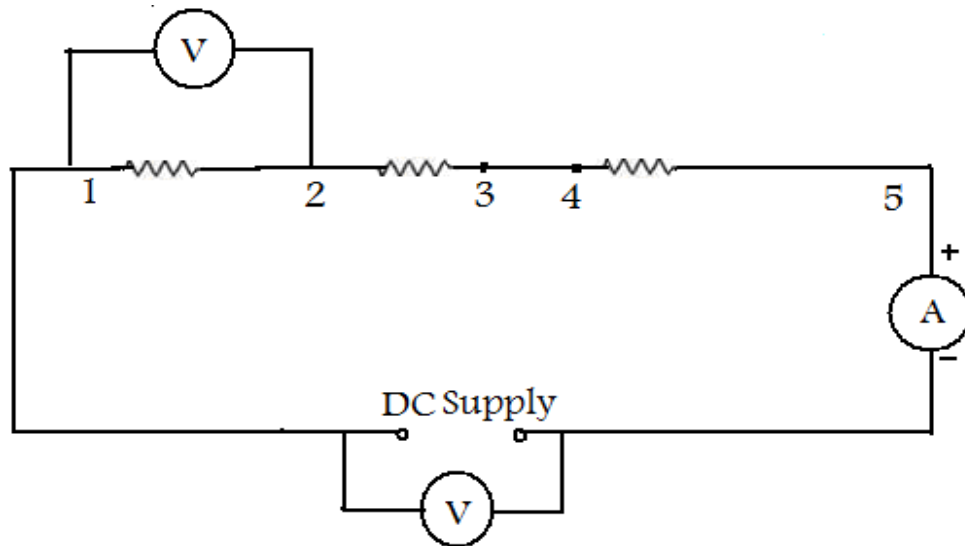
- 1) Digital voltmeter - 0-300V DC - 02 No.
- 2) Digital ammeter - 0-5Amp DC - 01 No.
- 3) Control circuits
- 4) Auto transformer
- 5) Auxiliary resistance
- 6) Fuses
- 7) M.C.B.

**THEORY:-**

This method is very popular since the instruments required for this test are usually available in the laboratory. The voltmeter reads the voltage across the resistance & ammeter reads the current through the resistance. Then the measured value of resistance is given by:

$$RM = \frac{\text{Voltage reading } V}{\text{Ammeter reading } I} = \text{---}$$

## CIRCUIT DIAGRAM:-



## PROCEDURE:-

- 1) Connect the circuit as per circuit diagram.
- 2) Keep the auto transformer at zero position.  
Note: looking system for auto key is available hence the auto key has to be at zero position before switching on the circuit.
- 3) Switch "ON" the MCB.
- 4) Switch "ON" the supply by pressing green switch.
- 5) Now adjust the autotransformer so that the voltmeter connected across the supply reads 220V.
- 6) Measure voltage in terminal 1 & 2.
- 7) Observe current from the ammeter.

**OBSERVATION TABLE:-**

Voltage (V)	Current (A)	Resistance (ohm)

**CALCULATIONS:-**

Voltage reading            V

RM = ----- = ----

Ammeter reading            I

**RESULT:-**

The value of unknown resistance R is shown in observation table.

**PRECAUTIONS:-**

- 1) Ensure that the autotransformer knob is at zero position before switching on the circuit.
- 2) When the circuit is ON, then first bring the first being the autotransformer knob at zero position & then switches OFF the circuit by pressing red switch. Finally switch OFF the MCB.

## EXPERIMENT-4

**AIM:-**To experimentally measure resistance using Wheatstone bridge equipment.

### APPARATUS REQUIRED:

S.No.	Apparatus	Range	Qty.
1	Resistors	1K $\Omega$	2
2	Unknown Resistors		
3	Decade Resistance box	-	1
4	Regulated DC Power Supply	0-30 V	1
5	Galvanometer	-	1
6	Wheat Bridge Equipment	-	1
7	Connecting Wires	-	Set

### THEORY:

#### Wheatstone bridge Theory:

The Wheatstone bridge is the most widely used circuit for precisely measuring resistance by the comparison method. The bridge is named after Charles Wheatstone who invented it in 1843.

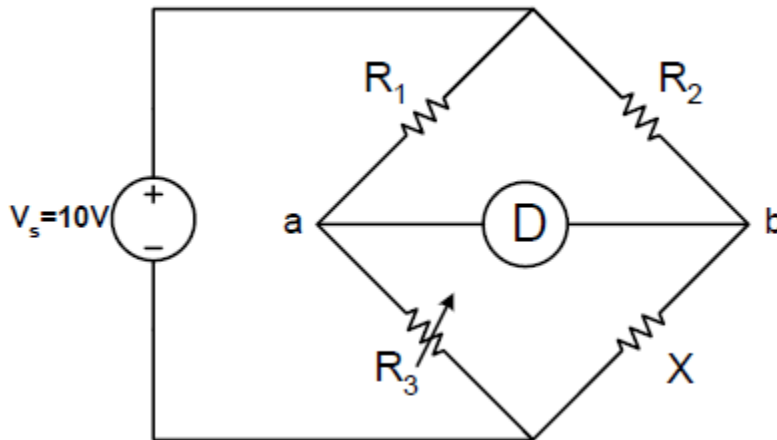
#### Wheatstone bridge Equipment Description:

The Wheatstone bridge is designed to be used for precision resistance measurements in the laboratory. Values of resistance from 0.001 to 9,999,000 ohms can be measured with this instrument. When the instrument is used as a Wheatstone bridge, the Ratio Multiplier switch allows selection of seven multipliers from 0.001 to 1,000. Multiplying the reading obtained from the decade dials by the ratio selected yields the value, in ohms, of the unknown resistance. Ratio resistances are accurate to  $\pm 0.05\%$ . The zero-center, null-point-indicating galvanometer has a sensitivity of 0.5  $\mu\text{A}/\text{div}$ .

## PROCEDURE:

### 1. Simplified Wheatstone Bridge:

A simplified Wheatstone bridge circuit is shown in Figure 1. In the figure,  $R_1$ ,  $R_2$  and  $R_3$  are precision, adjustable resistances and  $X$  is the unknown resistance. You are required to measure the unknown resistance  $X$ .



**Fig.1 Simplified Wheatstone Bridge Circuit**

- i. Connect the power supply and resistances as shown in figure 1.
- ii. Now vary resistances  $R_3$  until the volt-meter deflection is zero.
- iii. Now using the following formula, the unknown resistance  $X$  can be determined:

$$R_1 * X = R_2 * R_3$$

$$X = \frac{R_2 * R_3}{R_1}$$

R1	R2	R3	X

## 2. Measurement of Resistance using Wheatstone Bridge:

- i. To measure the unknown resistance, set the Ratio Multiplier to “1.0” and set all decade dials to “5”.
- ii. Tap the “Low” Galvanometer Sensitivity key and note the direction of the galvanometer deflection.
- iii. When the direction of the galvanometer deflection is determined, change the Ratio Multiplier one step at a time until the galvanometer deflection reverses direction.
- iv. Vary the 1000-ohm decade dial to make the deflection a minimum. Continue to decrease the deflection by varying the 100-ohm decade dial, the 10-ohm decade dial and finally the 1-ohm decade dial.
- v. Depress the “High” Galvanometer Sensitivity key and, if necessary, further adjust the decade dials for zero galvanometer deflection.
- vi. When the bridge is balanced the value of unknown resistance is equal to the product of the Ratio Multiplier and the decade reading.

Resistor ( Nominal Value)	100 $\Omega$	1 K $\Omega$	100 K $\Omega$
Ohm-Meter Reading			
Wheatstone Bridge Reading			

**CONCLUSIONS:**

## EXPERIMENT-05

**AIM:-** To measure the value of unknown low resistance using Kelvin's double bridge.

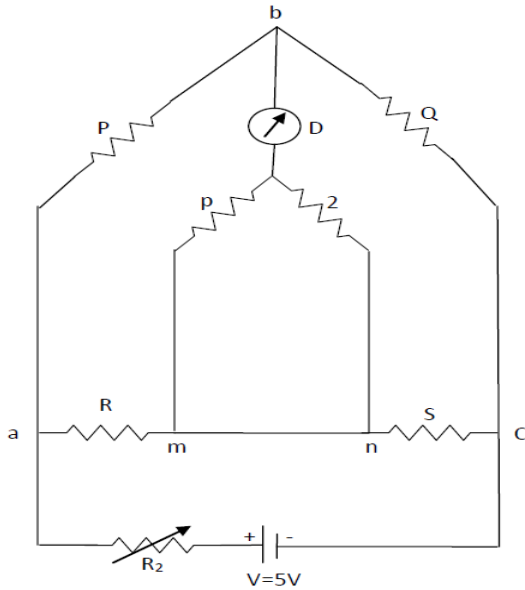
### APPARATUS REQUIRED:

S.No.	Apparatus	Quantity
1	Kelvin's Bridge board	1
2	Null detector	1
3	Supply Voltage	1
4	Unknown Resistance	1
5	Connecting Wires	Set

### THEORY:-

The problem involved in the measurement of low resistance with an ordinary wheat stone bridge is being eliminated using Kelvin's double bridge. This bridge uses two ratio ARMS & a four terminal low resistance standard resistor (S)

The outer ratio Arms consists of P & Q inner ratio Arms p,2 Both the arms are connected to the potential terminals so as to eliminate the effect of leads. Under balanced condition no current flow through the galvanometer and hence the potential drop across the resistor of an outer Arms is equal to sum of drop across the low resistance and inner arm resistance.



### Measurement of resistance using Kelvin's double bridge

#### PROCEDURE:-

- 1) Connect the circuit as per circuit diagram.
- 2) Connect the unknown resistance "R".
- 3) Switch on the power supply.
- 4) By varying the standard resistance "S" obtains the balance condition (Null deflection).
- 5) Calculate the unknown resistance by using the Formula.

$$R = \frac{P}{Q} * S$$

#### PRECAUTIONS:-

- 1) Avoid loose connections.
- 2) Avoid parallax errors.

**OBSERVATION TABLE:-**

S.No.	R1( $\Omega$ )	R2( $\Omega$ )	R3( $\Omega$ )	R <sub>x</sub> (Theory) $\Omega$	R3(Practical)( $\Omega$ )

**RESULT:-**

The unknown resistance is calculated by using Kelvin's double bridge.

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## EXPERIMENT-6

**AIM:-** Measurement of earth resistance by using earth tester.

### APPARATUS REQUIRED:

1. Digital earth resistance tester PE-331.
2. Earthing rods.
3. Auxiliary earth associated with tester.
4. Cables associated with tester.

### THEORY:

As shown in Figure1, A current ( $I$ ) is passed through the earthing plate  $X$  to an auxiliary electrode  $Z$  in the ground at a considerable distance away from it. A second electrode  $Y$  is inserted between the plate  $X$  and the electrode  $Z$ . The potential difference (voltage) between  $X$  and  $Y$  is measured to find the earth resistance at any point. By Ohm's Law:  $R_X = V/I$

The value of  $R_X$  depends on the placing of the auxiliary electrode. A curve showing the  $R_X$  for different distance of  $Y$  from  $X$  as shown in Figure 2 the correct value of  $R_X$  is that in section  $A$  to  $B$  on the curve. By the means of earth resistance tester PE-331 the resistance  $R_X$  can be measured directly.

In this experiment two earthing plates are used:

X1 diameter  $D_1$

X2 diameter  $D_2$

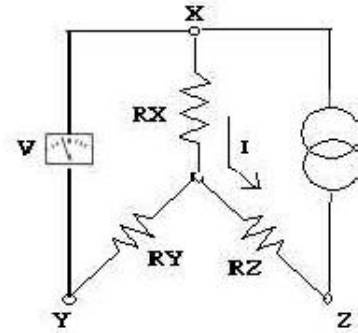
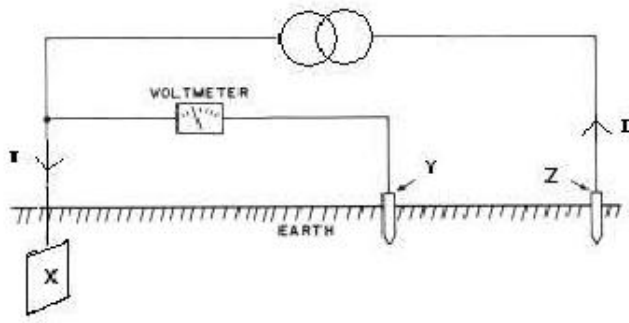


Figure 1. Principle of earth resistance measuring.

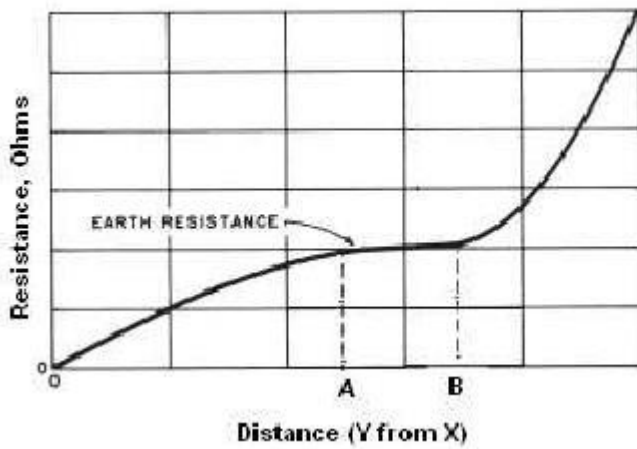


Figure3. Earth resistance measuring curve.

**PROCEDURE:**

1. For each earthing electrodes perform the following:
2. Fit an existing earth electrode into the ground to be measured
3. Connect the earth to be measured X and auxiliary earth Y and Z to the corresponding terminals of the tester.
4. Select range of ohm as appropriate.
5. On the power of the tester.

6. For each distance between Y and X, press the push button control, read the displayed resistance and then turn off the tester.

7. Tabulate the resistance values as shown in table 1

Note: All distance should be taken in straight line direction.

9. Joint the two earthing electrodes and then repeat the procedures.

10. Plot the results of on an graph paper.

**Table 1. Results.**

Earthing plate	Distance X-Y (m)	Measuring results										
		0	0.5	1	1.5	2	3	5	10	15	18	21
X1	RX1 (ohm)											
X2	RX2 (ohm)											
X1//X2	R(X1//X2) (ohm)											
X1 chg. Direction	RX1chg. (ohm)											

**RESULT:**

## EXPERIMENT-7

**AIM:-** To measure the power in an inductive circuit, Eg: transformer, by 3-voltmeter method.

### APPARATUS REQUIRED:

S.No.	Apparatus	Range	Quantity
1	Ammeter	(0-5A) MI	1
2	Voltmeter	(0-150V) MI (0-300V) MI	2 1
3	Transformer	230V/115V, 1KVA	1
4	Auto Transformer	-	-
5	Auto Transformer	-	1
6	Rheostat	100ohm	1

### PRECAUTION:

1. The DPST switch must be kept open initially.
2. The auto transformer must be kept at minimum potential position
3. The rheostat must be kept at maximum resistance position.

### PROCEDURE:

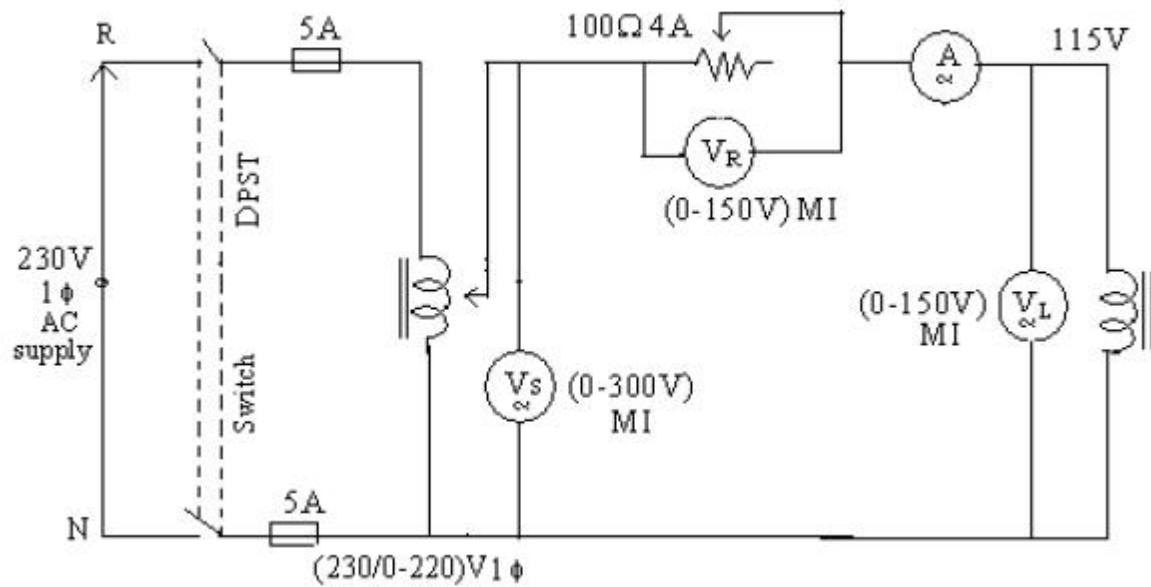
1. Give the connections as per the circuit diagram.
2. Adjust the auto transformer, to bring the rated voltage of the transformer
3. Note down the transformer and voltmeter readings.
4. Vary the rheostat for different values and note down the corresponding meter readings.

### 3 VOLTMETER METHOD OBSERVATION TABLE:.

Record your observation as shown in table

Table observation and calculations for 3-Volters method

S.No.	I	V <sub>S</sub>	V <sub>R</sub>	V <sub>L</sub>	P	CosΦ



### FORMULA USED:

$$1. \quad \text{Power (P)} = \frac{V_S^2 - V_R^2 - V_L^2}{2R} \text{ watts}$$

$$R = V_R / I$$

$$2. \quad \text{Cos } \phi = \frac{V_S^2 - V_R^2 - V_L^2}{2 V_e V_L}$$

**RESULT:**

The power measured for given circuit using 3 voltmeter method is

EX, NIIST, BPL

## EXPERIMENT-8

**AIM:-** To calibrate the  $1\Phi$  induction type energy meter and to plot the curves b/w

a) % error Vs load current.

b) % Correction Vs load current.

### APPARATUS REQUIRED:

One single phase energy meter, one single phase load, Stop watch and connecting wires.

### THEORY:

Energy meter is an instrument which measures electrical energy. It is also known as watt-hour (Wh) meter. It is an integrating device. There are several types of energy meters single phase induction type energy meter are very commonly used to measure electrical energy consumed in domestic and commercial installation. Electrical energy is measured in kilo watt-hours (kWh) by this energy meter.

### Construction: -

A single phase induction type energy meter consists of driving system, moving system, braking system and registering system. Each of the systems is briefly explained below.

### Driving system: -

This system of the energy meter consists of two silicon steel laminated electromagnets. M1 & M2 as shown in fig.1 The electromagnet M1 is called the series magnet and the electromagnet M2 is called the shunt magnet. The series magnet M1 carries a coil consisting of a few turns of thick wire. This coil is called the current coil (CC) and it is connected in series with the circuit. The load current flows through this coil. The shunt magnet M2 carries a coil consisting many turns of thin wire. This coil is called the voltage coil (VC) and is connected across the supply it consist of current proportional to the supply voltage. Short circuited copper bands are provided on the lower part of the central limb of the shunt

magnet. By adjusting the position of these loops the shunt magnet flux can be made to lag behind the supply voltage exactly  $90^\circ$ . These copper bands are called power factor compensator (PFC). A copper shading band is provided on each outer limb of the shunt magnet (fc1 & fc2) these band provides frictional compensation. Moving system: - The moving system consists of a thin aluminum disc mounted on a spindle and is placed in the air gap between the series and the shunt magnets. It cuts the flux of both the magnet forces are produced by the fluxes of each of the magnets with the eddy current induced in the disc by the flux of the other magnets. Both these forces act on the disc. These two forces constitute a deflecting torque.

**Braking system: -**

The braking system consists of a permanent magnet called brake magnet. It is placed near the edge of the disc as the disc rotates in the field of brake magnet eddy current are induced in it. These eddies current react with the flux and exert a torque. This torque acts in direction so that it opposes the motion of disc. The braking torque is proportional to the speed of the disc.

**Registering system: -**

The disc spindle is connected to a counting mechanism this mechanism records a number which is proportional to the number of revolutions of the disc the counter is calibrated to indicate the energy consumed directly in kilo watts-hour (kWh)

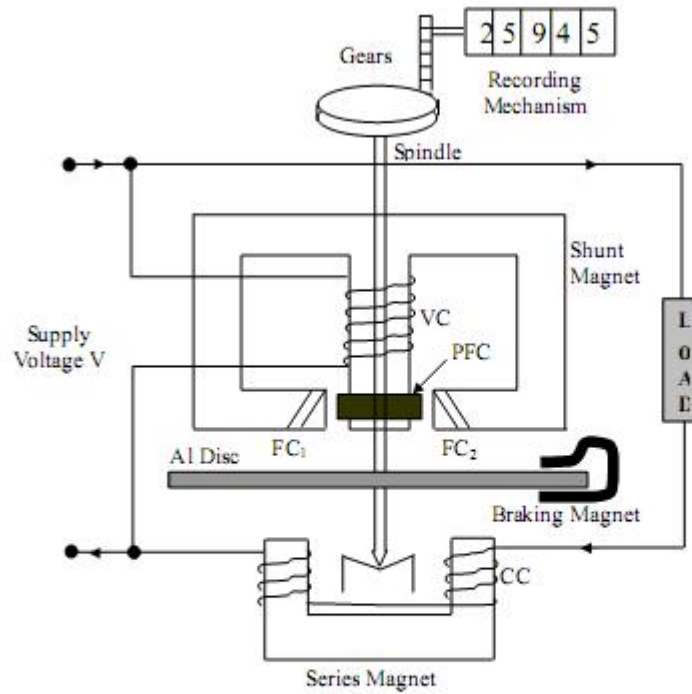


Fig.1

$F_c1$  = Friction Compensators  
 $PFC$  = Power factor compensator  
 $CC$  = Current coil  
 $VC$  = Voltage coil

**Working:-**

**Let  $V$ =Supply voltage**

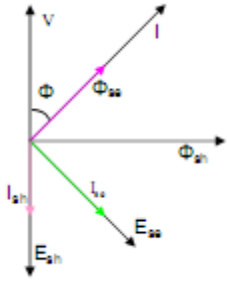
**$I$ =Load current lagging behind  $V$  by  $\Phi$**

**$\cos \Phi$  = Load Power Factor (Lagging)**

**$I_{sh}$ = Current setup by  $\Phi_{sh}$  in disc**

**$I_{se}$ = Current setup by  $\Phi_{se}$  in disc**

**Phase diagram will be as follows**



### Instantaneous deflecting torque

$$T_d \propto VI \cos \Phi$$

$$\propto \text{Power}$$

$$\text{Meter Constant } K = \frac{\text{No. of revolution made}}{\text{kWh}}$$

### PROCEDURE:

1. Connections are made as per circuit diagram.
2. Vary the load resistance to vary the load current and note the time taken for 5 revolutions of the disc of energy meter.
3. The above procedure is repeated for varies load current.
4. Note down the readings of the ammeter, voltmeter and wattmeter for each load current.
5. Calculate the %error for each load current.
- 6 . Draw the graph b/w %error Vs load current Vs load current and %correction Vs load current.

**OBSERVATION TABLE:-**

**Time period of observation (T)=30 min**

V Volts	I Amps	W Watts	Time for 5 revolutions in t sec	Energy consumed (p×t)E1 w/min	Energy indicating by meter E2 (watts)	Error E <sub>2</sub> .E <sub>1</sub>	%error E <sub>2</sub> .E <sub>1</sub> /E <sub>2</sub> × 100

**CALUCULATIONS:**

Meter constant K = .....

Energy consumed E1 = .....

= No. of revolutions/K×1000×60×60

E2 = Wattmeter reading ×time

$$\%Error = \frac{E2-E1}{E2} *100$$

$$Energy\ Calculated = \frac{N}{K} \dots\dots\dots Kwh$$

$$= \dots\dots\dots Kwh$$

$$= \dots\dots\dots Kwh$$

**RESULTS:** - Study has been done on 1 phase energy meter and verification of energy is done as shown in the above observation table

## EXPERIMENT-9

**AIM:-** To measure power drawn by 3-phase inductive load using two watt meters.

### APPARATUS REQUIRED:

S No.	Name	Type	Range	Quantity
1	Voltmeter	MI	0-600 V	1
2	Ammeter	MI	0-10 A	1
3	Wattmeter	Dynamometer	5/10 A, 200/400V	2
4	3 $\Phi$ variac	Variable	400/0-400V, 15A	1
5	3 $\Phi$ inductive load	Inductive	I/P V=415	1

### THEORY:

Power consumed by a 3-phase balanced or unbalanced load (star or delta connected) can be measured by using two wattmeters properly connected in the load circuit. The current coils of the wattmeters are connected in series with the load in any two lines, where the two pressure coils are connected between these lines and the third lines.

The phasor diagram of this circuit, assuming balanced lagging load has been shown in fig2. As such, rms values of current,  $I_R$ ,  $I_Y$ ,  $I_B$ , are taken equal in magnitude and lagging by an angle  $\Phi$  with respect to its own phase voltage. The phase sequence has been assumed as R,Y,B. Based on the phasor diagram, power consumed and the power factor of load can be calculated from the readings of two wattmeter's  $W_1$  and  $W_2$  as explained below.

(1) Power consumed by the load :

- Voltage across the pressure coil of wattmeter,  $W_2 = V_{RB}$
- Phase difference between  $I_R$  and  $V_{RB}$  (ref. phasor diagram) =  $30^\circ - \Phi$





Dividing eqns (6) by eqns (5)

$$\tan\Phi = \sqrt{3} (W_1 - W_2) / (W_1 + W_2)$$

Thus, power factor angle of the load =  $\Phi = \tan^{-1} \sqrt{3} (W_1 - W_2) / (W_1 + W_2)$

And the power factor of the load =  $\cos \Phi = \cos [\tan^{-1} \sqrt{3} (W_1 - W_2) / (W_1 + W_2)]$

Hence the power factor of the load can also be calculated from the observed readings of the two wattmeters.

### **RESULT:**

Following important conclusions can be drawn from the above derivations, reading the balanced inductive load.

1. When the power factor of the load is low (less than 0.5), the reading of wattmeter  $W_2$  will be negative.
2. When the power factor of the load is greater than 0.5, both the wattmeter will show positive reading.
3. When the power factor of the load is unity, the reading of both the wattmeter will be same.

## EXPERIMENT-10

**AIM:-** Measurements using Instrument Transformers

### APPARATUS REQUIRED:

S.N.	NAME	SPECIFICATION	QTY
1.	C.T.	(15/5A ) or any suitable ratio	1
2.	P.T.	(220/110V)	1
3.	Voltmete	0-150 V A.C.,0-300 V	1
4.	r	0-5A A.C.,0-15A A.C.	1
5.	Ammete	0-270V,15 A	1
6.	r Variac Load	Up to 15 A	-

### THEORY:

#### Proposition 1 : Instrument Transformers.

These are the transformers employed in conjunction with relevant instruments (ammeter, voltmeter,

wattmeter, energymeter) and they serve as an important part of the measuring devices.

These transformers are of two types -

Current Transformer (C. T.) or Series Transformer and

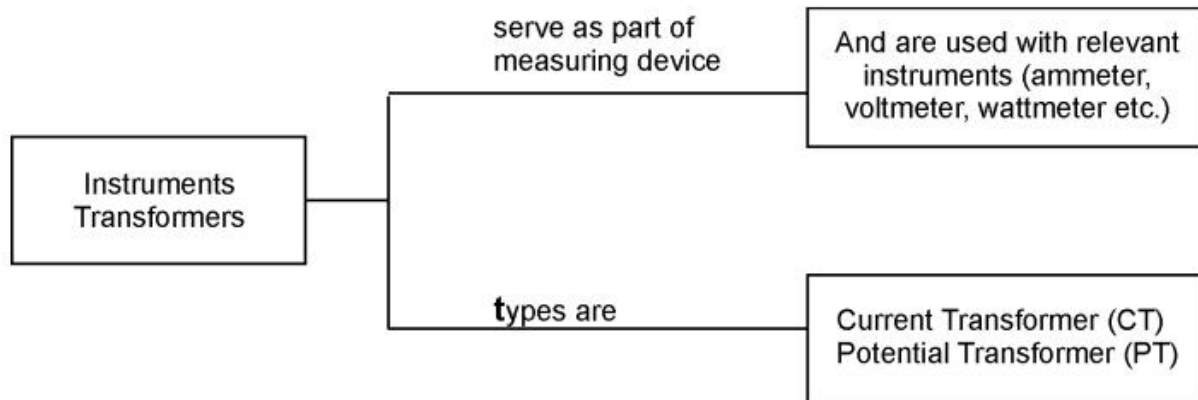
Potential Transformer (P. T.) or Parallel Transformer.

**Concept**

**Structure**

**1**

:



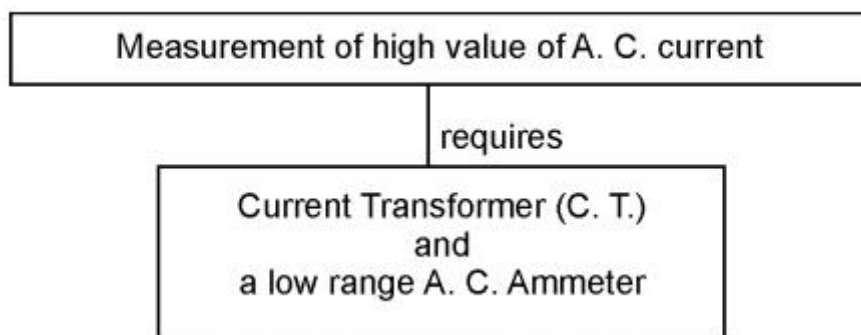
**Proposition 2 :**

Current Transformer is employed along with a low range A. C. ammeter so as to measure high

value of A. C. current where ever and when ever the current of an A. C. circuit exceeds the safe

working current of the measuring instrument (for e.g. ammeter, wattmeter or energymeter).

**Concept Structure 2 :**



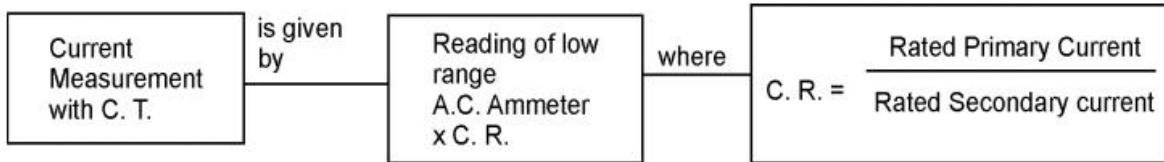
**Proposition 3 :**

The high value of current to be measured is equal to the reading of low range

A.C. Ammeter multiplied by Current Ratio (C. R.) of the C. T. , where

$$\text{Current Ratio} = \frac{\text{Rated Primary Current}}{\text{Rated Secondary Current}}$$

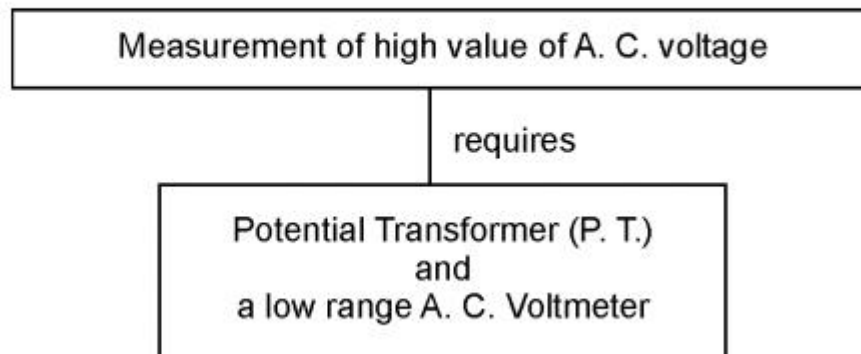
**Concept Structure 3 :**



**Proposition 4 :**

Potential Transformer is employed along with a low range A. C. voltmeter so as to measure high value of A. C. voltage wherever and whenever the voltage of an A. C. circuit exceeds the safe working voltage of the instrument.

**Concept Structure 4 :**

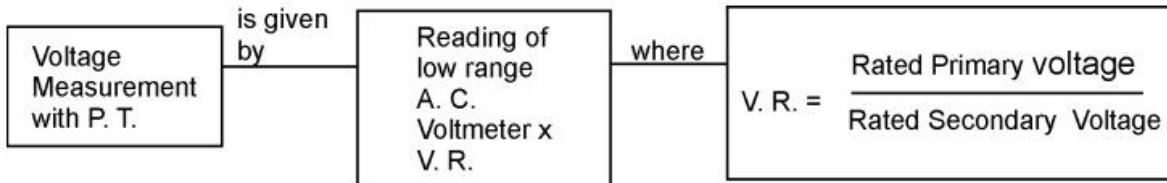


**Proposition 5 :**

High value of voltage to be measured is equal to the reading of low range A. C. Voltmeter multiplied by Voltage Ratio (V. R.) of the P. T. Where

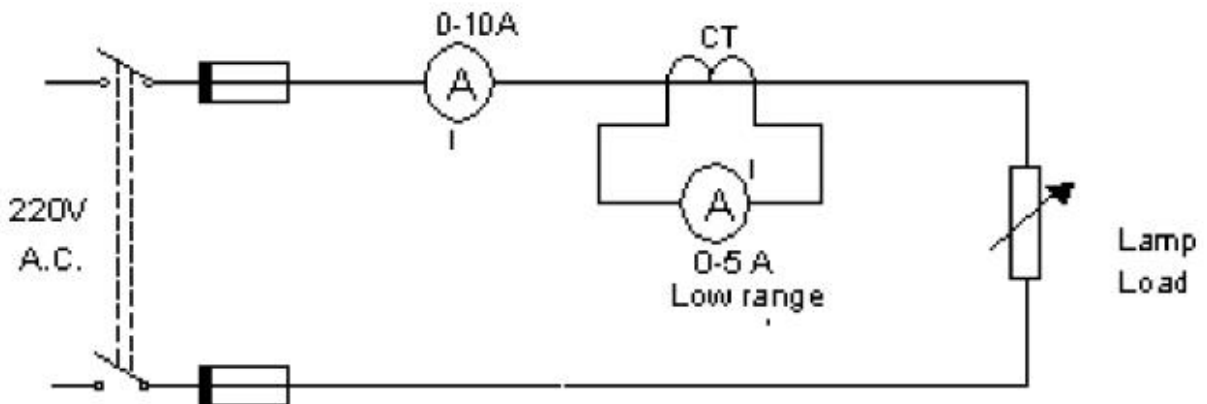
$$\text{Voltage Ratio} = \frac{\text{Rated Primary Voltage}}{\text{Rated Secondary Voltage}}$$

**Concept Structure 5 :**

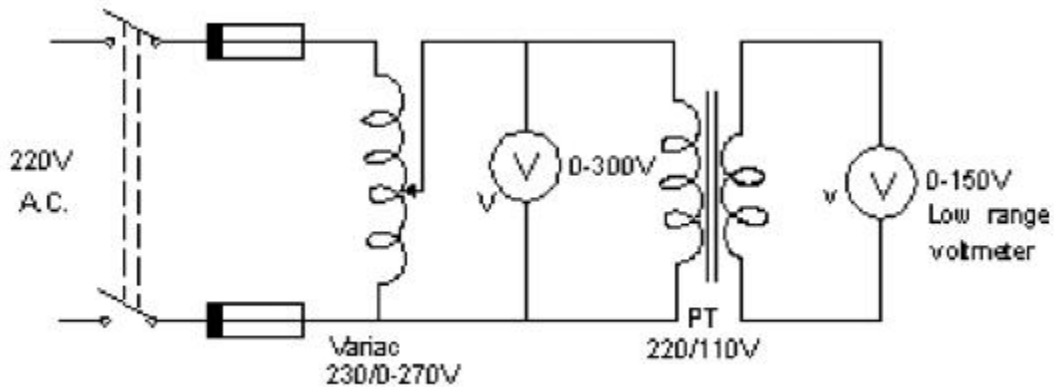


**CIRCUIT DIAGRAM :**

A) To measure high value of A. C. current by a Low range A. C. Ammeter and Current Transformer.



B) To measure high value of A. C. Voltage by a Low range A. C. Voltmeter and Potential Transformer.



## PROCEDURE :

### Part A :

1. Connect the circuit as shown in circuit diagram 1.
2. Switch on the supply
3. Increase current 'I' in steps to 2, 4, 6, 8, 10, 15 Amp and not down 'i'.
4. Find  $I / i$  .
5. Switch off the supply.

### Part B :

1. Connctet the circuit as shown in circuit diagram 2.
2. Keep variac to such position that minimum voltage is applied to the circuit initially.
3. Switch on the supply.
4. Increase voltage 'V' in steps to 50, 100, 150, 200, 220V and note down 'v'.
5. Find  $V / v$ .
6. Switch off the supply.

## OBSERVATIONS :

### Part A :

Current Ratio of C. T. =

Sr. No.	Current 'I' Amp	Current 'i' Amp	I / i	Actual Current = i x C.R. Amp
1				
2				
3				

### Part B :

Voltage Ratio of P. T. =

Sr. No.	Current 'I' Amp	Current 'i' Amp	I / i	Actual Current = i x C.R. Amp
1				
2				
3				

## CALCULATIONS :

Actual Current = i x C. R.

Actual Voltage = v x V. R.

## RESULT :

(Write conclusion by selecting appropriate word from the bracket.)

- Measurement of ..... (Low / High) value of A. C. current is done by ..... (High / Low) range A. C. Ammeter and C. T.
- The ..... (same / different) instrument (A. C. Ammeter) can be used to measure A. C. currents of different ranges by employing ..... (same / different) C. T.s.
- Measurement of ..... (Low / High) value of A. C. voltage is done by ..... (High / Low) range A. C. Voltmeter and P. T.
- The ..... (same / different) instrument (A. C. Voltmeter) can be used to measure A. C. voltages of different ranges by employing ..... (same / different) P. T.s.

EX, NIST, BPL