EXPERIMENT NO : 1

TITLE: Introduction to various Basic Instruments of Electrical Science

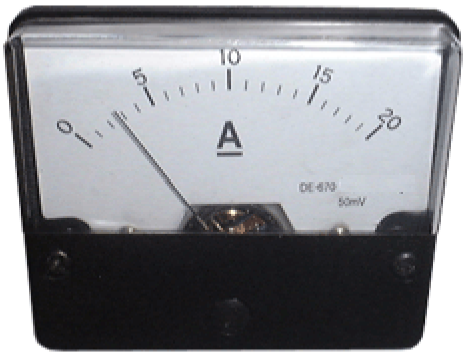
OBJECTIVE: Introduction to various Supply Systems, Ammeter, Voltmeter, Wattmeter, Energy meter, Tachometer, Rheostat, Loading Devices, Transformer.

APPARATUS REQUIRED: Demonstration of various instruments like Ammeter, Voltmeter, Wattmeter, Energy Meter, Tachometer, Rheostat, Various Capacitors, Various Resistors, AC and DC Power Supply.

THEORY OF EXPERIMENT:

AMMETER

Ammeter is employed for measuring of current in a circuit and connected in series in the circuit. As ammeter is connected in series, the voltage drop across ammeter terminals is very low. 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. So for protecting the equipment a low resistance is connected in parallel to the current coil and it is known as shunt resistance



Analog Ammeter

VOLTMETER

Voltmeter is employed to measure the potential difference across any two points of a circuit. It is connected in the parallel across any element in 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.

Analog voltmeter

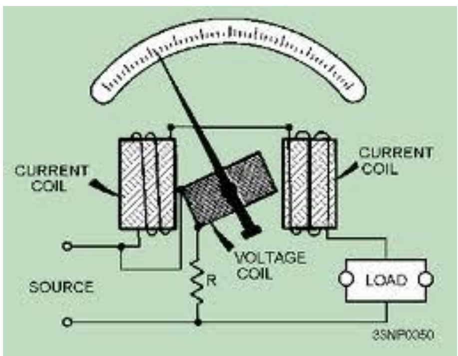
<u>WATTMETER</u>

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

$$VI \cos \Phi$$

where, $\cos \Phi$ is power factor.

A wattmeter has two coils, namely, current coil and pressure coil. The current coil (CC) is connected in series with the load and the pressure coil (PC) is connected across the load. Watt meters are available in dual range for voltages as well as for current



Internal Cicuit of Wattmeter **Wattmeter**

<u>ENERGY METER</u>

Energy meter is an instrument which is used to measure the consumption of electric energy in a circuit (DC or AC). It measures energy in kWh. The essential difference between a energy meter and a wattmeter is that the former is fitted with some type of registration mechanism where by all the instantaneous readings of power are summed over a definite period of time whereas the latter indicates the value at particular instant when it is read.

Energy Meter

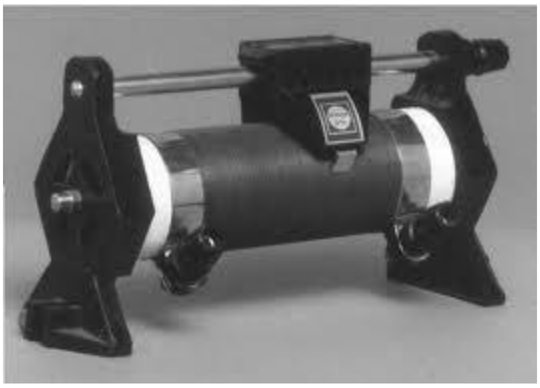
TACHOMETER

Tachometer is an instrument to measure the speed in (revolutions per minute (r.p.m.)).The speed of a rotating shaft is measured by inserting the tapered projected part of the tachometer into the tapered hole in the rotating shaft speed of which is to be measured.

Tachomet

RHEOSTAT

Rheostats are made up of high resistivity material, like, nickel-chromium iron alloy closely wound over a circular tube. These are available both in single tube and double tube. Inter-turn insulation is provided to avoid short circuiting of turns. The tube of rheostat is made of insulating material, like asbestos. These are employed at places where resistance of a circuit is to be varied without breaking the circuit.



Rheostater

LOADING DEVICES

The most commonly used loading devices are (1) lamp Bank (2) loading Rheostat. Lamp Bank load consists of number of lamps connected to form a load. These are suitably connected and controlled by a no. of switches. The switches are provided in a manner so that it should be possible to switch on any required no. of lamps at a time.

A loading rheostat type of load consists of no. of identical resistive elements. These elements are connected in series or parallel. The rheostat is made up of high resistivity material such as like nickel-chromium. The elements of the load can be designed to take 1A, 2A or 4 A of current.

Loading Rheostat

VAROIUS SUPPLY SYSTEM

(a) A.C supply systems: There are two types of supply.

(i) **Single phase-230V**: In this system we have two wires, one is known as phase/line and the other is neutral. Voltage between them is 230 V.

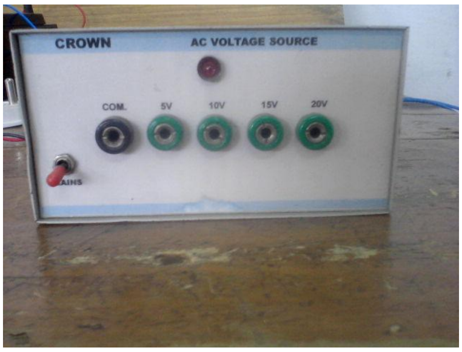
(ii) **Three phase - 400 V (line to line)**: In his system we have three wires, one for each phase or line. In case the fourth wire is there it is neutral. While voltage between two phases/lines is 400 V, between any phase/line and neutral it is 230 V.

(b) DC Supply System

There are two type of D.C supply system

(i)From battery: We use rectifiers for 6V or 12V D.C supply current.

(ii)From generator



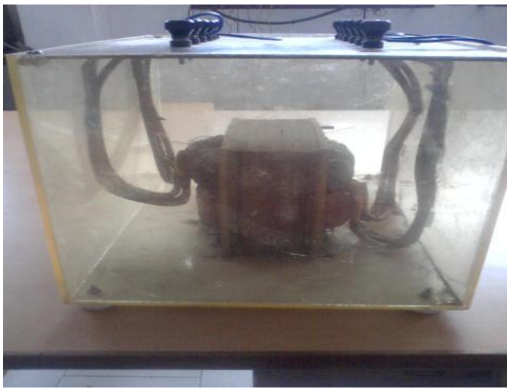
DC Supply **AC Supply**

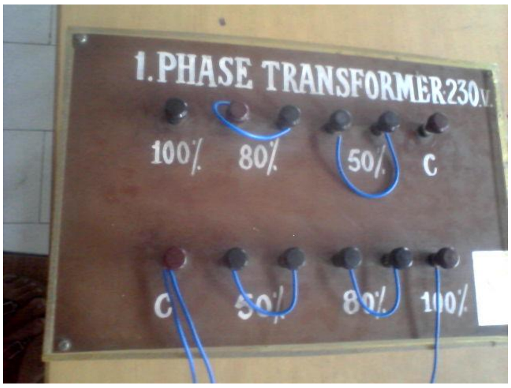
MULTIMETER

Multimeter is a measuring instrument used to measure the current ,voltage and resistance.These can be used to troubleshoot many electrical equipments such as domestic appliances,power supplies etc.

Multimeter

<u>TRANSFORMER</u>: A transformer is a static device which consists of two or more stationary electric circuits interlinked by a common magnetic circuit for the purpose of transferring electrical energy between them. The transfer of electric energy takes place from one circuit to another circuit without change in frequency. Transformer may be for stepping up voltage from low to high or stepping down voltage from high to low.





Single Phase Transformer

Auto Transformer

<u>REFERENCES</u>

Books

1."Electrical Science" by J. B. Gupta

2. "A Text book of Electrical Technology" by B. L. Thereja Vol-11

3."Electrical Engineering Fundamentals" by Del Toro

4."Electric Circuits" by James Nelson (Pearson publication)

5."Basic Electrical Engg." By DC Kulshreshtha, TMHill.

<u>URL's</u>

1. www.brighthub.com

2. www.allaboutcircuits.com

3. www.howstuffworks.com
4. www.nptel.iitm.ac.in

LAB TUTORIALS

1. What are the basic measuring instruments for measuring electrical quantities?

2. What is the working principle of wattmeter and an energy meter?

3. What are the various safety measures to be taken while performing practical work in electrical science lab?

4. Discuss various types of resistors and capacitors?

5 Define the term ideal current and ideal voltage source?

EXPERIMENT NO : 2

TITLE: Calibration of moving iron type ammeter/voltmeter.

OBJECT: To calibrate moving iron type voltmeter and ammeter against permanent magnet moving coil type voltmeter and ammeter.

THEORY:

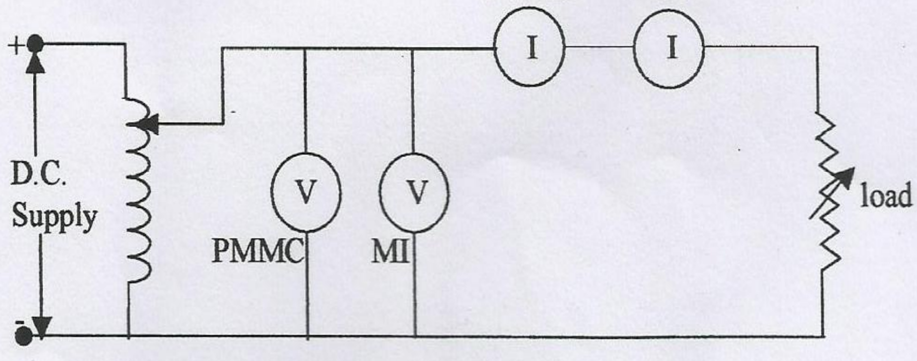
The calibration of all instruments is important since it affords the opportunity to check the instrument against a known standard and subsequently to find errors and accuracy. Calibration procedures involve a comparison of the particular instrument with either (1) a primary standard, (2) a secondary standard with a higher accuracy than the instrument to be calibrated, or (3) an instrument of known accuracy. So all working instruments must be calibrated against some reference instruments, which have a higher accuracy.

Permanent-magnet moving-coil type instrument can be used for direct current measurements only but moving iron instruments can be used for both a.c. and d.c. quantity measurement. Although, the moving iron instrument is responsive to d.c., the hysteresis effect causes an appreciable error in measurement. But the permanent magnet moving coil instrument is the most accurate type for direct current measurement. So it is important to know the error in the reading of moving-iron voltmeter and ammeter compared to a standard permanent magnet moving coil type voltmeter and ammeter when the d.c. voltage or current is measured in any circuit.

INSTRUMENTS/EQUIPMENTS REQUIRED:

Sl. No.	Name of Apparatus	Quantity	Type	Range	Maker's Name
1	Voltmeter				
2	Ammeter				
3	Voltmeter				
4	Ammeter				
5	Variac				

CIRCUIT DIAGRAM:



PROCEDURE:

Step1: Make the circuit as shown in the circuit diagram.
Step2: Switch on the supply.
Step3: Observe the voltmeters and ammeters readings.
Step4: Calculate the errors caused by the moving-iron voltmeter and ammeter with reference to permanent magnet moving coil voltmeter and ammeter.
Step5: Vary the load and take at least five readings.

OBSERVATION TABLE:

No. of Obvs.	Standard voltmeter (PMMC) reading (V_S)	Calibrated voltmeter (MI) reading (V_C)	Standard ammeter (PMMC) reading (I_S)	Calibrated Ammeter (MI) reading (I_C)	% Error in voltmeter	% Error in ammeter

CALCULATION:

DISCUSSION:
Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 3

TITLE: Calibration of Dynamometer type Wattmeter.

OBJECT: To measure the D.C. power consumed by a load with a wattmeter and also with the voltmeter-ammeter and to compare the wattmeter reading with VI where V is the voltmeter reading and I is the ammeter reading.

THEORY:

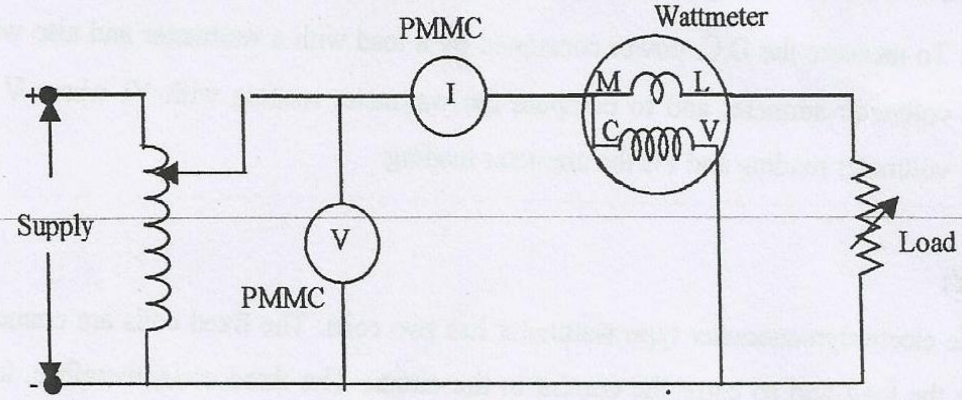
The electrodynamometer type wattmeter has two coils. The fixed coils are connected in series with the load and so carry the current in the circuit. The fixed coils, therefore, form the "current coil" or simply C.C. of the wattmeter. The moving coil is connected across the load and, therefore, carries a current proportional to the voltage. The moving coil is known as "pressure coil" or "voltage coil" of the wattmeter. The deflection of the wattmeter depends upon the current in the two coils.

The power taken by a load from a D.C. supply may be measured either by wattmeter or by an ammeter and voltmeter. If the circuit contains an ammeter and voltmeter the product of those readings gives the power in the circuit. If V is the voltmeter reading and I is the ammeter reading then the power consumed by the load **P= VI**. Similarly if a wattmeter is connected to the same load for power measurement then suppose that the wattmeter reading is **W**. Comparing this wattmeter reading W with the P(VI) error can be calculated.

INSTRUMENTS/EQUIPMENTS REQUIRED:

Sl. No.	Name of Apparatus	Quantity	Type	Range	Maker's Name
1	Voltmeter				
2	Ammeter				
3	Wattmeter				
4	Rheostat				
5	Variac				

CIRCUIT DIAGRAM:



PROCEDURE:

Step1: Make the connection as shown in the circuit diagram

Step2: Give the power to the circuit.

Step3: Set up the voltage by variac.

Step4: Note down the voltmeter, ammeter and wattmeter reading.

Step5: Vary the load and observe the meter readings. Determine the error caused by the wattmeter reading. Take at least five readings.

OBSERVATION TABLE:

No. of Obvs.	Wattmeter Reading(W) (Watt.)	Voltmeter Reading(V) (Volt.)	Ammeter Reading(A) (Amp.)	P=VI	%Error $= \frac{VI - W}{VI} \times 100\%$

CALCULATION:

DISCUSSION:

Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 4

TITLE: CALIBRATION OF 1 – PHASE ENERGY METER

OBJECTIVE: To calibrate an Energy meter by phantom loading method.
APPARATUS:

Name of the apparatus	Type	Quantity	Range
1-ph Energy meter			
Digital Wattmeter			
Digital Voltmeter			
Digital Ammeter			
1-ph Auto-transformer			
Stop watch			

THEORY :

The calibration of energy meter becomes inaccurate during its rigorous use due to various reasons. It is necessary to calibrate the meter to determine the error, so that same meter can be used for correct measurement of energy.

Phantom loading is performed in this experiment because the current rating of the meter under test is high. The driving system of the meter consists of current coil connected in series with load and shunt coil connected in parallel to the supply. The moving system consists of a non-magnetic material and light material i.e aluminum disc. This disc is positioned in the air gap between series and shunt magnets. A permanent magnet is positioned near the edge of the aluminum disc, which forms the braking system. At steady speed of the disc, the driving torque is equal to the braking torque.

For 1200 rev. the meter reads 1 KWh
So, for x revolutions the meter reads x/1200 KWh

$$\% \text{ error in speed} = \frac{\text{Actual r.p.m} - \text{True r.p.m}}{\text{Actual r.p.m}} \times 100$$

% error in measurement =

$$\frac{\text{Measured Energy in kwh} - \text{Actual energy in kwh} \times 100}{\text{Measured Energy in kwh}}$$

No .of revolutions in given time $N_{th} = \frac{T \times P}{3000}$ (in watts)

$$\% \text{ error} = \frac{N_{th} - N_a}{N_{th}} \times 100$$

So, for x revolutions the meter reads x/1200 KWh

$$\% \text{ error in speed} = \frac{\text{Actual r.p.m} - \text{True r.p.m}}{\text{Actual r.p.m}} \times 100$$

% error in measurement =

$$\frac{\text{Measured Energy in kwh} - \text{Actual energy in kwh} \times 100}{\text{Measured Energy in kwh}}$$

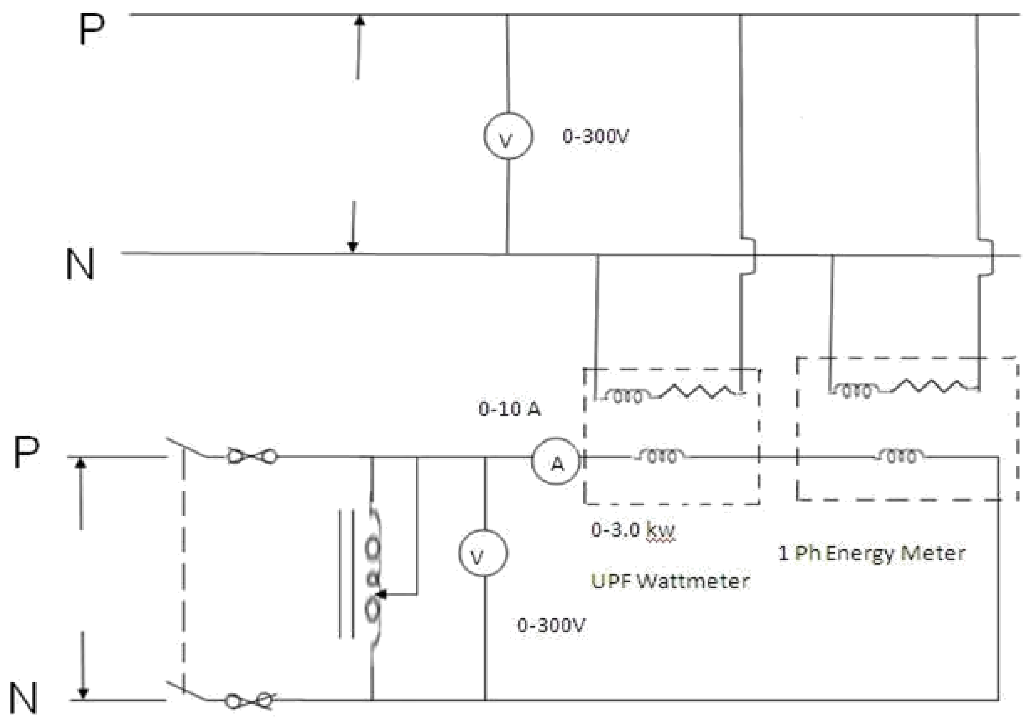
No .of revolutions in given time $N_{th} = \frac{T \times P}{3000}$ (in watts)

$$\% \text{ error} = \frac{N_{th} - N_a}{N_{th}} \times 100$$

PROCEDURE :

1. Connect the circuit as shown in figure
2. Keep the auto transformer at zero position.
3. Increase the current in the current coil of the energy meter till the current reaches its maximum value of 5A.
4. Ensure the direction of the rotation of the disc in the energy meter as per the direction marked.
5. Record the time and wattmeter reading for every 10 revolution at different values of current.

CIRCUIT DIAGRAM:



Observation:

S.No	V (volts)	I (amps)	P (KW)	Time for 10 Rev. 1 sec	No. of Rev. in Time	% error

Result :

The given energy meter is calibrated using calibrated wattmeter, voltmeter and ammeter.

DISCUSSTION: Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 5

TITLE: KELVIN'S DOUBLE BRIDGE

OBJECTIVE: To determine the value of the resistance f the given wire using Kelvin's Double Bridge

APPARATUS:

S.NO	Equipment	Range	Type	Quantity
1	Kelvin's Double Bridge			
2	DC Power supply			
3	Rheostat Standard resistance			
4	boxes			
5	Galvanometer			
6	Connecting Wires			

THEORY:

The KDB is a modification of the wheat stone Bridge (WB) and provides increased accuracy in the measurement of low resistance's. The resistance's of the lead and contact resistance of which is a major source of error in the WB is overcome in this method.

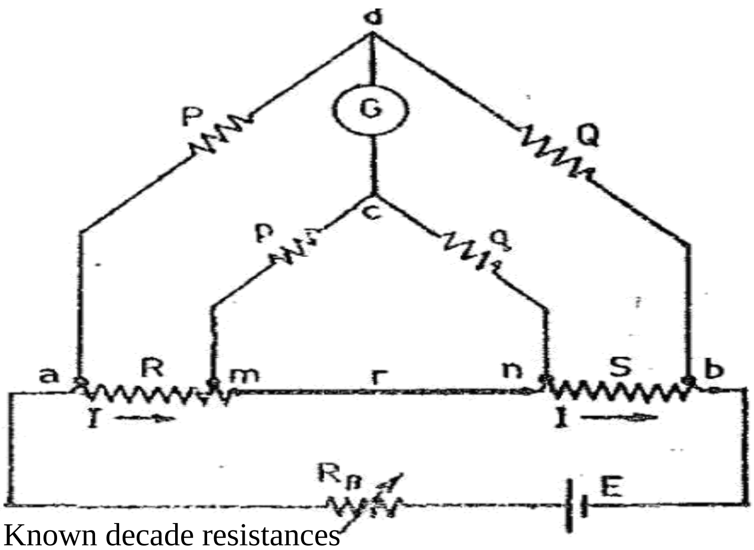
The KDB incorporates the idea of a second set of ratio arms – hence the name Double Bridge – and the use of four – terminal resistor for the law resistance arms. As shown in the figure the first of ratio arms is P & Q. The second set of ratio arms, P and V, is used to connect the galvanometer to point D at the appropriate potential between points M and N to eliminate the effect of connecting lead of resistance R between the known resistance R and the Standard resistance S.

The ratio P/Q is made equal to p/q. under balance conditions there is no current through the galvanometer, which means that the voltage drop between a and b, Eab is equal to the voltage drop E and I between a and c

The last equation indicates that the resistance of connecting lead, r has no effect on the measurement. Provided that the two sets of ratio arms equal ratios. The last but one equation above, shows that the error that is introduced in case the ratios are not exactly equal it indicates that it is desirable to keep as possible in order to minimize the errors in case there is a difference between ratios. P/Q and p/q.

The effect of thermo electric emfs can be eliminated by making another measurement with the battery connections revered. The true value of R being the mean of the two readings.

CIRCUIT DIAGRAM:



P, p, Q, q – Known decade resistances

R – Unknown resistance whose value is to be determined.

S – Standard resistance.
Rb – Regulating resistance.
G – Galvanometer.
K – Key switch.

PROCEDURE:

1. The connections as per the circuit diagram.
2. Keep Q = q = 1000 ohms and S = 1 ohm. The ratio P/Q should
    a. always be kept equal to p/q. as Q =q, we must keep P = p.
    b. To start with P and p may be kept at zero position.
3. Switch on the DC power supply and adjust the voltage to about 2
    a. volts with the regulating resistance cut in fully.
4. Adjust P and p simultaneously to get balance. If a light spot
5. Galvanometer is used, then increases the sensitivity in steps and
    a. get exact balance in the direct portion. Bring back the sensitivity
    b. Knob of the galvanometer to the starting position.
6. Note the value of P.
7. Repeat steps (3) and (4) reversing the DC power supply polarity.
8. Repeat steps (3) to (5) above fo
9. Q = q = 100 ohms, 10 ohms, 1 ohms choosing suitable values for S
    a. So that the value of p at balance is obtained in hundreds.
10. The unknown resistance is calculated in each case using the Formula R = P/Q.S

OBSERVATION:

S.No	Main dial	Slide wire	Multiplier

PRECAUTIONS:

1. In the case of a light spot galvanometer, the sensitivity knob of the galvanometer should be in the shorted position when the bridge isunbalanced. It should be brought back to shorted position from thedirect position, immediately after obtaining balance.
2. The DC power regulating resistance (R b) should be cut in fully toStart with and adjusted later if necessary to get larger deflection.

RESULT:

DISCUSSION: Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 6

TITLE: Measurement of Power using Instrument Transformer.

OBJECT: To measure the power using current transformer (C.T.) and potential transformer (P.T.).

THEORY:

Transformers used in conjunction with measuring instruments for measurement purposes are called "Instrument Transformers". The transformer used for measurement of current is called "current transformer" or simply "C.T." and the transformer used for measurement of voltage is called "Potential Transformer" or simply "P.T.".

The extension of instrument range, so that current, voltage, power can be measured with instruments or meters of moderate size is of very great importance in commercial metering. In power systems, currents and voltages handled are very large and, therefore, direct measurements are not possible as these currents and voltages are far too large for any meter of reasonable size and cost. So these currents and voltages are stepped down with the help of instrument transformers so that they could be measured with the ammeters and voltmeters of moderate sizes.

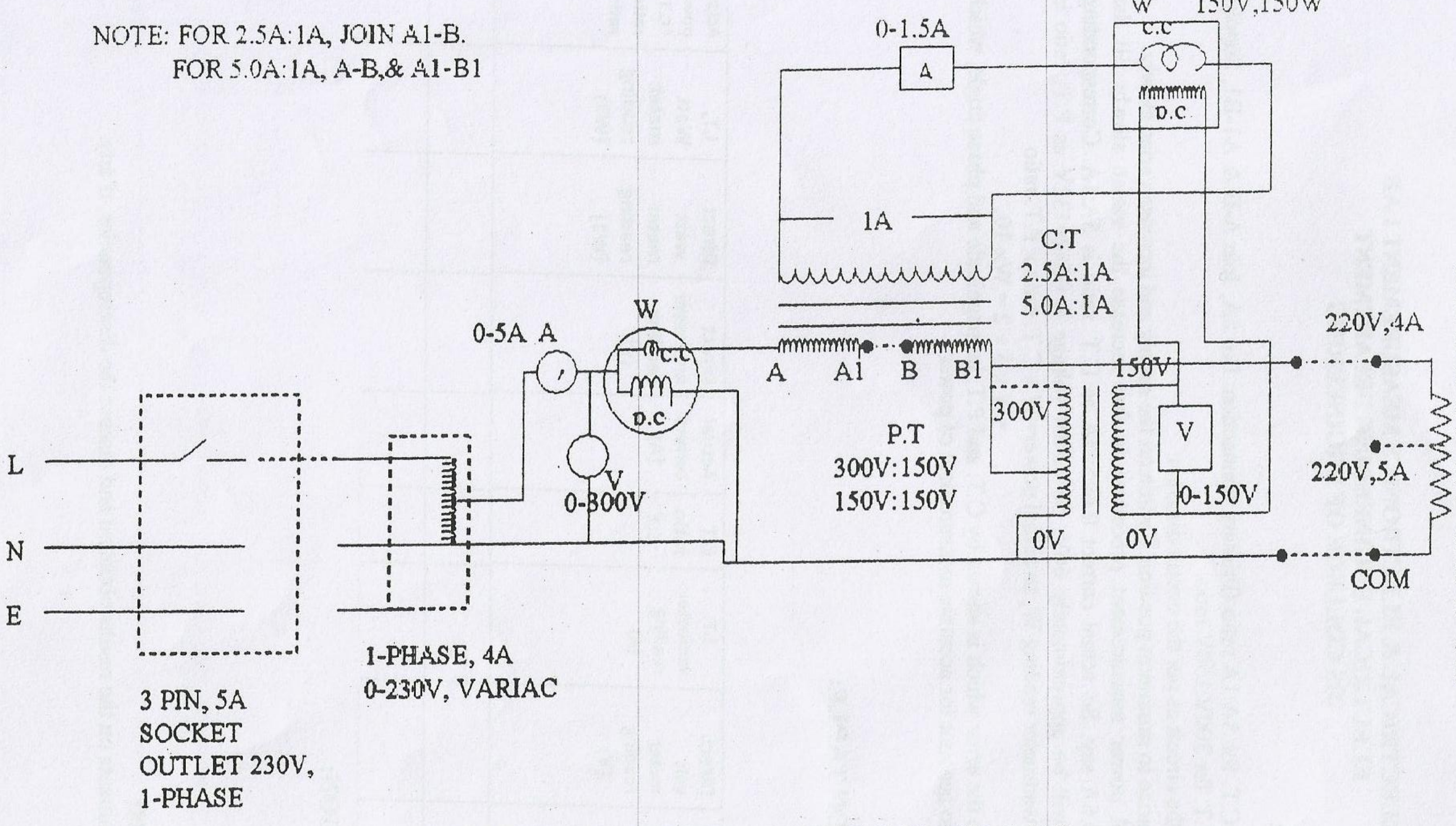
So a very general method of increasing the range of a.c. instruments is to use instrument transformers in conjunction with them. C.T. and P.T. are used for increasing the current and voltage range of respective a.c. measuring instruments. The primary winding of C.T. is so connected that the current being measured passes through it and the secondary winding is connected to an ammeter. The C.T. steps down the current to the level of ammeter. The primary winding of P.T. is connected to the voltage being measured and secondary winding to a voltmeter. The P.T. steps down the voltage to the level of voltmeter.

C.T. and P.T. are most commonly used with wattmeters just as they are used with ammeters and voltmeters. By using C.T. for the supply of the wattmeter current coil and a P.T. for its pressure coil, the same wattmeter may be used to cover a very wide range of power measurements.

INSTRUMENTS/EQUIPMENTS REQUIRED:

Sl. No.	Name of Instruments/Equipments Apparatus	Quantity	Type	Range	Maker's Name
1	Current transformer				
2	Potential transformer				
3	Ammeter				
4	Voltmeter				
5	Wattmeter				
6	Variac				
7	Resistive load				

NOTE: FOR 2.5A:1A, JOIN A1-B.
FOR 5.0A:1A, A-B,& A1-B1



MEASUREMENT OF POWER USING C.T & P.T

PROCEDURE:

Step 1: Connect C.T. for 5A:1A ratio (Primary connection: For 5A, Join A-B & A1-B1, Supply at A & B1) and P.T. for 300V:150V ratio.

Step 2: Connect the circuit as per the circuit diagram.

Step 3: Put the variac to minimum position. Switch on the supply and increase variac slowly.

A typical power measurement procedure is that increase the variac slowly till the ammeter reads 0.6A say. So actual current 0.6x5=3A as C.T. ratio is 5A:1A. Corresponding voltage reading will be approximately 66V. So actual voltage is 66x2=132V as P.T. ratio is 2V:1V. Suppose wattmeter reading W, so actual power=W x C.T. ratio x P.T. ratio

=W x 5 x 2 = Wx 10.

Step 4: Calculate the error which is shown by C.T. and P.T. in magnitude and phase angle, which must be taken into account for accurate measurement of power.

OBSERVATION TABLE:

No. of obs.	I.T. Volt meter reading (V)	P.T ratio 2:1	Actual voltage (V)	Direct volt meter reading (V)	I.T. Ammeter reading (A)	C.T ratio 5:1	Actual current (A)	Direct ammeter reading (V)	Direct watt meter reading (W1)	I,T, Watt meter reading (W2)	Actual power=W2 *C.T ratio*P.T ratio	% Error

CALCULATION:

DISCUSSION:

Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 7

Title: Measurement of 3 – Phase Power by 2 Wattmeters

OBJECTIVE: Measurement of power by 2-wattmeters for balanced loads in a 3-phase circuit

.**APPARATUS:**

Sl. No.	Name of the apparatus	Type	Quantity	Range
1	3 pole Fuse Switch			
2	U.P.F. Wattmeters			
3	Ammeter			
4	Voltmeter			

THEORY :

In a 3-phase, 3-wire system, power can be measured using two watttmeters for balance and unbalanced loads and also for star, delta type loads.

This can be verified by measuring the power consumed in each phase. In this circuit, the pressure coils are connected between two phase such that one of the line is coinciding for both the meters.

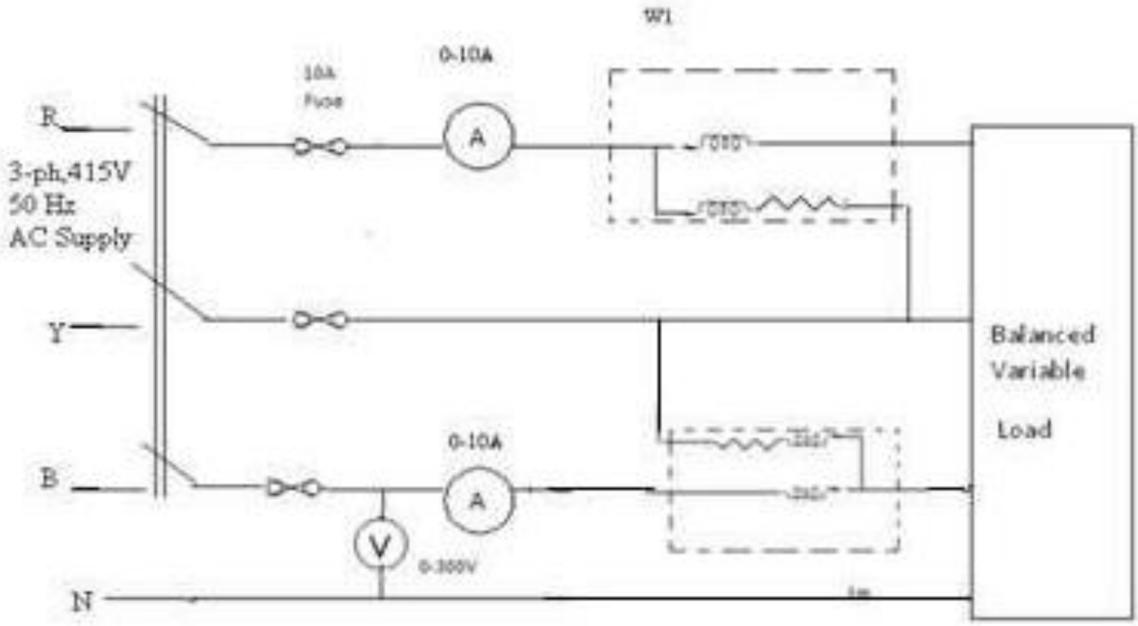
$P_1 + P_2 = 3 V_{Ph} I_{Ph} COSØ$

Power factor $CosØ = Cos (tan^{-1} \sqrt{3} ((P_1 – P_2)/(P_1 + P_2)))$

PROCEDURE:

a) Connect the circuit as shown in the circuit diagram.
b) Keep all the toggle switches in ON condition.
c) Switch on equal loads on each phase i.e. balanced load must be maintained with different load combinations.
d) Connect the ammeter in R-Phase and then switch OFF the toggle switch connected across the ammeter symbol.
e) Connect the pressure coils of two wattmeter across R-Y phase and B-Y phase respectively, current coil in R-phase and B-phase .
f) For different balanced loads take readings of wattmeters W1 and W2.

CIRCUIT DIAGRAM:



OBSERVATIONS:

Type of Load (W)	W_1 KW	W_2 KW	I_1 Amps	I_2 Amps	V_{ph} Volts	W_1+ W_2 KW	P KW

R	Y	B	W_1	W_2	I_R	I_B	V_{ph}	(W_1+ W_2) X2	P KW

RESULT:

Measurement of power by 2-wattmeters for balanced loads in a 3-phase circuit is determined.

DISCUSSION: Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 8

TITLE: Wien's Bridge

OBJECTIVE: To determine the unknown frequency of a circuit.

THEORY:

Wien Bridge has a series RC combination in one and a parallelcombination in the adjoining arm. Wien's bridge shown in fig 2.1.

its basic form is designed to measure f r e qu ency. It can also be used for the instrument of an unknown capacitor with great accuracy, The impedance of one arm is

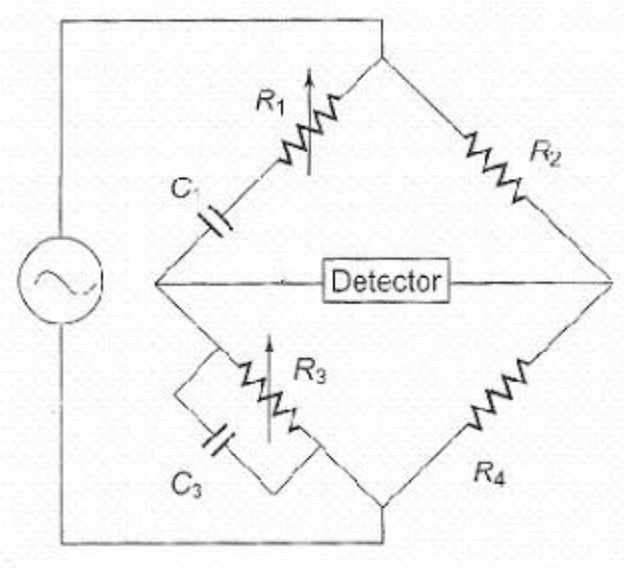


fig 2.1 Wein's Bridge

$$Z_1 = R_1 - j/\omega C_1$$

The admittance of the parallelarm is

$$Y_3 = 1/R_3 + j\,\omega\,C_3$$

Using the bridge balance equation,we have

We have

$$Z_1\,Z_4 = Z_2\,Z_3$$

Therefore

$$Z_1\,Z_4 = Z_2/Y_3,\ \text{i.e. } Z_2 = Z_1\,Z_4\,Y_3$$

$$R_2 = R_4\left(R_1 - \frac{j}{\omega C_1}\right)\left(\frac{1}{R_3} + j\omega C_3\right)$$

$$R_2 = \frac{R_1 R_4}{R_3} - \frac{j R_4}{\omega C_1 R_3} + j\,\omega\,C_3\,R_1\,R_4 + \frac{C_3 R_4}{C_1}$$

$$R_2 = \left(\frac{R_1 R_4}{R_3} + \frac{C_3 R_4}{C_1}\right) - j\left(\frac{R_4}{\omega C_1 R_3} - \omega\,C_3\,R_1\,R_4\right)$$

Equating the real and imaginary terms we have as,

$$R_2 = \frac{R_1 R_4}{R_3} + \frac{C_3 R_4}{C_1} \quad \text{and} \quad \frac{R_4}{\omega C_1 R_3} - \omega\,C_3\,R_1\,R_4 = 0$$

Therefore,

$$\frac{R_2}{R_4} = \frac{R_1}{R_3} + \frac{C_3}{C_1}$$

.... (1.1)

And,

$$\frac{1}{\omega C_1 R_3} = \omega C_3 R_1 \qquad ....(1.2)$$

$$\omega^2 = \frac{1}{C_1 R_1 R_3 C_3}$$

$$\omega = \frac{1}{\sqrt{C_1 R_1 C_3 R_3}}$$

$$\omega = 2\pi f$$

$$f = \frac{1}{2\pi\sqrt{C_1 R_1 C_3 R_3}} \qquad ....(1.3)$$

The two conditions for bridge balance, (1.1) and (1.3), result in an expression determining the required resistance ratio R2/R4 and another express determining the frequency of the applied voltage. If we satisfy Eq. (1.1) an also excite the bridge with the frequency of Eq. (1.3), the bridge will be balanced. In most Wien bridge circuits, the components are chosen such that R 1 = R3 = R and C1 = C3 = C. Equation (1.1) therefore reduces to R2IR4 =2 at Eq. (1.3) to f= 1/2ΠRC, which is the general equation for the frequency of fl bridge circuit.

The bridge is used for measuring frequency in the audio range. Resistances R1 and R3 can be ganged together to have identical values. Capacitors C1 and C3 are normally of fixed values The audio range is normally divided into 20 - 200 - 2 k - 20 kHz range In this case, the resistances can be used for range changing and capacitors, and C3 for fine frequency control within the range. The bridge can also be use for measuring capacitance. In that case, the frequency of operation must be known.

The bridge is also used in a harmonic distortion analyzer, as a Notch filter, an in audio frequency and radio frequency oscillators as a frequency determine element.

An accuracy of 0.5% - 1% can be readily obtained using this bridge. Because it is frequency sensitive, it is difficult to balance unless the waveform of the applied voltage is purely sinusoidal.

OBSERVATION:

Sl. No.	**I in AMPS**	**V in volts**	**Wattmeter Reading**	**Power factor**	**% Error**

PRECAUTIONS:

1. Instruments used should be of proper range.
2. All the connections should be tight.

RESULT:

DISCUSSTION: Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 9

TITLE: ANDERSON'S BRIDGE

OBJECTIVE: To determine the unknown value of inductance using Anderson's bridge.

APPARATUS:

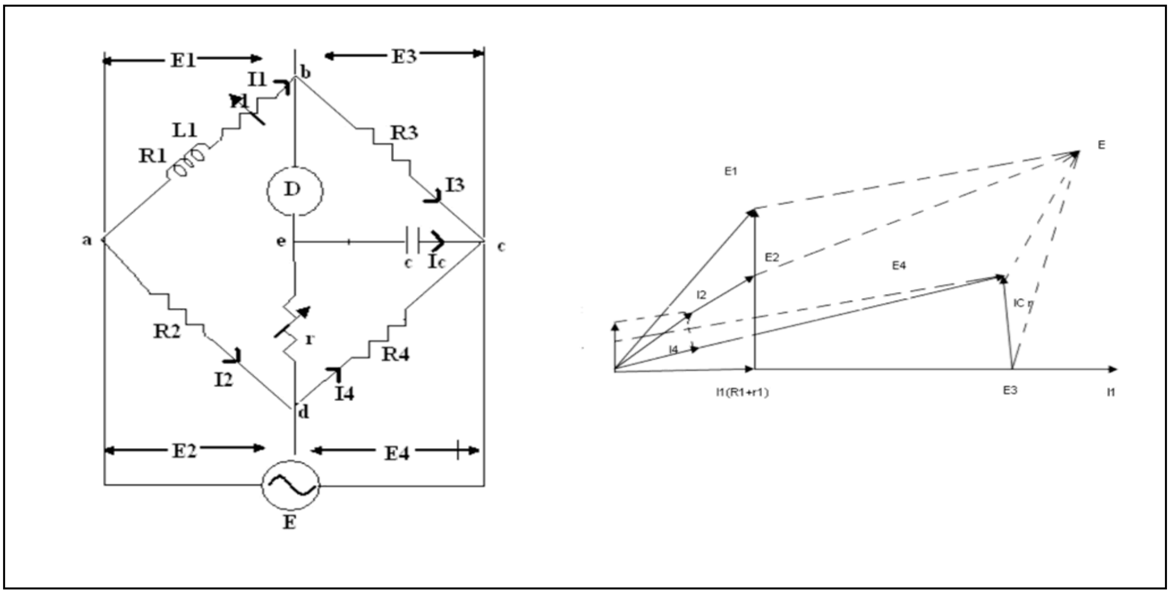
Sl. No.	Name of the apparatus	Type	Quantity	Range
1	Transformer			
2	Bread board			
3	Resistors			
4	Variable Resistor			
5	Capacitors			
6	Inductors			
7	Digital Multimeter			

THEORY:

In this bridge, the self inductance is measured in terms of a standard capacitor. This method is applicable for precise measurement of self-inductance over a very wide range of values. Figures below show the connections and the phasor diagram of the bridge for balanced conditions.

Let L1 = self inductance to be measured,R1 = resistance of self-inductor,

r,R2,R3,R4 = known non-inductive resistance ,r1 = resistance connected in series with self-inductor,



At, balance, $I_1 = I_3$ and $I_2 = I_C + I_4$.

Now, I1R3= IC/jωC, therefore, IC= I1jωCR3

Writing the other balance equations.

I1(r1+R1+jωL1) = I2R2 + ICr, and IC(r+1/jωC) = (I2-IC) R4

By substituting IC value and equating real and imaginary parts

R1 = R2R3/R4 – r1

L1 = C R3/R4{ r(R4+R2)+R2R4}

PROCEDURE:

1. Connect the circuit as shown in the figure.
2. Connect the unknown inductance in L1.
3. Select any value of r.
4. Connect the multimeter between ground and output of imbalance amplifier.
5. Vary r1 and r, from minimum position, in clockwise direction.
6. Calculate the inductance L1 by substituting known values.

OBSERVATION:

Actual value of L in mH	R in ohms	Practical value of L in mH

RESULT:

DISCUSSION: Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 10

TITLE: DESAUTY'S BRIDGE

OBJECTIVE: To determine the unknown value of capacitance using Desauty's bridge.

Apparatus:

Sl. No.	Name of the apparatus	Type	Quantity	Range
1	Transformer			
2	Bread board			
3	Resistors			
4	Variable Resistor			
5	Capacitors			
6	Digital Multimeter			

THEORY:

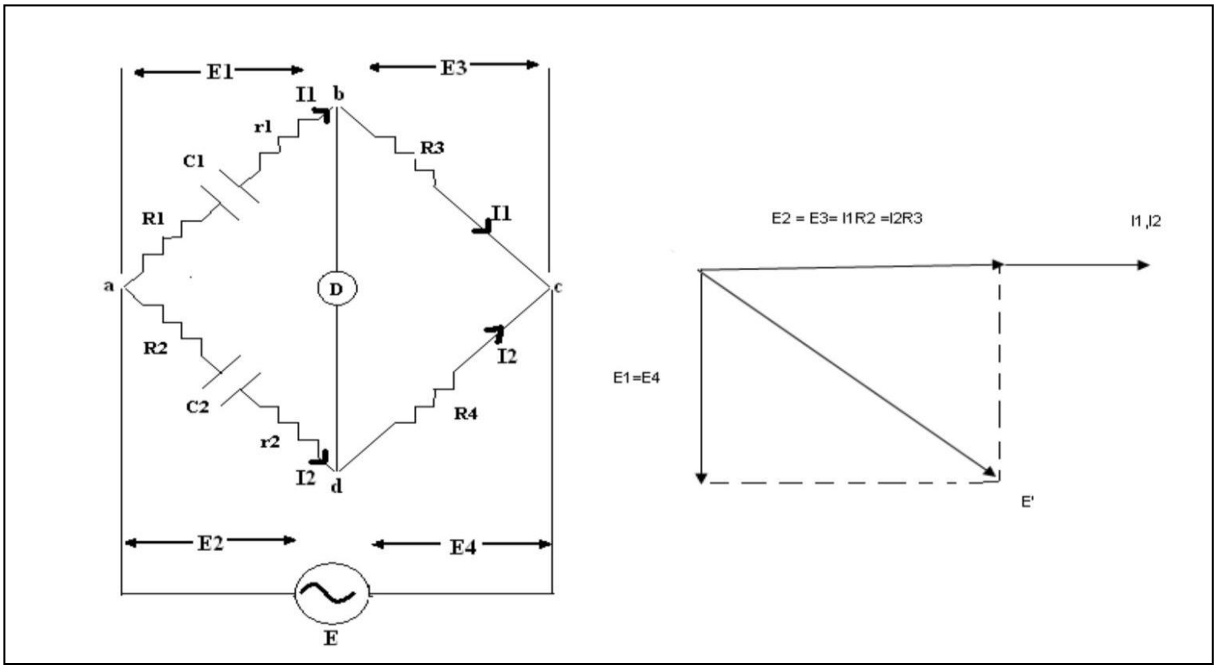
The bridge is the simplest of comparing two capacitances. The connections and the phasor diagram of this bridge are shown below. Let

C1 = Capacitor whose capacitance is to be measured.

C2 = A standard capacitor

R3, R4 = Non-inductive resistors.

The balance can be obtained by varying either R3 or R4. Resistors R1 and R2 are connected in series with C1 and C2 respectively. r1 and r2 are small resistances representing the loss component of the two capacitors.



At balance, $(R_1 + r_1 + 1/j\omega C_1) R_4 = (R_2 + r_2 + 1/j\omega C_2) R_3$

From which we have $C_1/C_2 = R_4/R_3$. Figure b shows the phasor diagram of the bridge under balance conditions. The angles δ_1 and δ_2 are the phase angles of capacitors C_1 and C_2 respectively.

Dissipation factor for the capacitors are $D_1 = \tan \delta_1 = \omega C_1 r_1$ and $D_2 = \tan \delta_2 = \omega C_2 r_2$

$D_2 - D_1 = \omega C_2 (R_1 R_4 / R_3 - R_2)$

Therefore, if the dissipation factor of one of the capacitors is known, the dissipation factor for the other can be determined.

PROCEDURE:

1. Connect the circuit as shown in the figure.
2. Connect the unknown capacitor in C1.
3. Select any value of R3.
4. Connect the multimeter between ground and output of imbalance amplifier.
5. Vary R2, from minimum position, in clockwise direction.
6. If the selection of R3 is correct the balance point can be obtained at minimum position.
7. If that is not the case, select another R3.
8. Since, the unknown capacitance whose resistive effect would be made for capacitive form and R2 is adjusted for minimum output.

OBSERVATION:

Sl.NO	R3	R2	C2	C1= R2C2/R3	True Value of C1

RESULT:

DISCUSSION: Write your comments on the results obtained and discuss the discrepancies, if any.

EXPERIMENT NO : 11

TITLE: SCHERING'S BRIDGE

OBJECTIVE: To determine the unknown value of capacitance using schering's bridge.

APPARATUS:

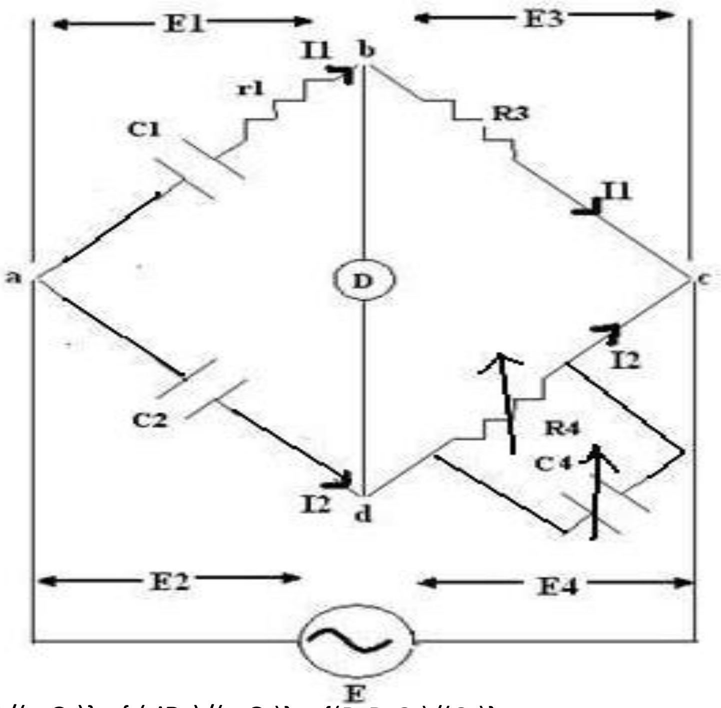
Sl. No.	Name of the apparatus	Type	Quantity	Range
1	Bread board			
2	Resistors			
3	Variable Resistor			
4	Capacitors			
5	Digital Multimeter			

THEORY:

Schering bridge is one of the most important of the a.c. bridge. It is extensively used in measurement of capacitance.

At balance, $\{r_1 + 1/(j\omega C_1)\}\ \{R_4/(1+j\omega C_4R_4)\} = R_3/(j\omega C_2)$

$$\{r_1 + 1/(j\omega C_1)\}\ R_4 = R_3/(j\omega C_2) * \{(1+j\omega C_4R_4)\}$$



$$r_1R_4 - \{(jR_4)/(\omega C_1)\} = \{(-jR_3)/(\omega C_2)\} + \{(R_3R_4C_4)/(C_2)\}$$

Equating real and imaginary terms,

$r_1 = R_3C_4/C_2$ and $C_1 = C_2R_4/R_3$

PROCEDURE:

1. Connect the circuit as shown in the figure.
2. Select any value of C_1.
3. Connect the multimeter between ground and output of imbalance amplifier.
4. Vary R_4 and C_4, from minimum position, in clockwise direction.
5. If the selection of C_1 is correct the balance point can be obtained at minimum position.
6. If that is not the case, select another C_1.
7. Calculate the Capacitance by substituting known values.

OBSERVATION:

C_4	C_1	C_2	R_3	R_4

RESULT: Hence the balanced condition of schering bridge is obtained and unknown value of capacitance is found.

DISCUSSION: Write your comments on the results obtained and discuss the discrepancies, if any.