EE 212

Measurement Laboratory

B. Tech (Electrical Engg.) - Third Semester (Core)

List of Experiments

1. To calibrate a three phase Energy Meter by comparing with a Sub–standard meter.
2. Measurement of Power and Power Factor of a three-phase circuit.
3. To calibrate Single–phase Energy meter by comparing with a Sub-standard meter.
4. To measure medium resistance with the help of Wheatstone bridge.
5. To measure medium resistance with the help of Substitution method.
6. To measure capacitance of a given capacitor by using A.C. bridge.
7. Measurement of Peak and RMS Voltages and Frequency of AC by using Cathode Ray Oscilloscope (CRO).

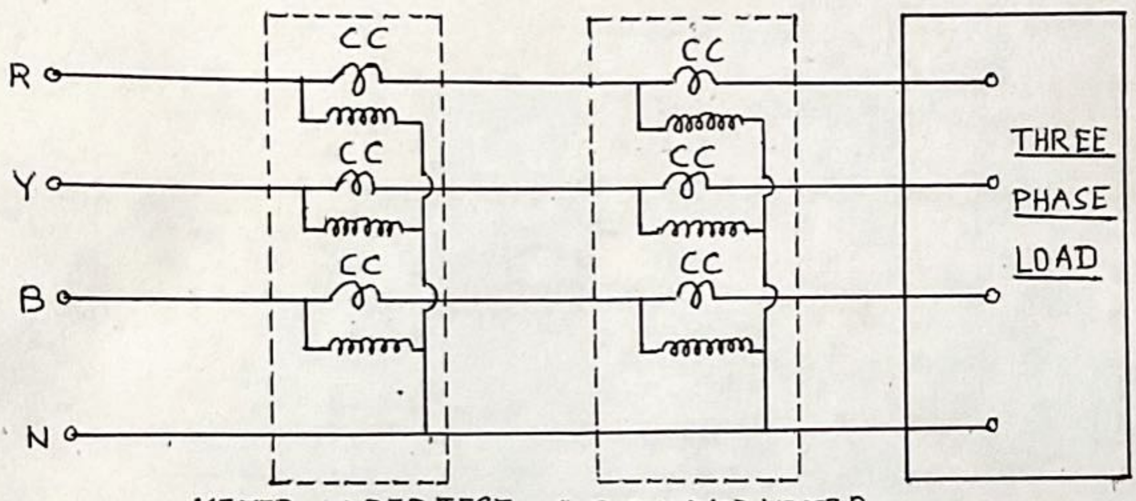
Experiment No.1

Name of the Experiment:- To calibrate a three phase Energy Meter by comparing with a Sub-standard meter.

Objectives:-To measure the Energy in a Three phase load using a Three phase Energy meter.

Brief Theory:- An Energy meter has two elements , current coil & Potential coils.Three phase Energy meters may have two elements or three elements.All the elements drive the same disc mounted on a spindle .In addition to compensating drives,attached to each element.an adjustable magnetic shunt is provided on one or both elements to balance the torque that produced .The Pressure coils are connected in parallel and the current coils are connected in series with three phase system having 3 phase load .

Circuit diagram:-



Instrument &Accessories:-

SL. No.	Name of the Equipment /Instrument	Range /Rating	Maker
1	Energy meter 3-ϕ induction type		
2	Energy meter 3-ϕ induction type		
3	3-ϕ variable load		
4	Any other		

Expt No: 01

Procedure :- The two 3-ϕ energy meters and variable load are connected according to ckt. diagram .Before switching "ON" the position and Reading of both the Energy meter's Disc & Registers are noted down .Power is now switched "ON "and a particular Load is thrown in the ckt.The Load is supplied with 3-ϕ power for an hour .Source is then switched off .Readings of the No. of revolutions made by Disc's of both Energy meter are noted down along with indicated value of registers Percentage Error is calculated.

Let, N_1 = No of Revolution of Sub-Standard meter
N_2 = No of Revolution of meter under test.

Percentage error = $100 * (N_2 - N_1) / N_1$

Observations and Results :-

Sl No	Revolution of Substandard Meter (N_1)	Revolution of meter under test (N_2)	Error ($N_2 - N_1$)	% ge Error = $100 * (N_2 - N_1) / N_1$

Comments and discussion on the result :-

Discuss on the methods of
~~an~~ testing of energymeters (any two method)

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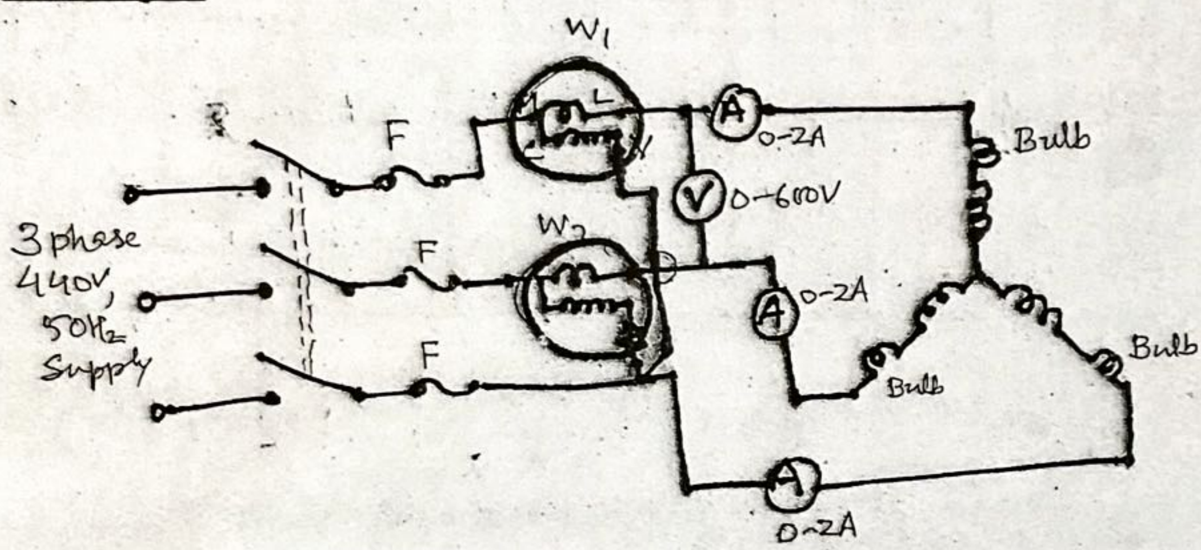
Experiment No.2

Title: Measurement of Power and Power Factor of a three phase circuit.

Aim: To measure the power in three phase AC circuit by two wattmeter method and to calculate the p.f of the load.

Circuit diagram:



Theory: In the two wattmeter method of power measurement in a three phase circuit.
The two wattmeter readings are

$W1=VI\cos(30-\phi)$ and $W2=VI\cos(30+\phi)$

$W1+W2=\sqrt{3}VI\cos\phi$; where V=line voltage
I=line current

$W1-W2=VI\sin\phi$

therefore, $\phi=\arctan(\sqrt{3}(W1-W2)/(W1+W2))$

therefore, p.f $=\cos\phi$

Procedure:

Experimental Observation

$$\text{M.F of wattmeter} = \frac{\text{C.C rating * P.C rating}}{\text{No of divisons}}$$

$W_1 - W_2$ $W_1 + W_2$ $\cos\left(\tan^{-1}\sqrt{3}\,\frac{(W_1 - W_2)}{(W_1 + W_2)}\right)$

Sl no	Wattmeter readings		V	I		W=W1+W2	cos ϕ	Inference
	W1	W2						
1								
2								
3								

Important:

Draw the phasor diagram and verify your calculated result with this graphical method and compare the phase angle.

Answer the following questions.

1) Draw the phasor diagram of the 3-phase circuit in the experiment.
2) What is lagging p.f load? How it is made?
3) Whether the p.f obtained here is lagging or leading?

70, 46

Experiment No. 3

Name of the Experiment :-To calibrate a Single-phase Energy meter by comparing with a Substandard meter and also by calculation .

Objectives :- (1) To measure Energy by using a Kwh-meter .
(2) To compare the Readings of a given Energy meter with that of a Sub standard-meter.

Brief Theory .-The manufacturer generally prints the meter constant on each Energy-meter . A meter constant of say 600 means that for 600 revolution of meter disc. the meter will record 1Kwh . To check correctness of this . the meter is connected in series with a sub standard meter with a known Load . The true value of Energy consume for a fixed period of time recorded by a stop watch ,is calculated from the readings of ammeter and Volt-meter.and a Power-factor meter .

The Energy recorded by the Energy-meter is calculated from its meter constant as follows :

For 600 revolutions the meter reads 1Kwh .
Therefore . for X revolutions the meter reads =(1*X)/600 Kwh .
Energy calculated by the Load is also calculated from the readings of the Voltmeter ammeter and Stop watch and Power-factor meter .

$$\text{Energy consumed Kwh} = \frac{VI\cos\phi}{1000} * \text{time in hours} = E_C$$

Let Energy recorded by the Substandard meter $= E_S$
Energy recorded by the meter under test $= E_T$
Energy Calculated $= E_C$

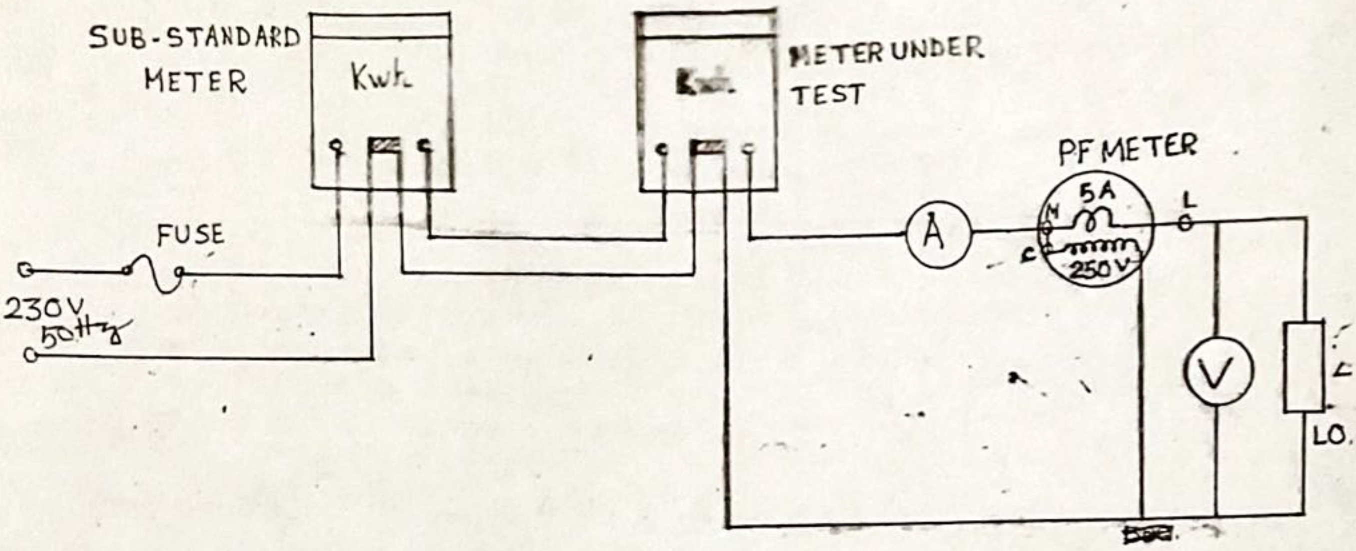
$$E_1 = \text{Percentage Error} = \frac{E_S - E_T}{E_S} * 100$$ by comparing with a sub-standard meter.

$$E_2 = \text{Percentage Error} = \frac{E_C - E_T}{E_C} * 100$$ by comparing with calculated Value .

Errors thus found may be compared .

Procedure :- (1)Make connection as per the circuit diagram .
(2)Switch 'ON' a fixed Load .
(3) Switch 'ON' main Power Supply .
(4)And at the same time run the Stop watch .
(5)Record the Energy meter readings over a fixed period of time (say 30 minutes) .
(6)Record the readings of Volt-meter ,Ammeter and Power- factor meter .
(7)Count the revolutions of Disc of Energy meter ,

Circuit Diagram :-



Instruments /Accessories required :-

Sl. No.	Name of the Equipment/Instrument	No.	Range / Rating	Maker's Name
1.	Energy meter , 1-ϕ			
2.	Sub standard Energy meter Single-Phase .			
3.	Stop watch .			
4.	Ammeter			
5.	Voltmeter			
6.	Single phase Load			
7.	Connection Lead			

Observations & Results :-

Sl. No.	No.of revolution of the meter under test	No.of revolution of the Sub - standard test	Voltmeter reading	Ammeter reading	~~Cost~~ Watt meter reading	% Error with Substan-dard meter E_1	% Error with calculate-dEnergy E_2	Remark -s on observat -ions if any
1.								
2.								

1. **Comments / Discussion on the Results** :-

2. Explain creeping and phantom loading.

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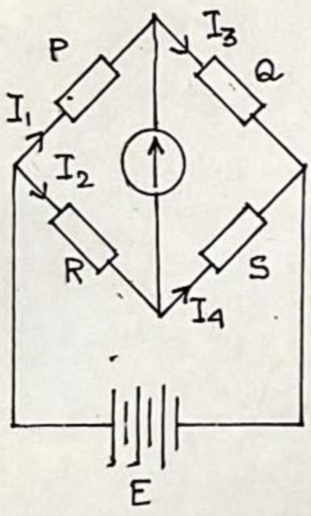
Experiment No. 4

Name of the experiment : To measure medium resistance with the help of Wheatstone Bridge.

Objective : To measure medium resistance and to verify the result with that of standard value.

Brief Theory : Wheatstone Bridge is a very simple circuit used most commonly for measuring medium resistances. It has four resistive arms, together with a source of emf (a battery) and a galvanometer/detector. A simple circuit of the Wheatstone Bridge is shown bellow:



At null point no current flows through the galvanometer. At balance (or at null point).

$$I_1P = I_2R \text{ ----------------------------(1)}$$

$$I_1 = I_3$$

And, $$I_2 = I_4$$

$$I_1 = I_3 = E/(P+Q) \text{ ----------------------(2)}$$

$$I_2 = I_4 = E/(R+S) \text{ ----------------------(3)}$$

Substituting I_1 and I_2 in equation (1) gives,

$$E.P/(P+Q) = E.R/(R+S)$$

or, $$PR + PS = PR + QR$$

or, $$PS = QR$$

or, $P/Q = R/S$

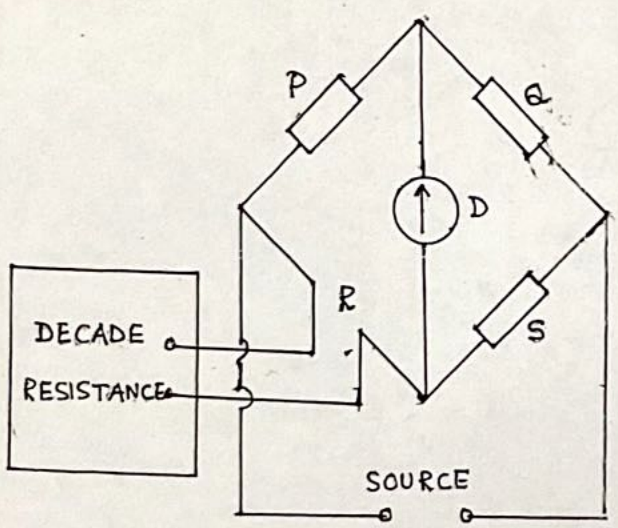
or, $R = S.P/Q$

where S is called standard arm and P and Q are called ratio arm of the bridge.

Procedure :

Make connection as shown below. Fix a Standard Resistance in the arm 'R' of Bridge, put on the supply. Now adjust resistance 'S' of standard resistance of Wheatstone bridge till a null point as indicated by the detector of the bridge is obtained. Increase the sensitivity of the detector and check the null point to confirm the balance of the bridge. Read the value of the standard resistance of the bridge as indicated by the knob. The value of this resistance is the value of the unknown resistance. Since unknown resistance is connected to the decade resistance box, the value of the unknown resistance as indicated by the decade resistance box is known. Compare the test value with standard value and find error.

In the industrial and laboratory form of the bridge, the resistors which make up P, Q and S are mounted together in a box, the appropriate values being selected by dial switches. Battery and galvanometer switches are also included together with a galvanometer and a dry battery in the portable sets. P and Q normally consist of four resistors each, the values being 10, 100, 1000 and 10,000 Ω respectively S consists of a 4 dial or 5 dial decade arrangement of resistors. Figure 14.4 shows the commercial form of Wheatstone bridge.



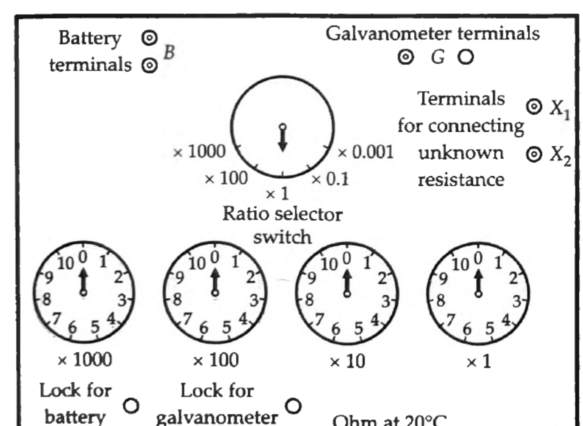


Fig. 14.4 Commercial form of Wheatstone bridge.

Instruments and Accessories :

Sl.No.	Name of instrument	Range, Rating

Observation and Result :

Sl.No.	Calculated value	Standard value	Difference	Error	% Error

Discussion/ Comments :

Explain the localization of faults in cables by i) Murray loop test
ii) Verley loop test

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Experiment No. 5

Name of the Experiment :- To measure the Medium resistance using Substitution - Method .

objectives :-(1) To get familiar with substitution Method for measuring Medium resistance.
(2) To get familiar with change over switch .

Brief Theory :- Resistance from the pt. of view of measurement may be classified as follows :

(1) *Low resistance*: All the resistances of the order of 1 ohm or less are classified as Low -resistance .

(2) *Medium resistance* : All resistances from 1 ohm to 100k-ohm are put under this class .

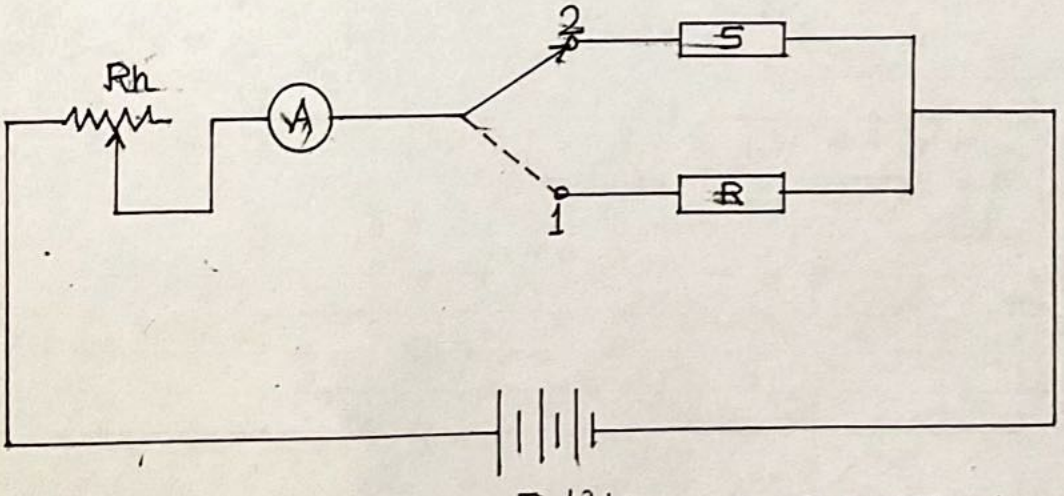
(3) *High resistance* : All resistances from 100k-ohm and above are classified as High resistance .

The different methods for measurement of medium resistances are :

(a)Ammeter-Voltmeter method .
(b)Wheastone-bridge method .
(c) Substitution-method .
(d) Ohm-meter-method .

Circuit Diagram :

The ckt. diagram used for measurement of Medium resistance by Substitution method is given below :



S =Standard variable resistance
R=Unknown resistance.
R_h= Rheostat .

The switch is first placed at the position 1 and a suitable current I is obtained in the ckt. by varying R_h .Switch is now placed at the position second standard resistance S varied till the same current I is obtained .The value of R is thus equal to dial reading of the variable resistance S .

This method is more accurate than Ammeter Voltmeter method.However, the source emf should be strictly const. during the measurement.

Instruments required :

Sl.No.	Name of the instrument	Range/Rating	Maker's name
1.	Ammeter (A)		
2.	Resistance(S)		
3.	Un-known resistance (R)		
4.	Rheostat (R_h)		
5.	Throw switch		

Procedure :(1) Connect all the components as shown in the ckt. diagram .
(2) Put the change over switch at the position 1 and vary R_h until a suitable a current I can be read from the ammeter .
(3) Now place the switch at the position 2 .
(4) Leave R_h unturned .
(5) Vary the standard resistance S until the same I is seen in the ammeter .
(6) This value of S is the value of your unknown resistance .

Observations & Results :-

Sl.No.	Reading of the Ammeter with switch at position 1(A)	Value of S Switch at position 2(ohm)	Value of Unknown resistance(R)
1.			
2.			
3.			
4.			
5.			

Discussion :-

Describe a method to measure resistance of stones (chips).

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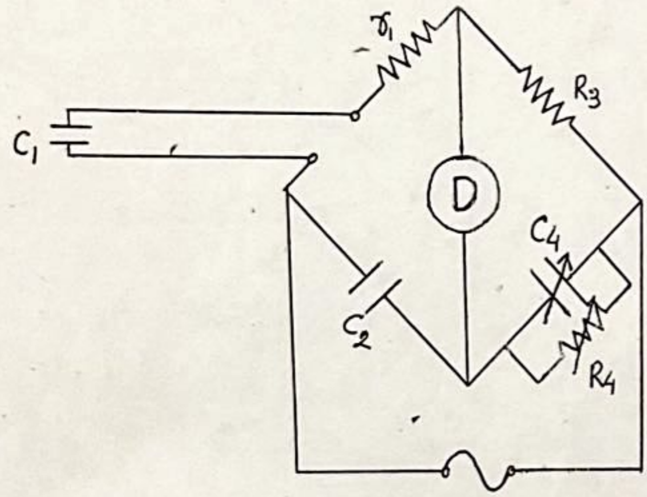
Experiment No. 6

Name of the experiment : To measure capacitance of a given capacitor.

Objective : To measure capacitance of a given capacitor using Schering Bridge and to calculate dissipation factor.

Brief Theory : Schering Bridge is an A.C Bridge which can be used to measure value of unknown capacitance of a capacitor. The figure below shows different components of arms of the bridge. By varing the capacitor C_4 and resistance R_4, a null point is obtained by using a ear phone as a detector. At balance condition.

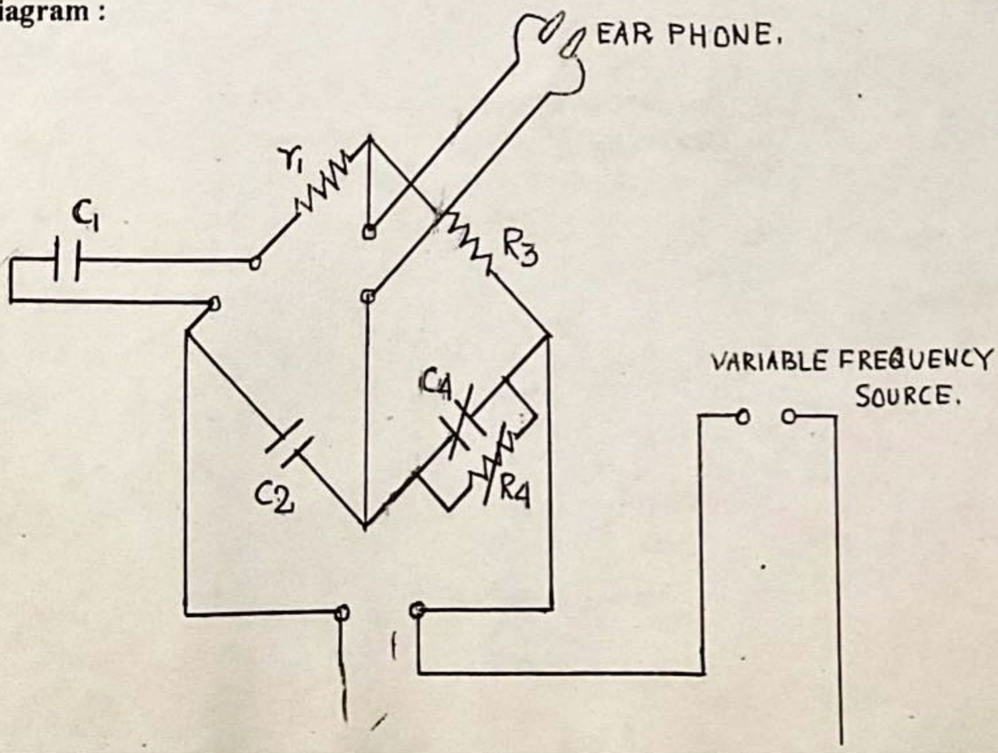
$$C_1 = (C_2 \cdot R_4)/R_3$$



Dissipation factor $D_1 = \tan\delta = wC_1r_1 = w\,C_4R_4$

Therefore for finding dissipation factor 'D_1', the frequency of the source must be known.

Circuit Diagram :



Procedure :

The connection is made as per circuit diagram as shown in other page. A variable frequency source is connected as shown. By varying C_4 and R_4 a balance condition is obtained with the help of a ear phone which acts as detector. The value of unknown capacitance and dissipation factor is calculated by using formulae mentioned in the theory.

Instruments and Accessories :

Sl.No.	Name of instrument	Range, Rating	Maker's name

Observation and Result :

Sl. No	Frequency Of the source CPS	Value Of C_4 in Farad	Value Of C_2 in Farad	Value Of r_1 in ohm	Value Of R_3 in ohm	Value Of R_4 in ohm	Calculated value of	
							Dissipation factor	C_1 in Farad

Discussion/ Comments :

Questions :

1. Draw the phasor diagram of the Bridge.
2. Discuss the advantages and disadvantages of the bridge.
3. Comment on selection of source frequency.
4. How the effect of stray capacitances can be eliminated.

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Experiment No. 7

Measurement of Peak and RMS Voltages and Frequency of AC by using Cathode Ray Oscilloscope (CRO)

Aim:- To study the different waveforms, to measure peak and RMS voltages and the frequency of A.C.

Apparatus:- A C.R.O and a signal generator.

Theory:- Cathode ray oscilloscope is one of the most useful electronic equipment, which gives a visual representation of electrical quantities, such as voltage and current waveforms in an electrical circuit. It utilizes the properties of cathode rays of being deflected by an electric and magnetic fields and of producing scintillations on a fluorescent screen. Since the inertia of cathode rays is very small, they are able to follow the alterations of very high frequency fields and thus electron beam serves as a practically inertia less pointer. When a varying potential difference is established across two plates between which the beam is passing, it is deflected and moves in accordance with the variation of potential difference. When this electron beam impinges upon a fluorescent screen, a bright luminous spot is produced there which shows and follows faithfully the variation of potential difference.

When an AC voltage is applied to Y-plates, the spot of light moves on the screen vertically up and down in straight line. This line does not reveal the nature of applied voltage waveform. Thus to obtain the actual waveform, a time-base circuit is necessary. A time-base circuit is a circuit which generates a saw-tooth waveform. It causes the spot to move in the horizontal and vertical direction linearly with time. When the vertical motion of the spot produced by the Y-plates due to alternating voltage, is superimposed over the horizontal sweep produced by X-plates, the actual waveform is traced on the screen.

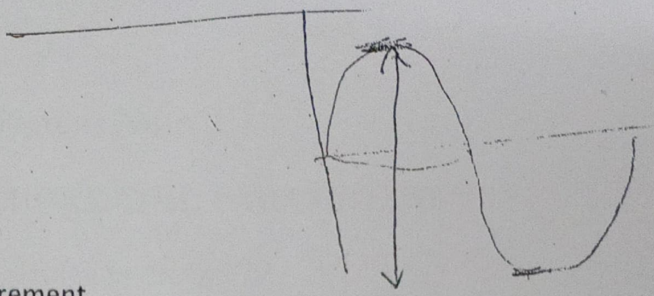
Procedure:-

Study of Waveforms: To study the waveforms of an A.C voltage, it is led to the y–plates and the time base voltage is given to the X-plates. The size of the figure displayed on the screen, can be adjusted suitably by adjusting the gain controls. The time base frequency can be changed, so as to accommodate one, two or more cycles of the signal. There is a provision in C.R.O to obtain a sine wave or a square wave or a triangular wave.

Measurement of D.C. Voltage: - Deflection on a CRO screen is directly proportional to the voltage applied to the deflecting plates. Therefore, if the screen is first calibrated in terms of known voltage. i.e. the deflection sensitivity is determined , the direct voltage can be measured by applying it between a pair of deflecting plates. The amount of deflection so produced multiplied by the deflection sensitivity, gives the value of direct voltage.

Measurement of A.C Voltage: - To measure the alternating voltage of sinusoidal waveform, The A.C. signal, from the signal generator, is applied across the y–plates. The voltage (deflection) sensitivity band switch (Y-plates) and time base band switch (X-plates) are adjusted such that a steady picture of the waveform is obtained on the screen. The vertical height (l) i.e. peak-to-peak height is measured. When this peak-to-peak height (l) is multiplied by the voltage (deflection) sensitivity (n) i.e. volt/div, we get the peak-to-peak voltage ($2V_o$). From this we get the peak voltage (V_o). The rms voltage V_{rms} is equal to $V_o/ 2$. This rms voltage V_{rms} is verified with rms voltage value, measured by the multi-meter.

Measurement of Frequency: - An unknown frequency source (signal generator) is connected to y-plates of C.R.O. Time base signal is connected to x–plates (internally connected). We get a sinusoidal wave on the screen, after the adjustment of voltage sensitivity band switch (Y-plates) and time base band switch (X-plates). The horizontal length (l) between two successive peaks is noted. When this horizontal length (l) is multiplied by the time base (m) i.e. sec/div, we get the time-period (T).The reciprocal of the time-period (1/T) gives the frequency (f). This can be verified with the frequency, measured by the multi-meter.



Result:

Table: 1
Voltage Measurement

Sl No.	Peak to peak (vertical) length. (Division) (l)	Voltage Sensitivity. (Volt/Div) (n)	Peak to peak voltage $(V_{PK}\text{-}V_{PK})=n\times l$ (volts)	$V_{max}=\frac{V_{PK}\text{-}V_{PK}}{2}$ (volts)	RMS Voltage $V_{rms}=\frac{V_{max}}{\sqrt{2}}$ (volts)	Measured voltage with multi-meter (volts)
1.	14	5V	~~7~~39	≈ 35	24.74	04.96
2.	13.9	2				
3.						
4.						
5.						

Table: 2
Frequency measurement

Sl No.	Horizontal length for a complete cycle. (Division) (l)	Time-base Sec/Div (m)	Time period T=mxl	Measured frequency F=1/T	Applied Frequency Hz	~~Measured frequency with multi-meter (Hz)~~
1.						
2.						
3.						
4.						
5.						9.686

Precaution: 1) The continuity of connecting wires should be tested first.

2) The frequency of the signal should be varies such that steady wave form is formed.