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STUDENT MANUAL FOR

ELECTRICAL MEASUREMENTS LAB

DEPARTMENT: ELECTRICAL & ELECTRONICS ENGG.

YEAR: 2015-2016 **SEM:** II

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ELECTRICAL MEASUREMENTS LAB : R-13 SYLLABUS

LIST OF EXPERIMENTS

Any 10 of the following experiments are to be conducted:

1. Calibration and Testing of single phase energy Meter
2. Calibration of dynamometer wattmeter using phantom loading-UPF
3. Crompton D.C. Potentiometer – Calibration of PMMC ammeter and PMMC voltmeter
4. Kelvin’s double Bridge – Measurement of resistance – Determination of Tolerance.
5. Capacitance measurement using Schering bridge.
6. Inductance measurement using Anderson bridge.
7. Measurements of 3 phase reactive power with single-phase wattmeter for balanced loading.
8. Measurement of complex power with Trivector meter and verification.
9. Optical bench – Determination of polar curve measurement of MHCP of electrical lamp.
10. Calibration LPF wattmeter – by direct loading.
11. Measurement of 3 phase power with single watt meter and 2 No’s of C.T.
12. C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given C.T. by Null method.
13. P.T. testing by comparison – V.G. as Null detector – Measurement of % ratio error and phase angle of the given P.T.
14. Dielectric oil testing using H.T. testing Kit.
15. LVDT and capacitance pickup – characteristics and Calibration
16. Resistance strain gauge – strain measurements and Calibration.
17. Polar curve using Lux meter, Measurement of intensity of illumination of fluorescent lamp.
18. Transformer turns ratio measurement using a.c. bridge.

19. A.C. Potentiometer – Polar form/Cartesian form – Calibration of AC Voltmeter, Parameters of Choke.
20. Measurement of power by using 3 voltmeter and 3 ammeter methods.
21. Measurement of parameters of a choke coil using 3 voltmeter and 3 ammeter methods.

LIST OF EXPERIMENTS (performed in the lab)

1. Calibration and testing of single phase energy meter.
2. Measurements of 3 phase reactive power with single-phase wattmeter for balanced loading.
3. Inductance measurement using Anderson bridge.
4. Capacitance measurement using Schering bridge.
5. Calibration LPF wattmeter – by direct loading.
6. Calibration of dynamometer wattmeter using phantom loading-UPF.
7. Measurement of 3 phase power with single watt meter and 2 No's of C.T.
8. Measurement of parameters of a choke coil using 3 voltmeter and 3 ammeter methods.
9. Measurement of power by using 3 voltmeter and 3 ammeter methods.
10. Crompton D.C. Potentiometer – Calibration of PMMC ammeter and PMMC voltmeter.

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1. Calibration and Testing of Single Phase Energy Meter

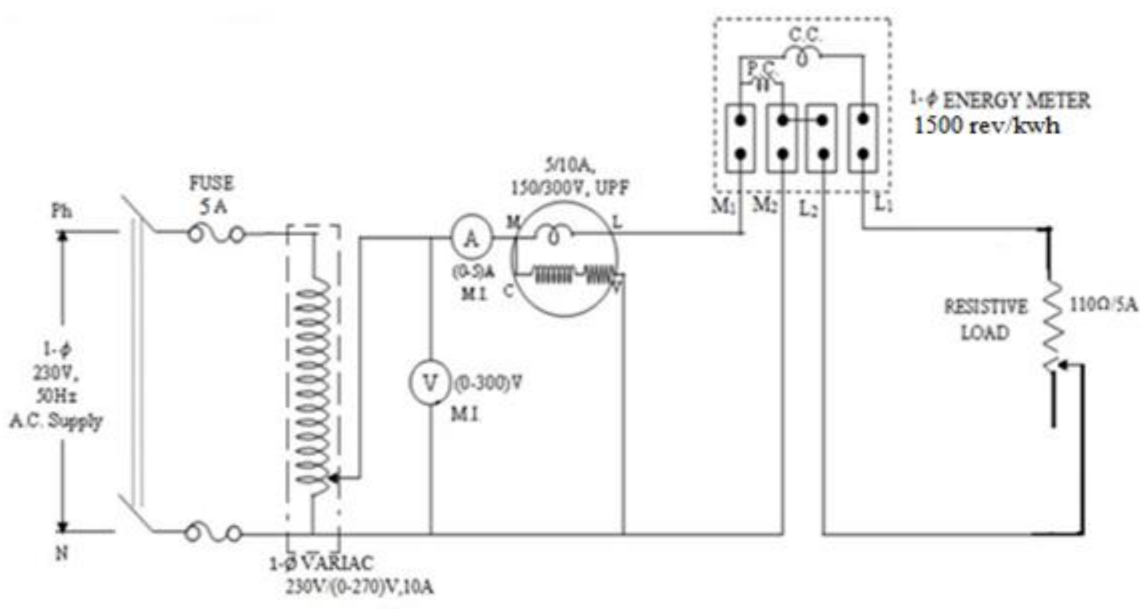
AIM:

To Calibrate and test the given Single phase energy meter by direct loading.

APPARATUS:

S.NO	NAME	TYPE	RANGE	QUANTITY
1	Single phase Energy Meter	Induction	1500REV/KWH	1
2	Wattmeter	UPF	300V/5A	1
3	Voltmeter	MI	(0-300)V	1
4	Ammeter	MI	(0-5)A	1
5	Single Phase Variac	1-Ø	230V/ (0-270)V,10A	1
6	Rheostat	WW	110Ω/5A	1
7	Stop Watch	Digital	-	1
8	Connecting Wires	-	-	Required

CIRCUIT DIAGRAM:



THEORY:

Induction type of energy meters are universally used for measurement of energy in domestic and industrial a.c. circuits. Induction type of meters possesses lower friction and higher torque/weight ratio. Also they are inexpensive and accurate, and retain their accuracy over a wide range of loads and temperature conditions.

There are four main parts of the operating mechanism:

(i) Driving system
(ii) Moving system
(iii) Braking system and
(iv) Registering system.

Driving System: The driving system of the meter consists of two electro-magnets. The core of these electromagnets is made up of silicon steel laminations. The coil of one of the electromagnets is excited by the load current. This coil is called the 'current coil'. The coil of second electromagnet is connected across the supply and, therefore, carries a current proportional to the supply voltage. This coil is called the 'pressure coil'. Consequently the two electromagnets are known as series and shunt magnets respectively. Copper shading bands are provided on the central limb. The position of these banks is adjustable. The function of these bands is to bring the flux produced by the shunt magnet exactly in quadrature with the applied voltage.

Moving System: This consists of an aluminium disc mounted on a light alloy shaft. This disc is positioned in the air gap between series and shunt magnets.

Braking System: A permanent magnet positioned near the edge of the aluminium disc forms the braking system. The aluminium disc moves in the field of this magnet and thus provides a braking torque. The position of the permanent magnet is adjustable, and therefore, braking torque can be adjusted by shifting the permanent magent to different radial positions as explained earlier.

Registering (counting) Mechanism: The function of a registering or counting mechanism is to record continuously a number which is proportional to the revolutions made by the moving system.

In all induction instruments we have two fluxes produced by currents flowing in the windings of the instrument. These fluxes are alternating in nature and so they produce emfs in a metallic disc or a drum provided for the purpose. These emfs in turn circulate eddy currents in the metallic disc or the drum. The breaking torque is produced by the interaction of eddy current and the field of permanent magnet. This torque is directly proportional to the product of flux of the magnet, magnitude of eddy current and effective radius 'R' from axis of disc. The moving system attains a steady speed when the driving torque equals braking torque.

The term testing includes the checking of the actual registration of the meter as well as the adjustments done to bring the errors of the meter with in prescribed limits. AC energy meters should be tested for the following conditions:

1. At 5% of marked current with unity pf.
2. At 100% (or) 125% of marked current.

3. At one intermediate load with unity pf.
4. At marked current and 0.5 lagging pf.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keep the single phase variac at zero volt position.
3. Now switch on the power supply.
4. Gradually vary the variac to apply the rated voltage (230 volts).
5. For different values of load, note down the readings of the ammeter, voltmeter, wattmeter and time taken for 10 revolutions of the disc.
6. Gradually vary the variac to minimum or zero volt position.
7. Switch off the power supply.
8. Calculate observed reading, actual reading, %error, %correction.
9. Draw the graph between Load current (vs) % Error.

TABULAR FORM:

S.No.	Voltmeter (Volts)	Ammeter (Amps)	Wattmeter (Watts)	Time for 10 rev(sec)	Theoretical E1	Practical E2=W*t	% Error= (E1-E2)/E2 *100

Theoritical reading = E1
Practical reading = E2

MODEL CALCULATIONS:

Theoritical reading = No. of revolutions / (energy meter constant (k)

Where, no. of revolutions = 10

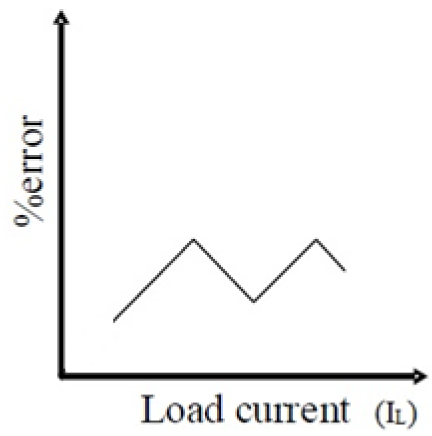
Energy meter constant k=1500 rev/kwh

Practical reading = W *t

%Error = [(E1-E2)/E2] *100

%Correction = - % Error

MODEL GRAPH:



PRECAUTIONS:

1. Avoid loose connections.
2. Be Careful while observing the revolutions with stop watch.
3. Do not apply more current, more than the rated energy meter current.
4. Take readings without error.
5. Live terminals should not be touched.

RESULT:

Hence calibrated the given single phase energy meter and tested at different loads and the graph is plotted for % Error Vs I_L and % Correction factor Vs $I_{L.}$

APPLICATIONS:

Electricity meters measure and display power consumption in residential, industrial, and commercial dwellings, as well as sub-stations in the electric grid. They are evolving rapidly, and different solutions and architectures are required to meet varying regional utility requirements.

VIVA QUESTIONS:

1. What is an energy meter?
2. What are the types of energy meter?
3. Which type of energy meters are used in dc circuits?
4. Energy meter is an _____________ (i) integrating instrument (ii) indicating instrument
5. Can the measured percentage error be negative?
6. What do you mean by ‘torque adjustment’?
7. What is operating torque?
8. Define braking torque?
9. When does the disc on the spindle rotate with a constant speed?
10. The operating torque is directly proportional to speed, state true or false.

2. Measurement of 3-Phase Reactive Power with Single Wattmeter for Balanced Loading

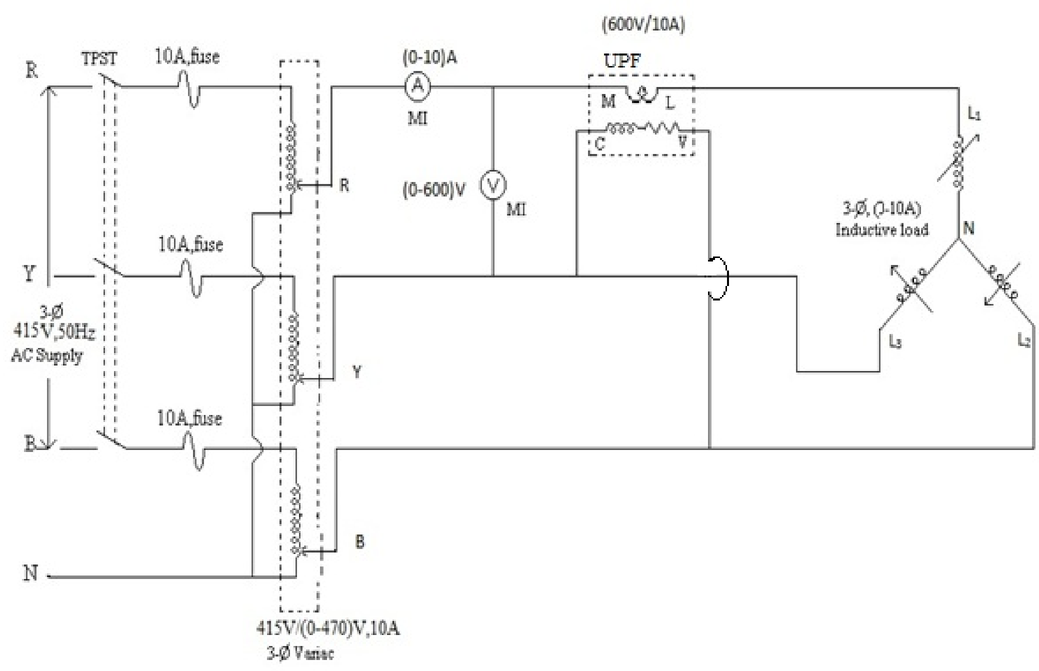
AIM:

To measure the 3-Phase reactive power using single wattmeter for balanced loading.

APPARATUS:

S. No	Name	Type	Range	Quantity
1	Voltmeter	MI	(0-600)V	1
2	Ammeter	MI	(0-10)A	1
3	Wattmeter	UPF	600V,10A	1
4	Three Phase Variac	AC	415V/(0-470)V 15A	1
5	Three Phase Variable Inductive Load	-	415V,10A	1
6	Connecting Wires	-	-	Required

CIRCUIT DIAGRAM:



THEORY:

The basic principle used for measuring active as well as reactive power in an a.c. circuit is the Blondels theorem.

If a network is supplied through ‘n’ conductors, the total power is measured by summing the readings of ‘n’ wattmeters is in each line and the corresponding voltage element is connected between the line and a common point.

If the common point is located on one of the lines, then the power may be measured by (n-1) wattmeters.

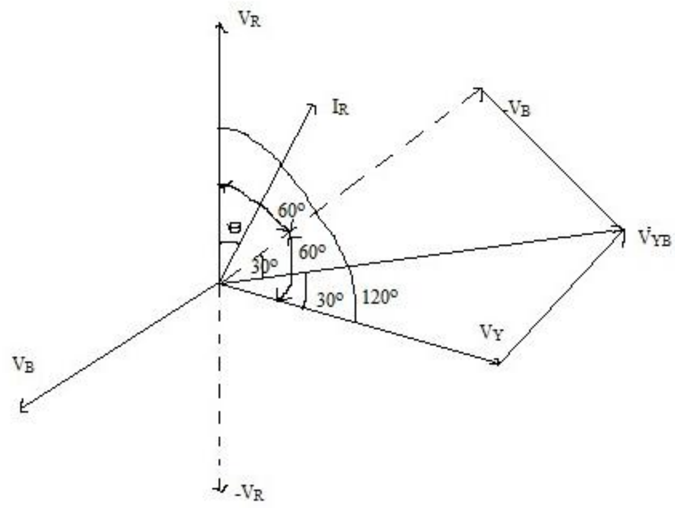
One wattmeter method can be used for the measurement of power but this method is applicable only for balanced loads the current coil is connected in one of the lines and one end of the pressure coil to some line, other end being connected alternatively to other two lines.

In case of balanced three phase circuits it is simple to use a single wattmeter to read reactive power the current coil of the wattmeter is connected in one line and pressure coil is connected across other two lines.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keep the three phase variac at zero volt position and inductive load at minimum position.
3. Switch on the three phase power supply.
4. Now slowly vary the three phase variac to its rated voltage (415V) and note down the readings of the ammeter, voltmeter and wattmeter.
5. By increasing the inductive load and tabulates the readings of ammeter, voltmeter and Wattmeter upto the rated current.
6. Now set the inductive load and three phase variac to its minimum position.
7. Switch off the three phase supply.
8. Calculate the three phase reactive power.

PHASOR DIAGRAM:



TABULAR FORM:

S.NO	VOLTMETER (V_L)VOLTS	AMMETER (I_L)AMPS	WATTMETER (W)WATTS	Q=√3*W	SinØ= $\frac{Q}{\sqrt{3} V_L I_L}$
1					
2					
3					

MODEL CALCULATIONS:

When the load is balanced,
P = 3*Vph*Iph cosΦ
Hence one wattmeter issued to measure the single phase power & then it is to be multiplied by 3
Q = 3VIsinΦ
$Q_{1-\Phi}= 3\ V_{Ph}\ I_{Ph}\ \sin\Phi$
$Q_{3-\Phi}= 3\ (V_L/\sqrt{3})\ I_L\ \sin\Phi$
$Q_{3-\Phi}= \sqrt{3}\ V_L\ I_L\ \sin\Phi$
$\sin\Phi= (Q_{3-\Phi})/(\sqrt{3}\ V_L\ I_L)$
Similarly,

$W = V_L I_L \sin\Phi$

$\sqrt{3}\,W = \sqrt{3}\, V_L I_L \sin\Phi$

$\sqrt{3}\,W = Q_{3-\Phi}$

PRECAUTIONS:

1. Live terminals should not be touched.
2. Connect the circuit without any loose connection.
3. If wattmeter reads reverse in reading change either current coil or pressure coil connections.
4. Load current should not exceed rated current value.

RESULT:

Hence the three phase Reactive power (Q= ____KVAR) with single-phase wattmeter for balanced inductive load is measured at sinΦ = ______.

APPLICATION:

1. It is used in electro-mechanical devices and other loads.

VIVA QUESTIONS:

1. How do you measure power?
2. State the difference between wattmeter and an energy meter?
3. Types of watt meters?
4. Which types of wattmeter is widely used?
5. How is the controlling torque obtained?
6. What are the errors in dynamometer type watt meters? State a few.
7. How many watt meters do we require to measure 3-phase power?
8. What is reactive power? State the formula.
9. How many watt meters are required to measure 3-phase reactive power?
10. How do we minimize the errors due to eddy currents in watt meters?

3. ANDERSON'S BRIDGE

AIM:

To measure the unknown inductance by using Anderson bridge.

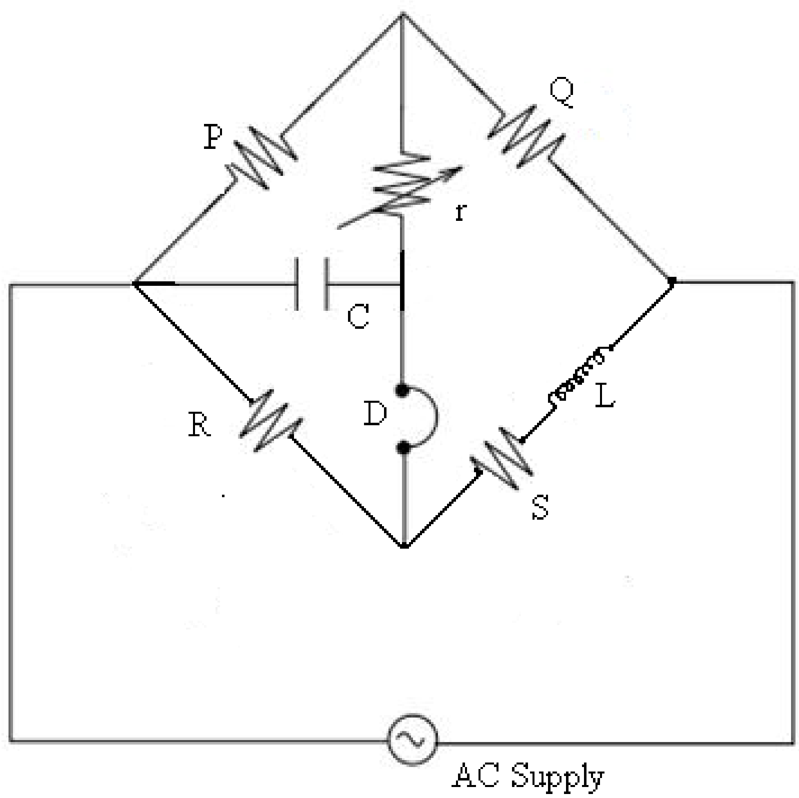
(OR)

1. To determine the self inductance of the coil (L) using Anderson bridge.
2. To calculate the value of inductive reactance (X_L) of the coil at a particular frequency.

APPARATUS:

S. NO	Name of the Equipment	Type	Range	Quantity
1	Anderson Bridge Kit	-	-	1no
2	Headset	-	-	1no
3	Patch Chords	-	-	Required

CIRCUIT DIAGRAM:



THEORY:

AC bridges are often used to measure the value of unknown impedance (self/mutual inductance of inductors or capacitance of capacitors accurately). A large number of AC bridges are available and Anderson's Bridge is an AC bridge used to measure self inductance of the coil. It is a modification of Wheatstones Bridge. It enables us to measure the inductance of a coil using capacitor and resistors and does not require repeated balancing of the bridge.

The bridge is balanced by a steady current by replacing the headphone H by moving coil galvanometer and A.C source by a battery. This is done by adjusting the variable resistance, r. After a steady balance has been obtained, inductive balance is obtained by using the A.C source and headphone.

Advantages:

1. Fixed capacitor is used in terms of variable capacitor.
2. The bridge is used for accurate determination of inductance in millimeter range.

Disadvantages:

1. Bridge is more complex
2. Difficult to attain balancing condition.

PROCEDURE:

STEP-I:

1. Connect the circuit to the D.C supply.
2. Switch on the power supply.
3. Now vary the ‘R’ and ‘S’ values one by one until it shows the null deflection in Galvanometer.

STEP II:

1. Then change the D.C supply terminals to the A.C supply terminals from the unknown port as well as connect the headset to the detector port by disconnecting the galvanometer terminals.
2. Now vary the ‘r’ value to obtain the null beep sound in the headset.
3. Switch off the supply.
4. Disconnect the circuit.

TABULAR FORM:

No	Resistance R (Ω)	Resistance Q (Ω)	Resistance P (Ω)	Variable resistance S (Ω)	Variable Resistance r (Ω)	Inductance L (H)

$$L = C[RQ + r(R+S)]$$

Where C = 0.01μF

$$X_L = 2\pi fL$$

Where f is the frequency and L is the self inductance of the coil.

PRECAUTIONS:

1. Vary the knobs smoothly.
2. Avoid loose connections.

RESULT:

Hence determine the unknown inductance by using Anderson Bridge.

APPLICATIONS:

1. Anderson Bridge is used to measure low quality factor.
2. To calculate the value of inductive reactance (X_L) of the coil at a particular frequency.

VIVA QUESTIONS:

4.SCHERING BRIDGE

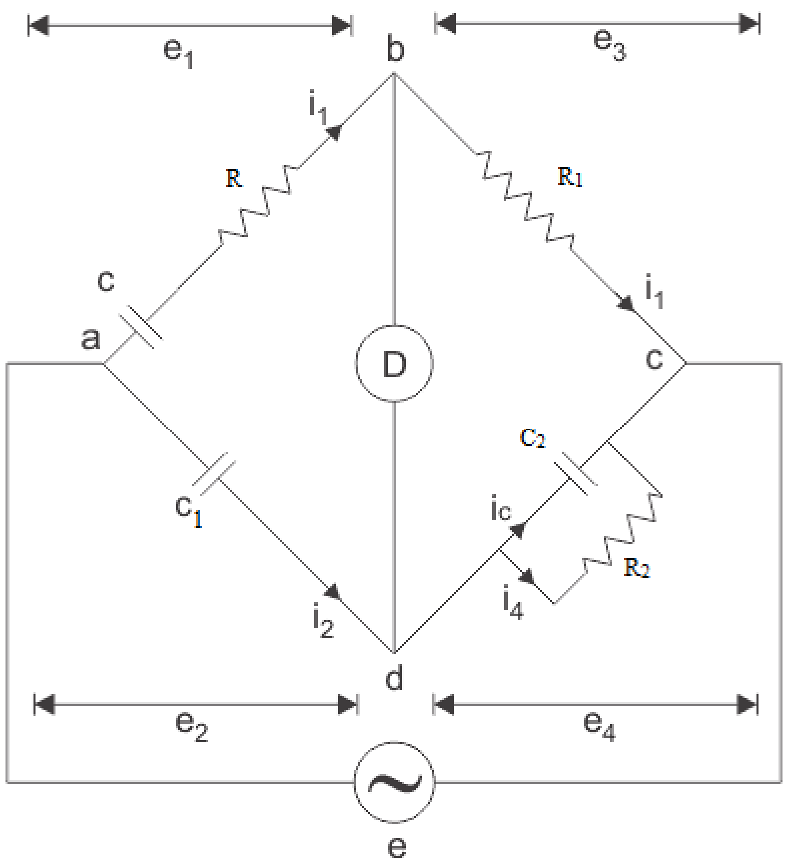
AIM:

To measure the unknown capacitance by using Schering bridge.

APPARATUS:

S. NO	Name of the Equipment	Type	Range	Quantity
1	Schering Bridge Kit	-	-	1no
2	Headset	-	-	1no
3	Patch Chords	-	-	Required

CIRCUIT DIAGRAM:



THEORY:

This bridge is used to measure to the capacitance of the capacitor, dissipation factor and measurement of relative permittivity.

(a) The bridge arms ab and ad consists of only capacitors as shown the bridge given and impedances of these two arms are quite large as compared to the impedances of bc and cd. The arms bc and cd contains resistor R_1 and parallel combination of capacitor C_2 and resistor R_2 respectively. As impedances of bc and cd are quite small therefore drop across bc and cd is small. The point c is earthed, so that the voltage across bc and dc are few volts above the point c.

(b) The high voltage supply is obtained from a transformer 50 Hz and the detector in this bridge is a vibration galvanometer.

(c) The impedances of arms ab and ad very are large therefore this circuit draws low current hence power loss is low but due to this low current we need a very sensitive detector to detect this low current.

(d) The fixed standard capacitor c_2 has compressed gas which works as dielectric therefore dissipation factor can be taken as zero for compressed air. Earthed screens are placed between high and low arms of the bridge to prevent errors caused due to inter capacitance.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Switch on the power supply.
3. Now fix the 'R_1' value and then vary the 'R_2' value until obtain the null beep sound in the headset.
4. To find the dissipation factor, apply the 'R' value to get beep sound (or) disturbance and then vary the 'C_2' to reduce (or) minimize that beep sound.
5. Take 'C_1' as standard value i.e., 0.01μfd value.
6. Repeat the above process for different 'R_1' values.
7. Switch off the power supply.
8. Disconnect the circuit.

TABULAR FORM:

PHASOR DIAGRAM:

PRECAUTIONS:

1. Avoid loose connections.
2. Vary the knobs smoothly.

RESULT:

Hence determine the unknown capacitance by using Schering Bridge method.

APPLICATIONS:

1. It is used for measuring the insulating properties of electrical cables and equipments.
2. It is used in the measurement of the properties of insulators, capacitor bushings, insulating oil and other insulating materials.

VIVA QUETIONS

5. Calibration of LPF Wattmeter by Direct Loading Test

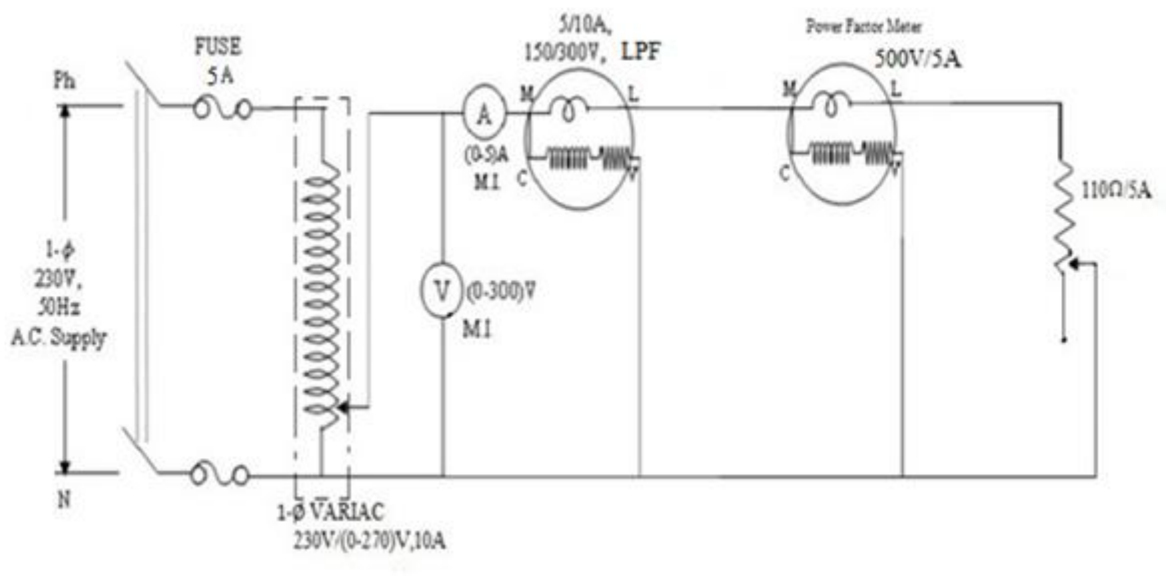
AIM:

To calibrate the given LPF wattmeter by direct loading test.

APPARATUS REQUIRED:

S. No	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY
1	Single Phase Variac	1-Ø	230/(0-270)V 10A	1
2	Voltmeter	MI	(0-300)V	1
3	Ammeter	MI	(0-5)A	1
4	Wattmeter	LPF	300V/5A	1
5	Power Factor Meter	Dynamometer	500V/5A	1
6	Rheostat	WW	110Ω/5A	1
7	Connecting Wires	-	-	Required

CIRCUIT DIAGRAM:



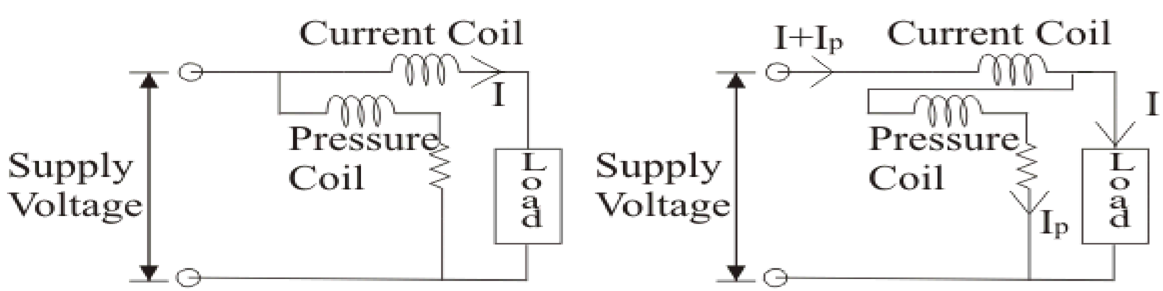
THEORY:

As the name suggests the low power factor meter are the instruments that measures lower values of power factor accurately. Before we study more about the **low** power factor **meter**, it is very essential to know why there is a requirement of low power factor meter though we use ordinary electrodynamometer to measure power factor? Answer to this question is very simple as it gives inaccurate results.

Now there are two main reasons that would suggests us that we should not use ordinary wattmeter in measuring the low value of power factor. (1) The value of deflecting torque is very low even though we fully excite the current and pressure coils. (2) Errors due pressure coil inductance.Above two reasons gives very inaccurate results thus we should not use normal or ordinary wattmeters in measuring the low value of power factor. However by doing some modification or adding some new features we can use modified electrodynamic wattmeter or low power factor to measure the low power factor accurately.

Here we are going to discuss, where we need to do modification. These are discussed one by one below:

(1) Modification in pressure coil: The electrical resistance of the ordinary wattmeter's pressure coil is reduced to low value such that current in the pressure coil circuit is increased, thus it leads to. In this category two cases diagrams arises and these are shown below:



In the first category both the ends of the pressure coil is connected to supply side (i.e. current coil is in series with the load). The supply voltage is equal to the voltage across the pressure coil. Thus in this case we have power shown by the first wattmeter is equal to the power loss in the load plus power loss in the current coil. Mathematically, P_1 = power consumed by load + I^2R_1.

In the second category, the current coil is not in series with the load and the voltage across the pressure coil is not equal to the applied voltage. The voltage across pressure coil is equal to the voltage across the load. In this power shown by the second wattmeter is equal to the power loss in the load plus the power loss in the pressure coil. Mathematically P_2 = power consumed by load + I^2R_2.

From the above discussion we conclude that in both cases we have some amount of errors hence there is need to do some modification in above circuits to have minimum error.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keep the single phase variac at minimum position and the load resistance at maximum position.
3. Switch on the single phase power supply.
4. Now slowly vary the variac to its rated voltage (230V) and note down the readings of ammeter, voltmeter, power factor meter and wattmeter.
5. Then decrease the load resistance in steps and simultaneously note down the readings of ammeter, voltmeter, power factor meter and wattmeter.
6. Finally adjust the load resistance and single phase variac to its starting positions.
7. Switch off the single phase power supply.
8. Calculate the % Error.

TABULAR FORM:

S. NO	VOLTAGE (V) VOLTS	CURRENT (I_L) AMPS	WATTMETER(W) WATTS	POWER FACTOR Cos Ø	% ERROR

MODEL CALCULATIONS:

% Error = [(True Value – Practical Value)/True Value]*100

Where True Value = V*I*COSΦ and

Practical Value = Wattmeter Reading

MODEL GRAPH:

PRECAUTIONS:

1. Connections should be tight.
2. Avoid parallax errors.

RESULT:

Hence calibrated the LPF wattmeter by direct loading test and the corresponding %Error, %Correction at different loads are calculated.

APPLICATIONS:

VIVA QUESTIONS:

1. What is meant by direct loading?
2. Is the load current in LPF wattmeter is high / low?
3. Why are the LPF wattmeter designed to have a smaller controlling torque?
4. What is the need of introducing compensating coil?
5. State a few errors in dynamometer wattmeter?
6. Applications of LPF wattmeter?
7. Why more operating torque is produced in LPF wattmeter?
8. Why the controlling torque in an LPF wattmeter is less?
9. What are the different methods used for measurement for 3-phase power?
10. What is meant by correction factor?

6. Calibration of Dynamometer UPF Wattmeter Using Phantom Loading

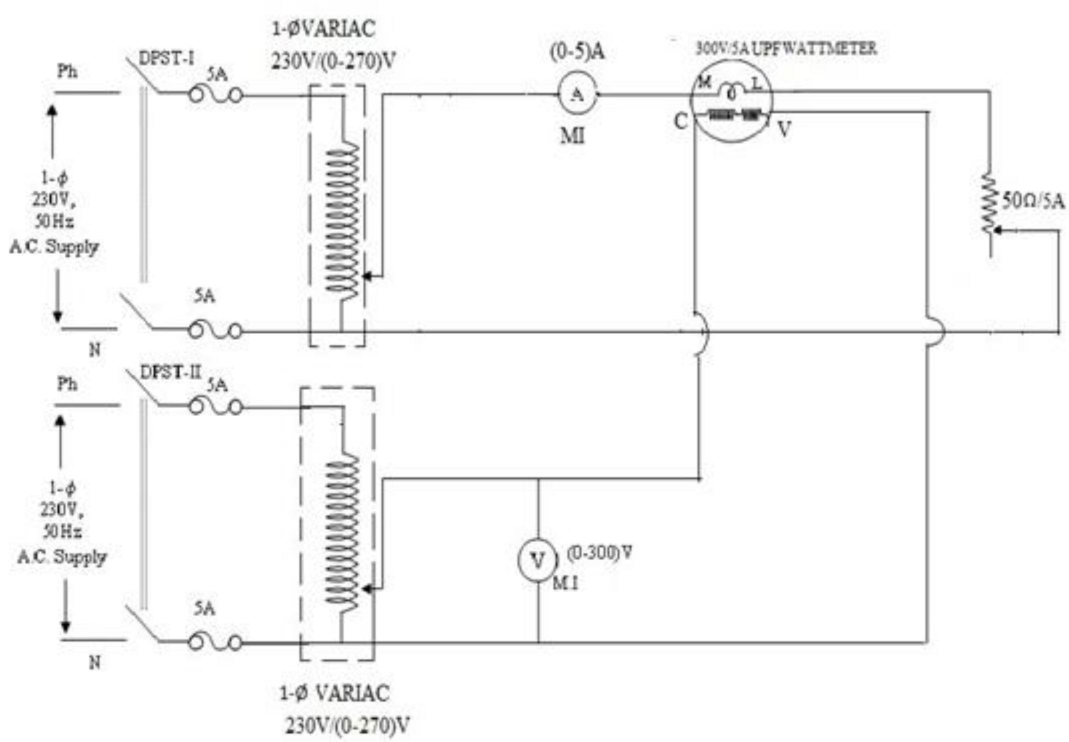
AIM:

To Calibrate the given UPF wattmeter by phantom loading.

APPARATUS REQUIRED:

S. NO	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY
1	Single Phase Variac	1-Ø	230V/(0-270)V 10A	2
2	Ammeter	MI	(0-5)A	1
3	Voltmeter	MI	(0-300)V	1
4	Wattmeter	UPF	300V,5A	1
5	Rheostat	WW	50Ω/5A	1
6	Connecting Wires	-	-	Required

CIRCUIT DIAGRAM:

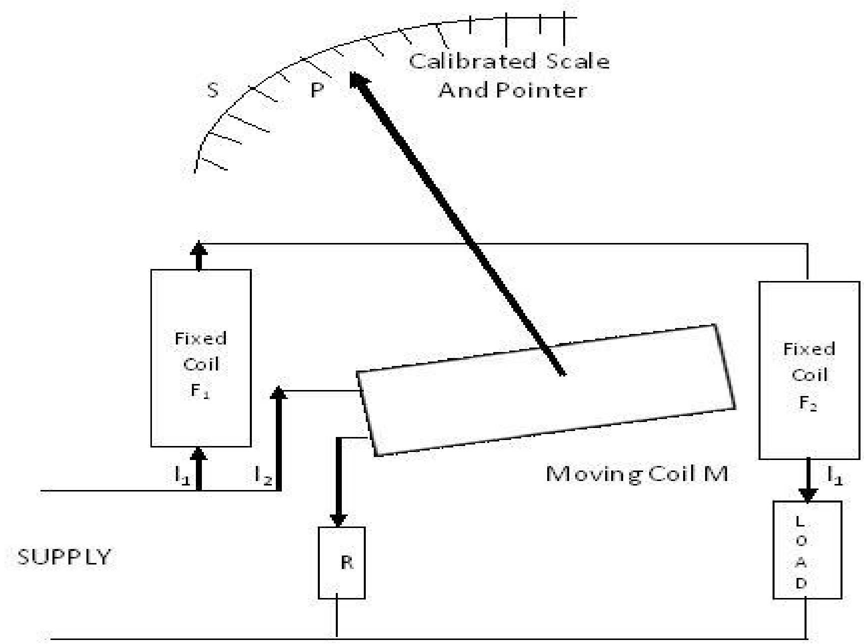


THEORY:

When the current rating of a meter under test is high a test with actual loading arrangements would involve a considerable waste of power. In order to avoid this "Phantom" or Fictitious" loading is done.

Phantom loading consists of supplying the pressure circuit from a circuit of required normal voltage, and the current from a separate low voltage supply as the impedance of this circuit very low. With this arrangement the total power supplied for the test is that due to the small pressure coil current at normal voltage, plus that due to the current circuit current supplied at low voltage. The total power, therefore, required for testing the meter with phantom loading is comparatively very small.

An electrodynamometer wattmeter consists of two fixed coils, FA and FB and a moving coil M as shown below.



The fixed coils are connected in series with the load and hence carry the load current. These fixed coils form the *current coil* of the wattmeter. The moving coil is connected across the load and hence carries a current proportional to the voltage across the load. A highly non-inductive resistance R is put in series with the moving coil to limit the current to a small value. The moving coil forms the *potential coil* of the wattmeter.

The fixed coils are wound with heavy wire of minimum number of turns. The fixed coils embrace the moving coil. Spring control is used for movement and damping is by air. The deflecting torque is proportional to the product of the currents in the two coils. Theses watt meters can be used for both DC and AC measurements. Since the deflection is proportional to the average power and the spring control torque is proportional to the deflection, the scale is uniform. The meter is free from waveform errors. However, they are more expensive.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keep the single phase variac (I & II) in minimum (or) zero volt position.
3. Switch on the single phase power supply.
4. Now gradually vary the variac ‘II’ up to the rated position (230V) without varying the variac ‘I’.
5. Then vary the variac ‘I’ for different current readings up to the rated current (5A) and note down the readings of ammeter, voltmeter and wattmeter.
6. After taking the readings, adjust the variac ‘I’ and ‘II’ to its minimum (or) zero volt position.
7. Finally switch off the single phase power supply.
8. Calculate the percentage error.

TABULAR FORM:

S. NO	VOLTMETER (V) VOLTS	AMMETER (I) AMPS	WATTMETER (W)WATTS	% ERROR

MODEL CALCULATIONS:

True Value = I^2R

Practical Value= Wattmeter Reading

%Error = [(True Value-Practical Value)/True Value]*100

MODEL GRAPH:

PRECAUTIONS:

1. Avoid loose connections.
2. Take readings without the parallax error.

RESULT:

Hence calibrated the UPF wattmeter by phantom loading test and the corresponding %Error, %Correction factor at different loads are calculated.

APPLICATIONS:

It is used in energy meter testing in order to avoid power wastage.

VIVA QUESTIONS:

1. What is meant by correction factor?
2. Is the load current in UPF wattmeter is high / low?
3. What is the difference between moving coil and fixed coil?
5. State a few errors in dynamometer wattmeter?
6. Applications of UPF wattmeter?

7. Measurement of 3-Phase Power with single wattmeter and 2 No's of C.T

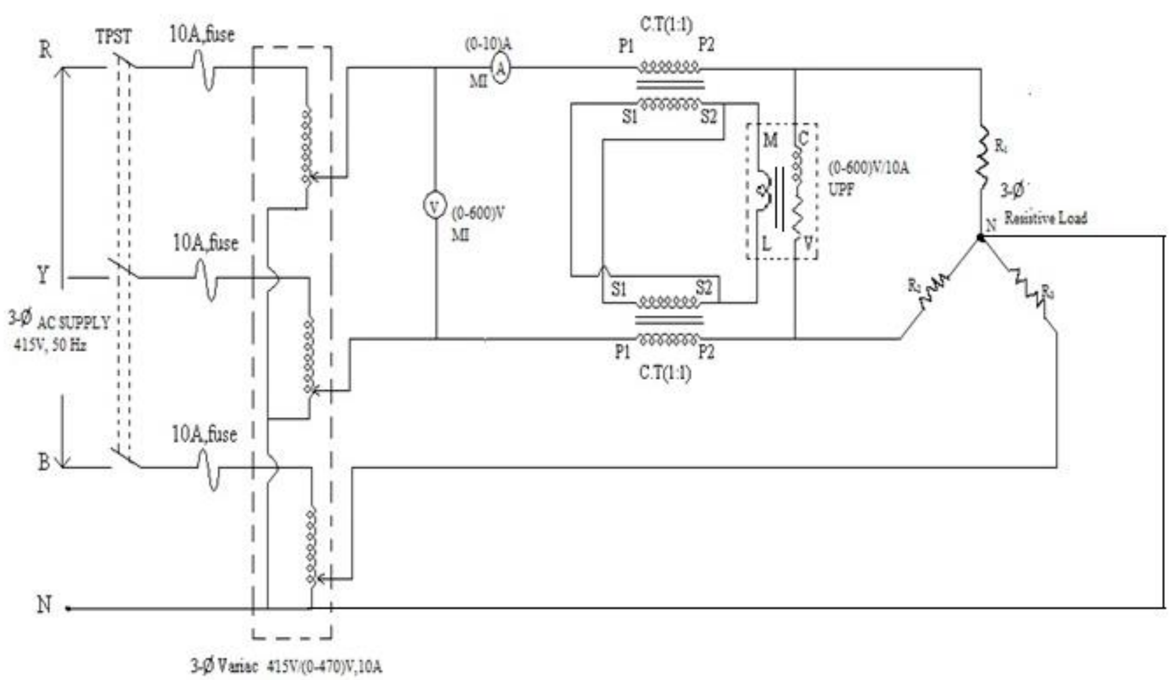
AIM:

To measure the 3- Phase power with single wattmeter and 2 No's of C.T.

APPARATUS:

S.NO	NAME OF THE EXPERIMENT	TYPE	RANGE	QUANTITY
1	Three Phase Variac	AC	415V/(0-470)V, 15A	1
2	Wattmeter	UPF	600V,10A	1
3	Voltmeter	MI	(0-600)V	1
4	Ammeter	MI	(0-10)A	2
5	Current Transformer		1:1,5/5A	2
6	Three Phase Load	Resistive Load	15A	1
7	Connecting Wires	-	-	Required

CIRCUIT DIAGRAM:



THEORY:

To measure 3- phase power using two CT's. Power can be measured in many ways, for an balanced load, only one wattmeter is enough to measure the 3- phase power, and for an unbalanced load, two wattmeter method is used to measure the 3- phase power. The primary windings of CT's are connected in series with two phases. The secondary of both the CT's are connected as shown in figure the current coil of wattmeter connected across both secondary's of CT's. The pressure coil is connected between the two phases.

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keep the three phase autotransformer at minimum or zero volt position.
3. Switch on the three phase power supply.
4. Vary the three phase variac slowly to its rated voltage (415V) and then apply the load in steps for different values and take the readings of the ammeter, voltmeter and wattmeter.
5. Now switch of the loads and adjust the variac to its previous (zero volt) position.
6. Switch off the three phase power supply.

FOR BALANCED CONDITION:

To check the balance condition, apply the two phase loads simultaneously and note down the two ammeter readings then it should show the same value.

TABULAR FORM:

S.NO	VOLTMETER (V_L)VOLTS	AMMETER (I_R)AMPS	AMMETER (I_Y)AMPS	WATTMETER (W)WATTS

For Balance Condition:

S. NO	VOLTMETER (V_L)VOLTS	AMMETER (I_R)AMPS	AMMETER (I_Y)AMPS	WATTMETER (W)WATTS

MODEL CALCULATIONS:

Three phase power is,

$$P = 3(VICOS\Phi)$$

PRECAUTIONS:

1. Avoid loose connections.
2. The secondary of CT should not be kept open.
3. Take readings without error.

RESULT:

Hence three phase active power (P=______KW) is calculated using single phase wattmeter and two CT's method at balanced and unbalanced load conditions.

VIVA QUESTIONS:

1. What is Burden of transformer?
2. Define (C.T&P.T) A. Transformation ratio
   B. Turns ratio
   C .Nominal ratio
   D .RCF
3. Why C.T secondary should not be opened?
4. Comparison between C.T & P.T

8. MEASUREMENT OF PARAMETERS OF CHOKE COIL USING 3-VOLTMETER AND 3-AMMETER METHODS

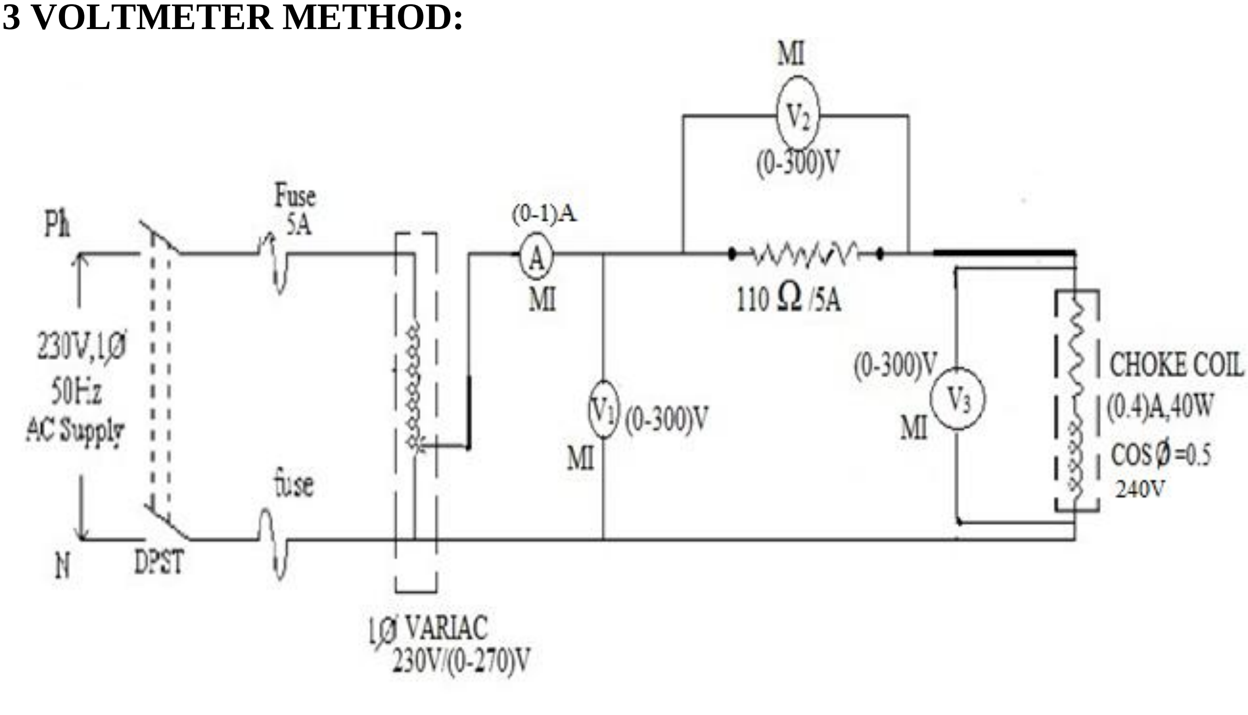
AIM:

To obtain the parameters (R, Z, L, X_L,) of given choke coil using 3 Voltmeter and 3Ammeter methods.

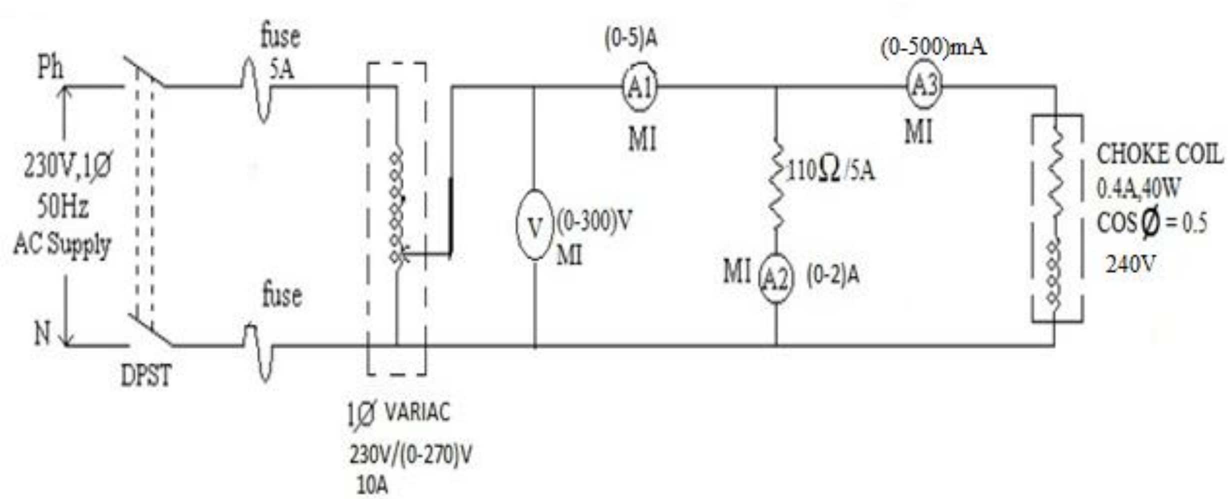
APPARATUS:

S.NO	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY
1	Single Phase Variac	AC	230V/(0-270)V,10A	1
2	Ammeter	MI	(0-500)mA	1
3	Ammeter	MI	(0-1)A	1
4	Ammeter	MI	(0-2)A	1
5	Voltmeter	MI	(0-300)V	3
6	Ammeter	MI	(0-5)A	1
7	Rheostat	WW	110Ω/5A	1
8	Choke Coil	-	0.4A, 40W, Cosϕ = 0.5, 240V	1
9	Connecting Wires	-	-	Required

3 VOLTMETER METHOD:



3 AMMETER METHOD:



THEORY:

An inductive transducer works on the principle of variation of inductance using multiple coils. The coils that are being used need to be evaluated and their parameters so defined such that the use of their parameters may be regarded as constant and accurate.

Thus emphasis needs to be laid upon the method of measurement of inductance of choke coil by using 3 voltmeter meter method and 3 ammeter methods.

Hence by using the known formulae we can calculate the inductance of a choke coil.

PROCEDURE FOR 3 VOLTMETER METHOD:

1. Connect the circuit as per the circuit diagram.
2. Keep the variac at minimum (or) zero volt position.
3. Now switch on the power supply.
4. Gradually vary the variac at different voltages up to rated voltage of choke coil and simultaneously note down the readings of the ammeter and three voltmeters.
5. Then adjust the variac to its minimum position.
6. Switch off the power supply.
7. Calculate the parameters of choke coil by the known formulae.

PROCEDURE FOR 3 AMMETER METHOD:

1. Connect the circuit as per the circuit diagram.
2. Keep the variac at minimum (or) zero volt position.
3. Now switch on the power supply.
4. Gradually vary the variac at different voltages up to rated current of choke coil and simultaneously take the reading of the voltmeter and three ammeters.

5. Then adjust the variac to its minimum position.
6. Switch off the power supply.
7. Calculate the parameters of choke coil by the known formulae.

TABULAR FORM:

FOR 3 VOLTMETER METHOD:

S. NO	V_1 VOLTS	I AMPS	V_2 VOLTS	V_3 VOLTS	CosΦ	SinΦ	R	Z	X_L	L

Average Inductance =
Average Resistance =

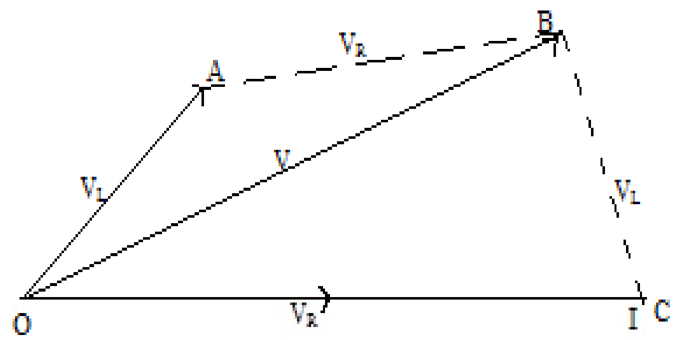
FOR 3 AMMETER METHOD:

S. NO	V VOLTS	I_1 AMPS	I_2 AMPS	I_3 AMPS	CosΦ	SinΦ	R	Z	X_L	L

Average Inductance =
Average Resistance =

MODEL CALCULATIONS:

From the Phasor Diagaram,



Let V_1=V, V_2= V_R, V_3=V_l and

We can write the Equation as

$(OB)^2 = (OA)^2 + (AB)^2 + 2(OA)(AB)COSØ$

$V^2 = (V_L)^2 + (V_R)^2 + 2V_LV_RCOSØ$ ------------------- 1

$V^2 – (V_L)^2 – (V_R)^2 = 2V_LV_RCOSØ$

$COSØ = V^2 – V_L{}^2 – V_R{}^2/2V_LV_R$

The above equation is for the COSØ.

From the equation 1, we can write as

$V^2= (V_L)^2 + (V_R)^2 + 2V_LIRCOSØ$

$V^2= (V_L)^2 + (V_R)^2 + 2PR$

$V^2 - (V_L)^2 - (V_R)^2= 2PR$

$P= V2 - (V_L)^2 - (V_R)^2/2R$

Similarly for the ammeter method, we can find the terms in I.

PRECAUTIONS:

1. Avoid loose connections.
2. Take readings without the parallax error.

RESULT:

By conducting 3-voltmeter and 3-ammeter method, the obtained parameters of choke coil are R=________, L=_________ respectively.

APPLICATIONS:

1. A choke is an inductor used to block higher-frequency alternating current (AC) in an electrical circuit, while passing lower-frequency or direct current (DC).
2. In fluorescent lamp circuit, Ac power pass through a 'choke' or 'reactor', this limits current and prevents the lamp from creating a type of short circuit which would destroy the lamp. All arc discharge lamps need a choke to limit current.
3. Choke practically produces enough voltage (for a very small time) to create a discharge between anode and cathode.

VIVA QUESTIONS:

1. What are the choke coil parameters?
2. What is the function of choke?
3. What are the methods are there to find choke coil parameters?
4. Which method is very important for finding the choke coil parameters?
5. What are the disadvantages of 3-voltmeter and 3-ammeter method?

9. Measurement of Power by 3 Voltmeter and 3 Ammeter methods

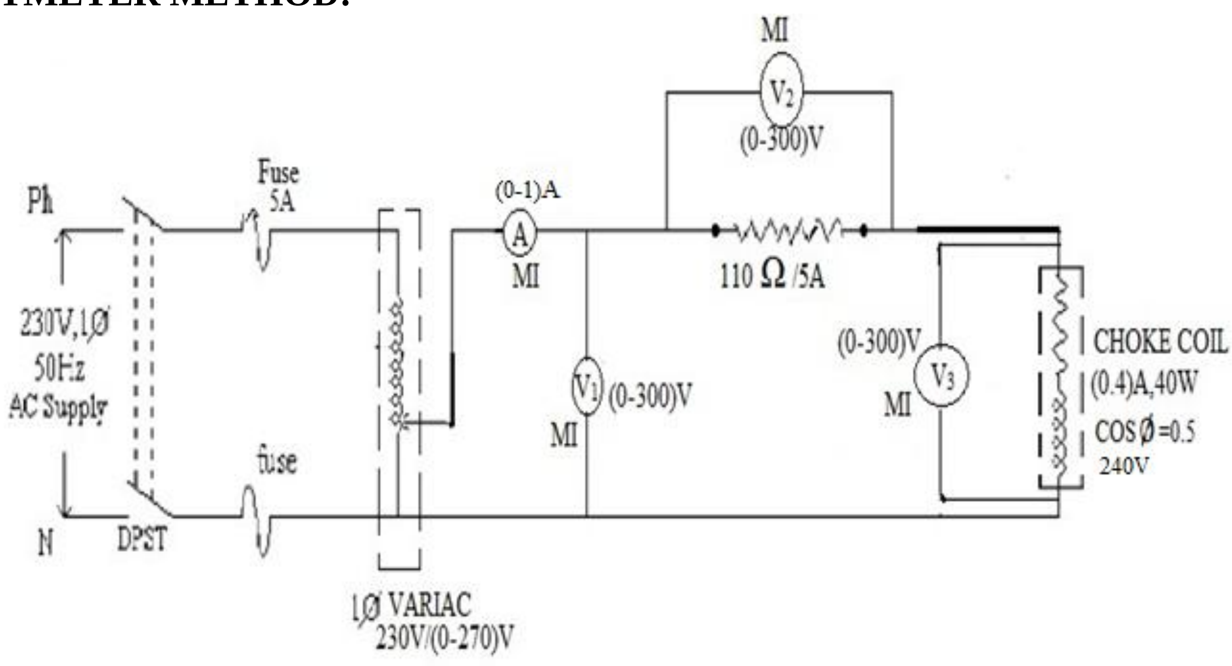
AIM:

To measure the Power by using 3 Voltmeter and 3Ammeter method.

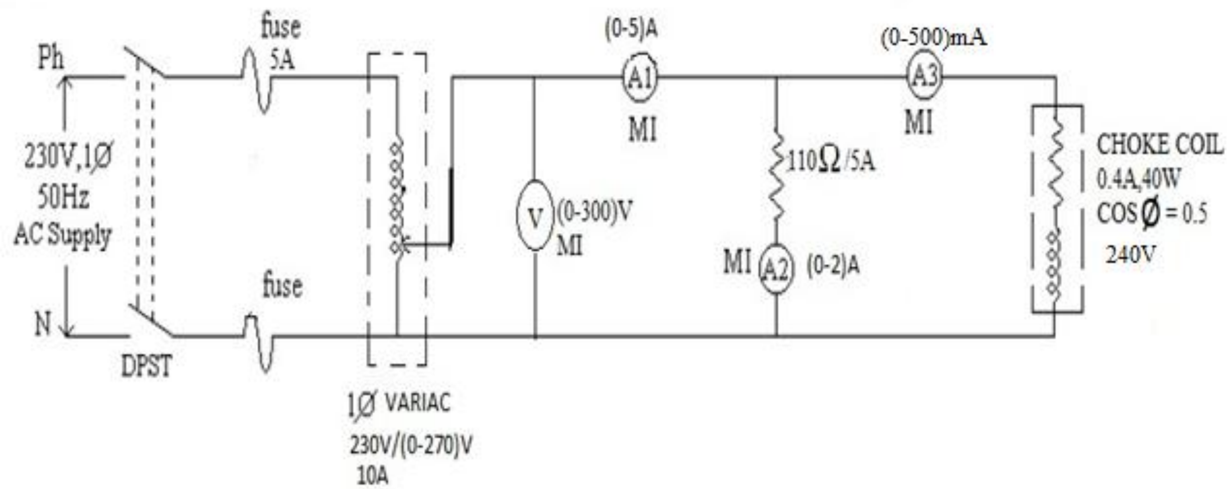
APPARATUS:

S.NO	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY
1	Single Phase Variac	AC	230V/(0-270)V,10A	1
2	Ammeter	MI	(0-500)mA	1
3	Ammeter	MI	(0-1)A	1
4	Ammeter	MI	(0-2)A	1
5	Voltmeter	MI	(0-300)V	3
6	Ammeter	MI	(0-5)A	1
7	Rheostat	WW	110Ω/5A	1
8	Choke Coil	-	0.4A, 40W, Cosϕ = 0.5, 240V	1
9	Connecting Wires	-	-	Required

3 VOLTMETER METHOD:



3 AMMETER METHOD:



THEORY:

An inductive transducer works on the principle of variation of inductance using multiple coils. The coils that are being used need to be evaluated and their parameters so defined such that the use of their parameters may be regarded as constant and accurate.

Thus emphasis needs to be laid upon the method of measurement of inductance of choke coil by using 3 voltmeter meter method and 3 ammeter methods.

Hence by using the known formulae we can calculate the inductance of a choke coil.

PROCEDURE FOR 3 VOLTMETER METHOD:

1. Connect the circuit as per the circuit diagram.
2. Keep the variac at minimum (or) zero volt position.
3. Now switch on the power supply.
4. Gradually vary the variac at different voltages up to rated voltage of choke coil and simultaneously note down the readings of the ammeter and three voltmeters.
5. Then adjust the variac to its minimum position.
6. Switch off the power supply.
7. Calculate the power of choke coil by the known formulae.

PROCEDURE FOR 3 AMMETER METHOD:

1. Connect the circuit as per the circuit diagram.
2. Keep the variac at minimum (or) zero volt position.
3. Now switch on the power supply.
4. Gradually vary the variac at different voltages up to rated current of choke coil and simultaneously take the reading of the voltmeter and three ammeters.
5. Then adjust the variac to its minimum position.
6. Switch off the power supply.
7. Calculate the power of choke coil by the known formulae.

TABULAR FORM:

FOR 3 VOLTMETER METHOD:

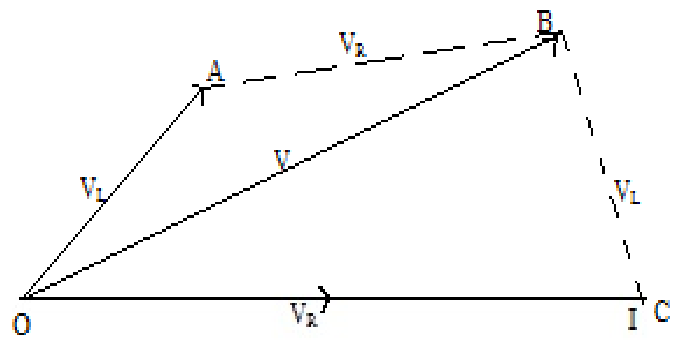
S. NO	V_1 VOLTS	I AMPS	V_2 VOLTS	V_3 VOLTS	CosΦ	Power WATTS

FOR 3 AMMETER METHOD:

S. NO	V VOLTS	I_1 AMPS	I_2 AMPS	I_3 AMPS	CosΦ	Power (P) WATTS

MODEL CALCULATIONS:

From the Phasor Diagaram,



We can write the Equation as

$(OB)^2 = (OA)^2 + (AB)^2 + 2(OA)(AB)COSØ$

$V^2 = (V_L)^2 + (V_R)^2 + 2V_LV_RCOSØ$ ------------------- 1

$V^2 – (V_L)^2 – (V_R)^2 = 2V_LV_RCOSØ$

$COSØ = V^2 – V_L{}^2 – V_R{}^2/2V_LV_R$

The above equation is for the COSØ.

From the equation 1, we can write as

$V^2= (V_L)^2 + (V_R)^2 + 2V_LIRCOSØ$

$V^2= (V_L)^2 + (V_R)^2 + 2PR$

$V^2 - (V_L)^2 - (V_R)^2= 2PR$

$P= V^2 - (V_L)^2 - (V_R)^2/2R$

Simillarly for the ammeter method, we can find the terms in I.

PRECAUTIONS:

3. Avoid loose connections.
4. Take readings without the parallax error.

RESULT:

Hence calculated the Power =____________ by using 3 Voltmeter and 3 Ammeter method respectively.

APPLICATIONS:

1. A choke is an inductor used to block higher-frequency alternating current (AC) in an electrical circuit, while passing lower-frequency or direct current (DC).

2. In fluorescent lamp circuit, Ac power pass through a 'choke' or 'reactor', this limits current and prevents the lamp from creating a type of short circuit which would destroy the lamp. All arc discharge lamps need a choke to limit current.

3. Choke practically produces enough voltage (for a very small time) to create a discharge between anode and cathode.

VIVA QUESTIONS:

1. What is the function of choke?
2. If we connect the voltmeter in series with the load what will happen?
3. If an ammeter is connected across the A.C line what will happen.

10. CALIBRATION OF PMMC AMMETER AND VOLTMETER USING D.C CROMPTON POTENTIOMETER

AIM:

To Calibrate PMMC Ammeter and Voltmeter using DC Crompton potentiometer

APPARATUS REQUIRED:

S.NO	NAME OF THE EQUIPMENT	TYPE	RANGE	QUANTITY
1	DC Crompton potentiometer	DC	-	1
2	Standard Cell	DC	1.0186V	1
3	Volt Ratio Box	-	Output 0-1.5V Input 0-1.5, 15, 30,100,300V	1
4	Regulated power supply (RPS)	DC	(0-30)V	1
5	Ammeter	MC	(0-2)A	1
6	Voltmeter	MC	(0-300)V	1
7	Sensitive galvanometer	Spot reflecting MC type	30-0-30	1
8	Standard resistance		0.1Ω,10A	1
9	Rheostat		50Ω,5A	1
10	Battery		2V	1
11	DC Supply		220V	1
12	Connecting Wires			Required

CIRCUIT DIAGRAM:

CALIBRATION OF VOLTMETER

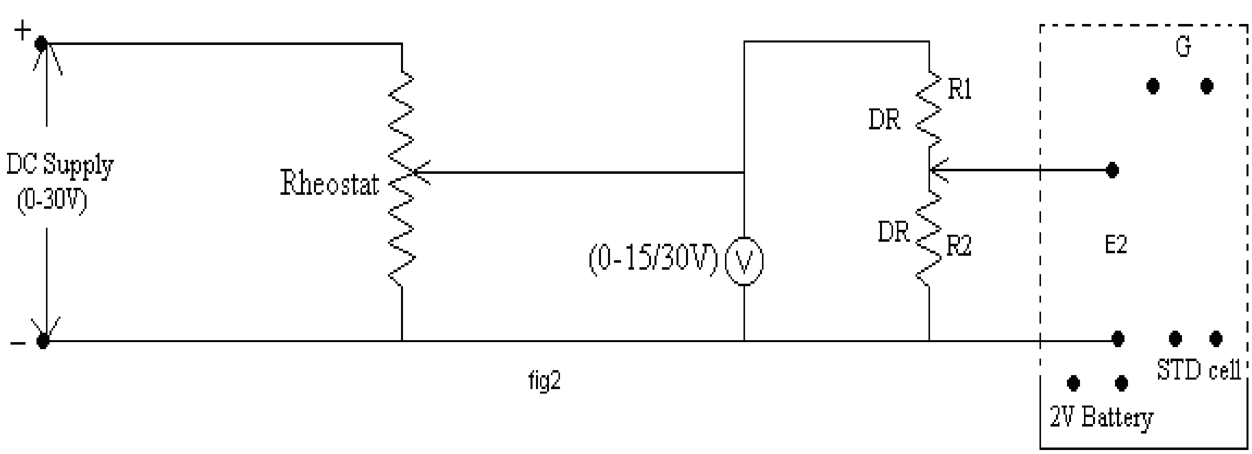
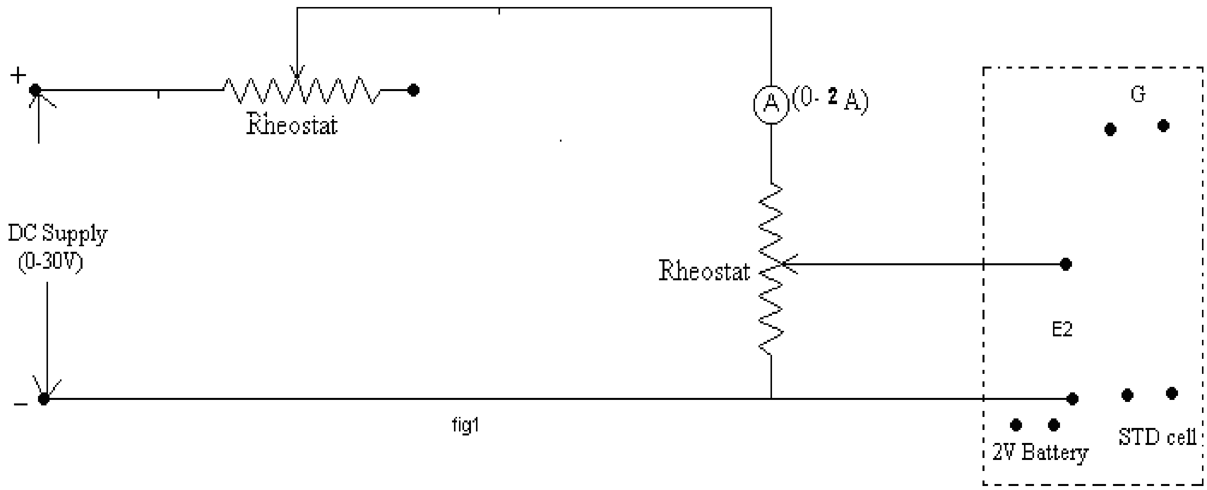


fig2

CALIBRATION OF AMMETER:



THEORY:

A Potentiometer is an instrument designed to measure an unknown voltage by comparing it with a known voltage. The known voltage may be supplied by a standard cell or any other known voltage – reference source. Measurements using comparison methods are capable of a high degree of accuracy because the result obtained does not depend upon on the actual deflection of a pointer, as is the case in deflectional methods, but only upon the accuracy with which the voltage of the reference source is known. Another advantage of the potentiometers is that since a potentiometer makes use of a balance or null condition, no current flows and hence no power is consumed in the circuit containing the unknown emf when the instrument is balanced. Thus the determination of voltage by a potentiometer is quite independent of the source resistance.

It can also be used to determine current simply by measuring the voltage drop produced by the unknown current passing through a known standard resistance. The potentiometer is extensively used for a calibration of voltmeters and ammeters and has in fact become the standard for the calibration of these instruments. For the above mentioned advantages the potentiometer has become very important in the field of electrical measurements and calibration.

Modern laboratory type potentiometers used calibrated dial resistors and a small circular wire of one or more turns, thereby reducing the size of the instrument. The resistance of slide wire is known accurately, the voltage drop along the slide wire can be controlled by adjusting the value of working current. The process of adjusting the working current so as to match the voltage drop across a portion of sliding wire against a standard reference source is known as "Standardisation".

PROCEDURE:
STANDARDIZATION:

1. Connections are made as per the circuit diagram.
2. Keep the function knob of the potentiometer at STD position. Switch on the 2V Supply
3. Adjust the main dail and slide wire of the potentiometer to read standard cell voltage (1.0186V).
4. Press the galvano key of the potentiometer and adjust the coarse and fine rheostats until the galvanometer gives null deflection. This completes standardization of the potentiometer. Once standardization is done the position of R1(coarse rheostat) & R2(fine rheostat) should not be changed.

CALIBRATION:
PMMC VOLTMETER:

1. Voltmeter under test is connected across potential divider in such a way that p.d across Voltmeter can be varied
2. V.R box is used in parallel to potentiometer to reduce voltage to the range of potentiometer
3. Change the function knob to E1 position. Switch on RPS and adjust a suitable voltage on V.R Box.
4. Press the galvano key of the potentiometer and adjust the slide contact and slide wire until the spot reflecting galvanometer gives null deflection.
5. Note down the readings of voltmeter, and potentiometer slide contact and slide wire readings.
6. Repeat the steps 4 and 5 for different voltages from RPS
7. Reduce the voltage of RPS and RPS to zero. Switch off the supply.
8. Draw the graph between Load current (vs) % Error.

PMMC AMMETER:

1. Ammeter to be calibrated is connected in series with variable resistor R & standard resistance S.
2. The standard resistance should of such a magnitude that current passed through it doesn’t exceed range of potentiometer.
3. V.R box is used in parallel to potentiometer to reduce voltage to the range of potentiometer
4. Keep the rheostat at maximum position and change the function knob to E1 position. Switch On RPS(2) and apply 30 volts.
5. Vary the rheostat gradually and adjust suitable current.
6. Press the galvano key on the potentiometer and adjust the slide contact and slide wire until the spot reflecting galvanometer gives the null deflection.
7. Note down the readings of ammeter, voltmeter, and potentiometer slide contact and slide wire readings.
8. Repeat the steps 5 to7 for different values of current.
9. Vary the rheostat to maximum position, reduce the voltage of RPS and RPS to zero. Switch

off the supply.

10. Draw the graph between Load current (vs) % Error.

TABULAR FORM:
FOR VOLTMETER:

S. No	Voltmeter reading(V) , V_{True}	E2 value(V)	V_{act}=(Coarse +Fine)*E2	% Error

For Ammeter:

S. No	Ammeter Reading(A), I_{True}	E_2 Value(V)	I_{act} = E/R	% Error

VOLTMETER CALCULATION:

Calibration of voltmeter:

V–R Box ratio = Input voltage / Output voltage

V_{True} = Voltmeter reading

V_{Act} = Reading obtained from potentiometer

= [Coarse voltage + Fine voltage] x Ratio of volt-ratio box

%Error = [(True value – Practical value) / (True Value)] * 100

AMMETER CALCULATION:

I_{True}= Ammeter reading

I_{Act}= $(Coarsevolt + Finevolt) * RatioofVoltRatiobox \big/ Standard Resistance$

%Error = [(True value – Practical value) / (True Value)] * 100

PRECAUTIONS:

1. Connect the circuit without loose connections.
2. Don’t vary the coarse and fine pots, after standardization.

RESULT:

Hence the calibration of PMMC Voltmeter and Ammeter is done using DC Crompton potentiometer and also calculated the %Error = ____and the corresponding %Correction factor.

APPLICATIONS:

1. Calibration of voltmeter and Ammeter.
2. Measurement of resistance.
3. Calibration of Wattmeter.
4. Measurement of unknown E.M.F.

The potentiometer method is the usual basis for the calibration of voltmeters, ammeters and watt meters. Since the potentiometer is a d.c. measurement device, the instruments to be calibrated must be of the d.c or electric dynamometer type.

VIVA QUESTIONS:

1. What do you mean by a potentiometer?
2. What are the types of potentiometer?
3. What is the working principle of a potentiometer?
4. What is standardization of potentiometer?
5. What is the purpose of connecting a standard battery in the circuit?
6. Application of dc potentiometer?
7. What do you mean by calibration curve of the ammeter?
8. What do you mean by a volt-ratio box?
9. What are the types of AC potentiometer?
10. What are the practical applications of ac potentiometer?

11. SILSBEES METHOD OF TESTING CURRENT TRANSFORMER

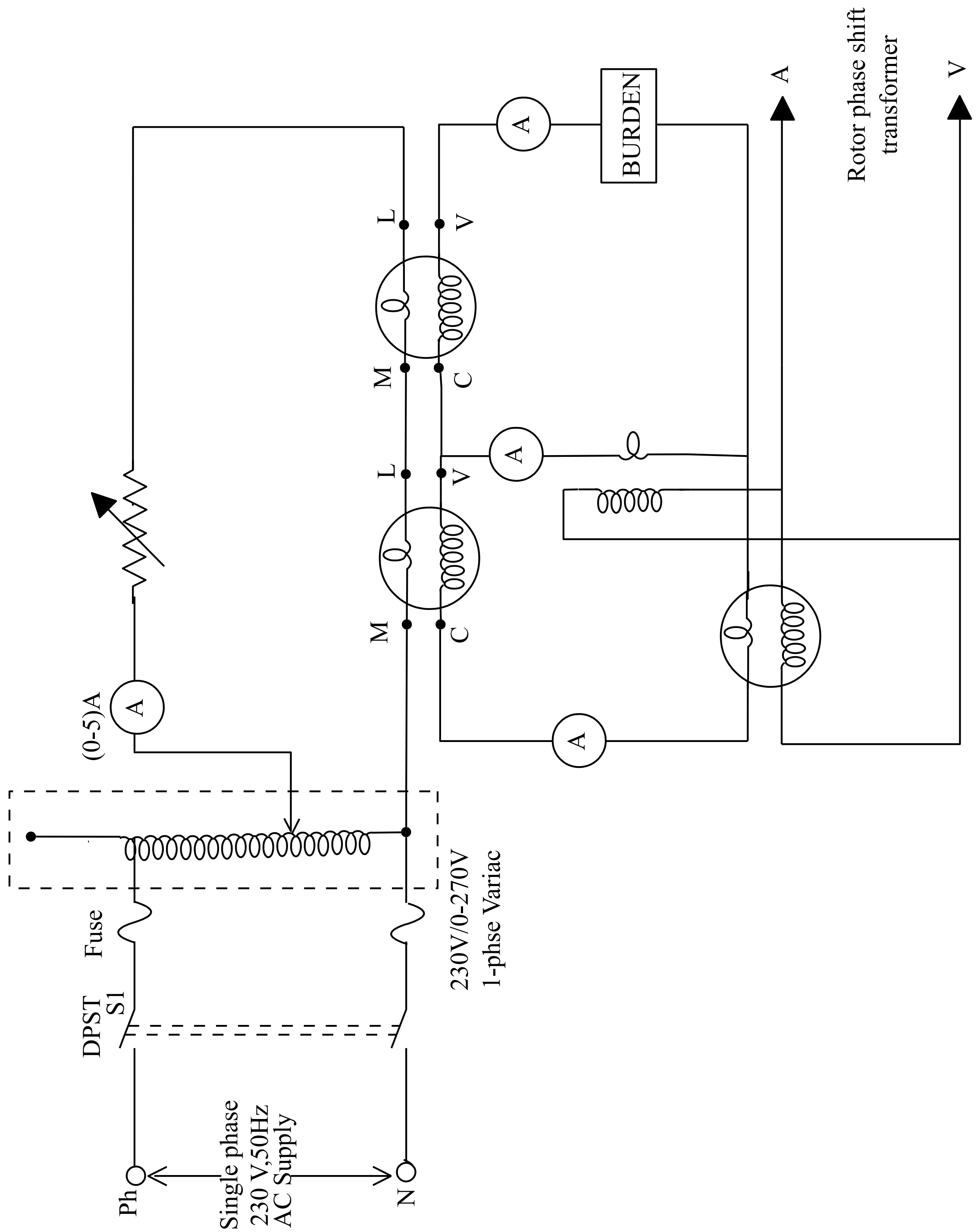
AIM:

To determine the percentage ratio error and the phase angle error of the given current transformer by comparison with another current transformer whose error are known

APPARATUS:

THEORY:

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit as per circuit shown.’
2. Using the auto T/ F, the current through the primary in gradually increased.
3. The difference b/ w C.T secondaries Δ I should be zero, if it is not zero then connection to any one of C.T secondaries are reversed .
4. The current I_p through C.T primaries is made equal to a fixed value using auto T/F.
5. By operating the phase shifter, W_1 is made zero. The readings of ammeter and W_2 are noted.
6. Now, W_1 is adjusted to maximum value by rotating phase shifting T/ F and ammeter and W_2 readings are noted.
7. Above procedure is repeated for different primary current.

PRECAUTIONS:

1. Avoid loose connections.
2. Readings to be taken without parallax error.

TABULAR FORM:

S.No	I(A)	I_{ss} (A)	W_{1q}(W)	W_{2q} (W)	W_{1P}(W)	W_{2P}(W)	R_x	θ_x
1								
2								
3								
4								

RESULT:

By conducting this experiment obtained the percentage ratio error ---------------and phase angle error ---------- at I -------------(Amps), W_{1q} ----------(watts), W_{2q} ----------(watts), W_{1p} ----------(watts), W_{2p} ----------(watts).

APPLICATIONS:

VIVA QUESTIONS:

1. Why the C.T & P.T are called instrument transformers?
2. Why we have to close the secondary of a C.T always?
3. What are the different errors in C.T's ?
4. What is the procedure to conduct silsbee's method?
5. Is there any another method to test the C.T?
6. What are the advantages & dis advantages in silsbee's method?