EXPERIMENT NO. 1

AIM: To measure the earth resistance.

APPARATUS REQUIRED:

Sr. no	Name of Equipment	Range	Quantity
1	Earth tester	-	1
2	Spikes	-	3
3	Connecting wires	-	As per connection

THEORY:

All the electrical installations and appliances should be earthed properly for ensuring human safety. A separate wire, known as earth wire runs along the supply line and is connected to the ground through an earth electrode. The total resistance of the earthing system should be small so that in the event of any fault, the fault current is sufficiently high to blow off the fuse. The earth resistance is the resistance offered by the soil and the electrode to the flow of earth leakage current, which will flow in case of earth fault only. The earth tester is a special type of ohmmeter which sends ac through earth and dc through the measuring instruments as shown in Fig. The direction of flow of current in the ground keeps on alternating due to current reverse whereas current directions in the two reverser and potential reverser are mounted on the main shaft of hand driven dc generator. The working principle of an earth tester is identical to that of megger. There are two moving coil viz. potential and current coil, which are deflected in the magnetic field of a permanent magnet. The hand driven generator or a set of batteries supply power to these coils. It has four terminals P1, E1, P2 and E2. Terminals P1 and E1 are shorted to form a common point which is connected to the earth electrode under test. The other two terminals E2 and P2 are connected to the auxiliary electrode A and B respectively. The value of earth resistance is indicated directly on the scale when the test button is pressed. The value of earth resistance depends upon the soil condition and its moisture contents. In hilly areas the earth resistance is higher if electrodes are not place properly in contact with the earth. Water content in the soil decreased the earth resistance. The normal value of earth resistance should lie between 1 to 2Ω.

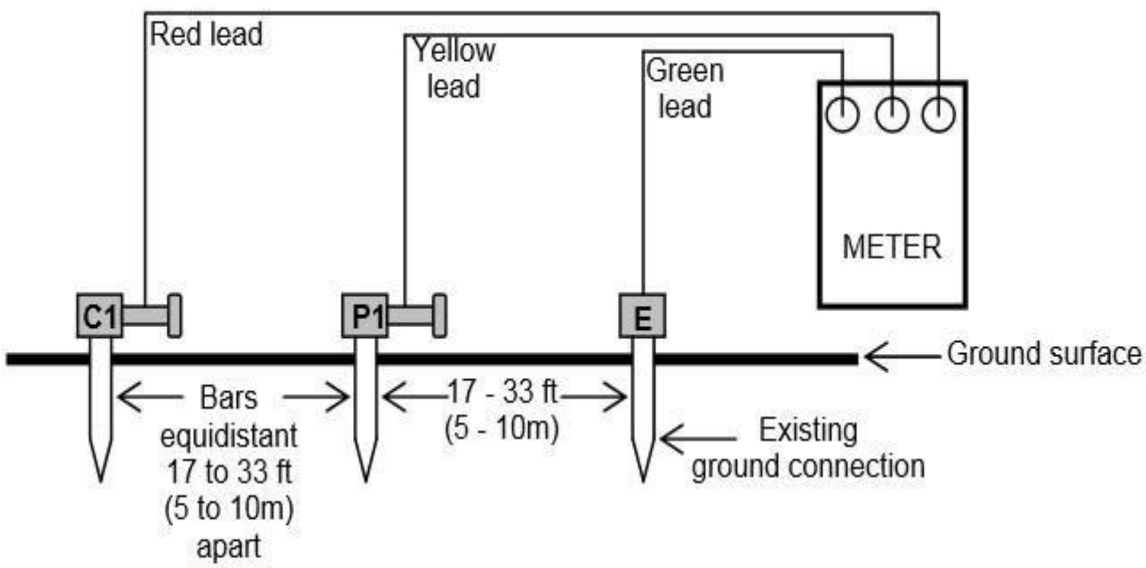
PROCEDURE :-

Connect the earth tester as shown in Fig.

2. Switch ON the earth tester

3. Adjust the resistance range button between 10Ω to 1000Ω and set to 10Ω.

4. Change the position of electrode B by 1m on the either side and observe the earth resistance by pressing the test button.



OBSERVATION TABLE :

Sr. No	Position of Rod	Earth resistance
Average Earth Resistance		

CONCLUSION

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EXPERIMENT NO. 2

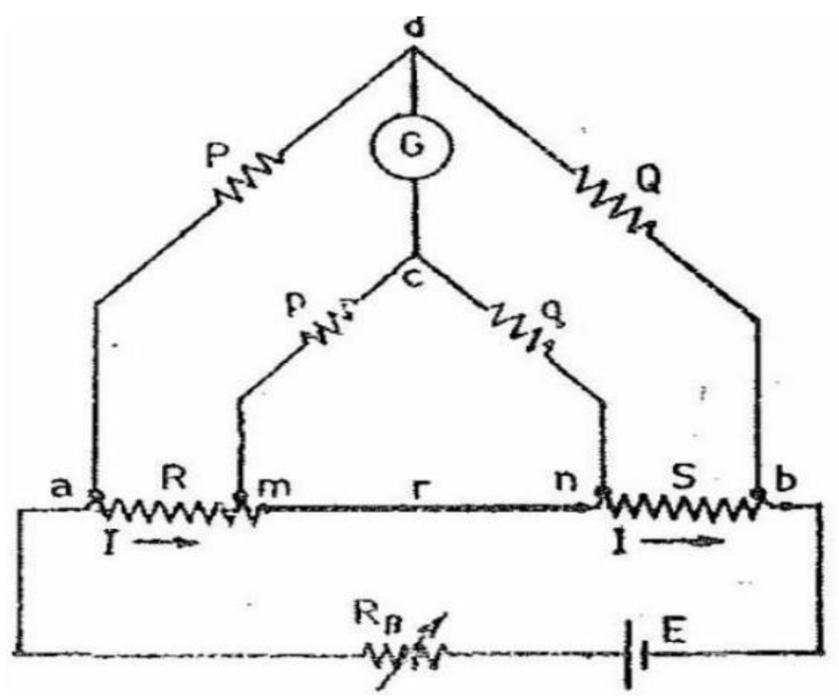
AIM: To measure the low resistance by using Kelvin's double bridge.

APPARATUS REQUIRED:

S. No	Name of the Apparatus	Type	Range	Quantity
1.	Kelvin's Double Bridge Kit			
2.	Rheostats			
3.	Connecting Wires			

Theory

Kelvin's double bridge or simply Kelvin's bridge (as it is commonly known as) is employed when a very low value of resistance is to be measured. Consider the value of resistance is in the magnitude of contact leads. For low resistance measurement, the resistance of lead and contacts becomes significant and can introduce an error; this can be eliminated using Kelvin"s bridge. This bridge is a modification over other DC bridges and provides greatly increased accuracy in measurement of low resistance. Figure below illustrates the basic principle of Kelvin"s bridge



PROCEDURE

1. Connect the circuit as shown in the diagram.
2. Keep the current switch at 'OFF' position.
3. Set the 12V supply in the DC battery.
4. Now keep the current switch value at 'NORMAL'.
5. Set the multiplier value (say 'X10').
6. Now adjust the 'Milli Ohms Fine (multiplier of 10mΩ)' & 'Milli Ohms Coarse (multiplier of 0.1Ω)'.
7. Press the 'INITIAL' button, and see whether the galvanometer deflects or not. If it deflects, repeat the steps 5 & 6 until the galvanometer shows zero deflection when 'INITIAL' button is pressed.
8. If the galvanometer shows zero deflection, Keep the current switch at 'REVERSE' position, and check whether the galvanometer is deflecting or not.
9. When galvanometer shows no deflection, take the values of Coarse, Fine and multiplier and calculate the value of unknown resistance by formula.

$R= n(C+F) * 10^{-3}\ \Omega$ where, C=Coarse value, F=Fine value, n=multiplier

OBSERVATION TABLE:

S. No	Multiplier	Resistance(Coarse)mΩ	Resistance (Fine)mΩ	$R=n*(C+F)*10^{-3}\ \Omega$

CONCLUSION

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EXPERIMENT NO:3

AIM: To measure the capacitance of given capacitor using Schering Bridge.

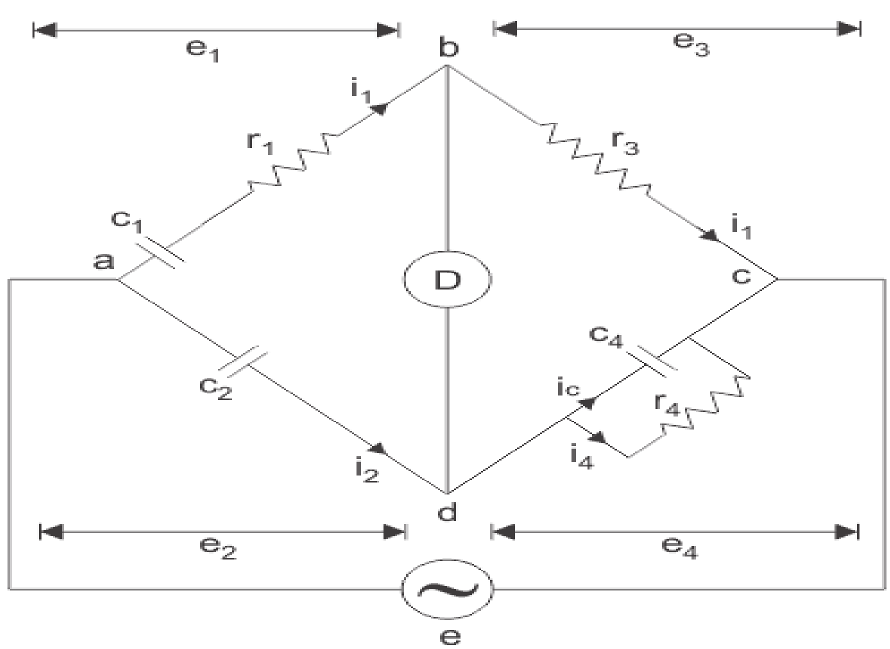
APPARATUS REQUIRED:

S. No	Name of the Apparatus	Type	Range	Quantity
1.	Schering Bridge Kit			
2.	Headphones			
3.	Connecting Wires			

THEORY-

The Schering's bridge gives the accurate measurement of self-Capacitance of the circuit. The bridge is the advanced form of Maxwell's inductance capacitance bridge. In Anderson bridge, the unknown inductance is compared with the standard fixed capacitance which is connected between the two arms of the bridge.

The bridge has fours arms ab, bc, cd, and ad. The arm ab consists unknown inductance along with the resistance. And the other three arms consist the purely resistive arms connected in series with the circuit. The static capacitor and the variable resistor are connected in series and placed in parallel with the cd arm. The voltage source is applied to the terminal a and c.



PROCEDURE:

1. Check the o/p of 1 kHz oscillator.
2. Note down the values of R_3, C_2.
3. Set R_4 at maximum & r_1 at minimum resistance.
4. Form the bridge as shown on the front panels by making all connections.
5. Choose the values of standard capacitor, C_4.
6. Connect the unknown capacitance, C_5 at 'C' terminal on the trainer.
7. Now apply 1 kHz Signal at bridge i/p terminal.
8. Connect the head phones at detector terminal & listen for sound.
9. Now, vary R_4 for min sound. At one value of R_4 sound will be minimum. Fix R_4 at that value & donot disturb it.
10. Now vary r_1 for least sound. Fix 'r_1' at value where the sound is less. Now parallel vary R_4, r_1 to geteven less sound; at one point the sound will not become complete silent due to dielectric loss of capacitors.
11. Note down the various values of R_4, r_1, C_4.
12. Calculate the unknown capacitance using the formula.

$$C_1 = R_4 / R_3 * C, \text{ where } C = C_5$$

$$r_1 = C_4 / C_2 * R_3$$

13. Calculate the dissipation factor $D = \omega C_1 R_1$, $\omega C_4 R_4$.
14. Repeat the above procedure with different values of standard capacitances & compare and also repeat for different values of unknown capacitances C_6, C_7, C_8, and C_9.
15. The theoretical & practical values may be slightly different due to various factors such as dielectric loss of capacitors, tolerance of resistors & some other factors.

Observation Table:

S. No	C4 (F)	R4(Ω)	R1(Ω)	R3(Ω)	C (F)

CONCLUSION

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EXPERIMENT NO:4

AIM: To measure the self-inductance of a given coil using Anderson's Bridge

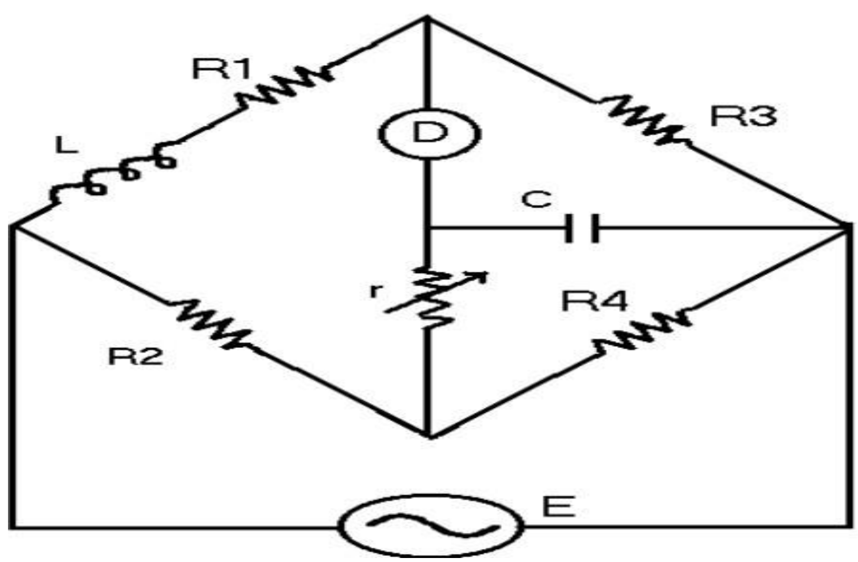
APPARATUS REQUIRED:

S. No	Name of the Apparatus	Type	Range	Quantity
1.	Anderson's Bridge kit			
2.	Head phones			
3.	Connecting Wires			

THEORY-

The Anderson's bridge gives the accurate measurement of self-inductance of the circuit. The bridge is the advanced form of Maxwell's inductance capacitance bridge. In Anderson bridge, the unknown inductance is compared with the standard fixed capacitance which is connected between the two arms of the bridge.

The bridge has fours arms ab, bc, cd, and ad. The arm ab consists unknown inductance along with the resistance. And the other three arms consist the purely resistive arms connected in series with the circuit. The static capacitor and the variable resistor are connected in series and placed in parallel with the cd arm. The voltage source is applied to the terminal a and c.



PROCEDURE:

1. Note down the practical resistances of R_1, R_2 and R_4.
2. Form the Anderson's bridge as shown on front panel with the help of patch cards.
3. First the bridge should be balanced for DC to find the DC resistances of self inductance. As R_1, R_2, R_4 are equal to 1kΩ, the fourth arm total resistance should also be 1kΩ.
4. Apply +12V DC into the bridge supply terminals & connect the galvanometer at detector terminals. Connect the inductor at inductor terminals.
5. Set 'r' at 0Ω. Now slowly vary R_3 till the galvanometer shows the zero deflection. Do not disturb itthroughout the experiment. The DC resistance of the inductor is equal to 1000Ω minus value of R_3.
6. Now connect audio oscillator of 1 kHz and head phones at detector terminals.
7. Now initially vary 'r' for min sound for i.e. for second balance.
8. At one value of 'r', the sound will be minimum. Since the capacitor has some dielectric loss in the head phones, perfect silence cannot be obtained but minimum sound can be obtained.
9. Now, slowly vary 'r' and R_3 simultaneously for least sound.

1. The value of 'C' should be chosen that there is sufficient adjustment in the value of 'r' when 'C' will be small & 'r' will be large.
2. Now, note down all the values such as C & r, R_3 etc. The value of self inductance can be found outby the formula.

$$L=C(r\ (R_1+R_2) + R_1R_4)$$

3. The bridge is useful for measuring small value of inductance in the range of 50mH to 200mH.

Note: The capacitor value of 0.01μF or 0.02μF should be used for obtaining best results. The value of 'r' will be between few Ω to few kΩ.

Observation Tables:

S. No	C (μF)	r (kΩ)	R3 (Ω)	L (mH)

CONCLUSION

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EXPERIMENT NO. 5

AIM: Measurement of High resistance and Insulation resistance using Megger.

APPARATUS REQUIRED:

S. No	Name of the Apparatus	Type	Range	Quantity
1.	Megger			
2	Connecting wires			
3	Sigle phase Xmer			
4	wire			

THEORY

Megger is used for the measurement of insulation resistance. It also measures the resistance of the insulator. The megger measures insulation or high resistance in terms of mega ohms. There are different types of megger instruments depending upon on the voltage rating such as:

- 500V
- 1000V
- 5 KV

Insulation and insulation resistance:

Insulation in simple terms means that it is offering some resistance to the current or heat flow. The insulation resistance of all appliances should be checked at regular interval of time because it gives the information about the condition of the appliance or wire. The insulation resistance depends upon the moisture, temperature, test voltage and duration of the appliance. The internal resistance of the wire is very less due to which the current easily flow in it. On wire we have small or thin coat of rubber like a synthetic material which is called insulation and without this insulation what will happened? If the wire has no insulation and it touches the equipment body or if a human touch this wire there will be flow of electric current and causing electric shock. So for this reason the wires covered with insulation. So this in mind insulation is a material which offers very high resistance to the flow of electricity. Insulation offers resistance to the leakage current.

PROCEDURE:-

1) Select the voltage range on Megger according to rating of equipment
2) Isolate the connection
3) Connect one terminal with ground
4) Connect terminal with equipment
5) Manually vary the Megger and take the reading

OBSERVATION TABLE

Sr. No	Name of Equipment	Insulation Resistance
1	Cable	
2	Single phaseTransformer	

CONCLUSION

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EXPERIMENT NO. 6

AIM: To measure the three-phase power by one wattmeter method.

APPARATUS REQUIRED:

S. No	Name of the Apparatus	Type	Range	Quantity
1.	One Wattmeter			
2.	RLC load bank			
3.	Connecting Wires			

THEORY:

In a balanced 3 wires, three phase load circuit the wire in each phase is equal and , therefore, total power of the circuit can be determined by multiplying the power measured in anyone phase by three.

$$W = W1+W2 + W3 \qquad (1)$$

With a balanced load, the total power is

$$W = 3\ W3 = 3\ Vp\ Ip\ Cos\phi \qquad (2)$$

Where, Vp = phase voltage

Ip = phase current

$Cos\phi$ = power factor of any phase

ϕ = phase angle between phase voltage and phase current

V_L= line voltage

I_L = line current

The total power of a balanced star or delta connected load is given by

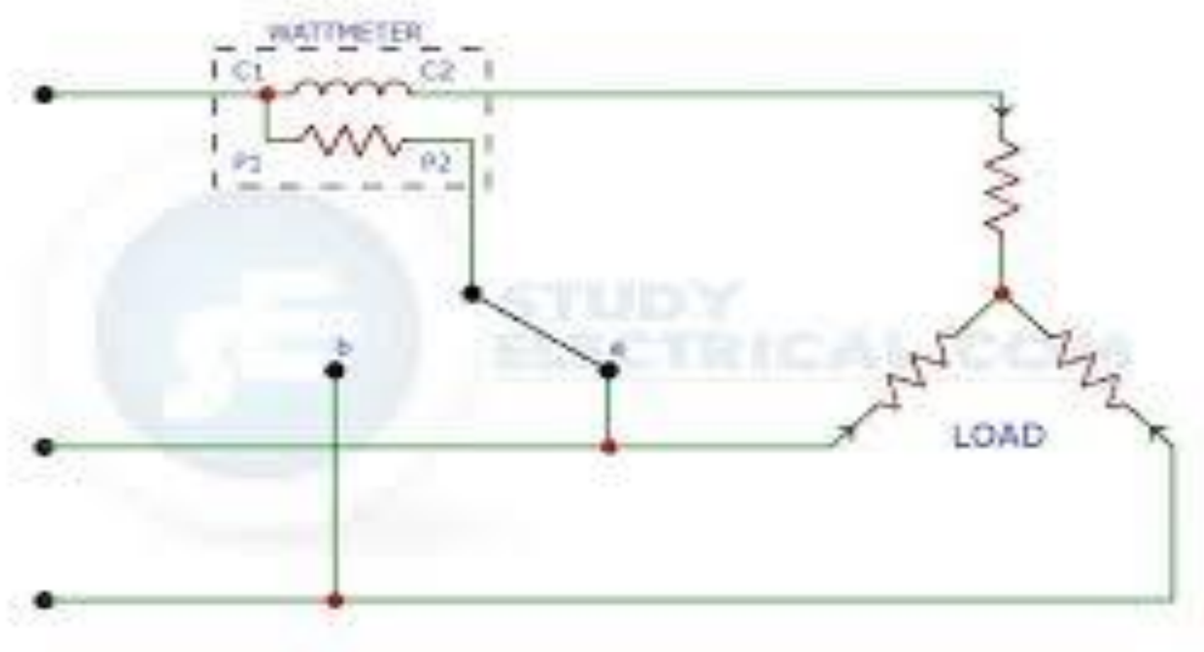
$$W = \sqrt{3}\ V_L\ I_L\ Cos\phi \qquad (3)$$

If the neutral point in a star-connected system is accessible, the power may be calculated from the readings of one wattmeter whose current coil has to carry the phase current and the voltage coil the phase voltage of the same phase. The total power is three times the power in one line.

$$W = 3 * W3 \qquad (4)$$

In a delta or star connected system with no access to neutral point, the power may be calculated from the readings of two wattmeters whose current coils are carrying line currents & the voltage coil are connected between the same lines and the third line. The total power is the algebraic sum of the two-wattmeter readings.

$W = W1 + W2$



PROCEDURE :-

Active power measurement using one wattmeter method

1) Make connections as shown in Fig. A

   Connect Balance load to the unit.

2) Put SW2 switch at position-1

   Put SW1 switch at position-1

3) Make 3-phase 440 Volt supply on to the unit.

   Note A1, A2, A3, V and wattmeter reading W1.

   Now Put SW1 switch at position-2 and note W2.

4) Make power off.

5) Repeat for different R, L and C combination load.

   NOTE:- Total Load should not be more than 4 Amp.

OBSERVATION TABLE :-

Sr.No.	Voltage (V)	Current (A)			Wattmeter (W)		Total Active Power (W)	Tan ϕ	Power Factor cos ϕ
		I_R	I_Y	I_B	W1	W2			

CONCLUSION :-

EXPERIMENT NO. 7

AIM: - To measure three phase power and power factor in a balanced three phase circuit using two single-phase wattmeters. Calculate the three-phase power for unbalance load condition.

APPARATUS REQUIRED: -

1. Three Phase Load.
2. A.C Wattmeter - 2 nos.
3. A.C Voltmeter.
4. A.C ammeters.
5. Three Phase supply
6. Connecting Wires.

THEORY: -

Single phase power can be measured using single wattmeter, But for measurement of 3 phase power can be done using following methods:

1. One wattmeter method.
2. Two wattmeter method.
3. Three wattmeter method.

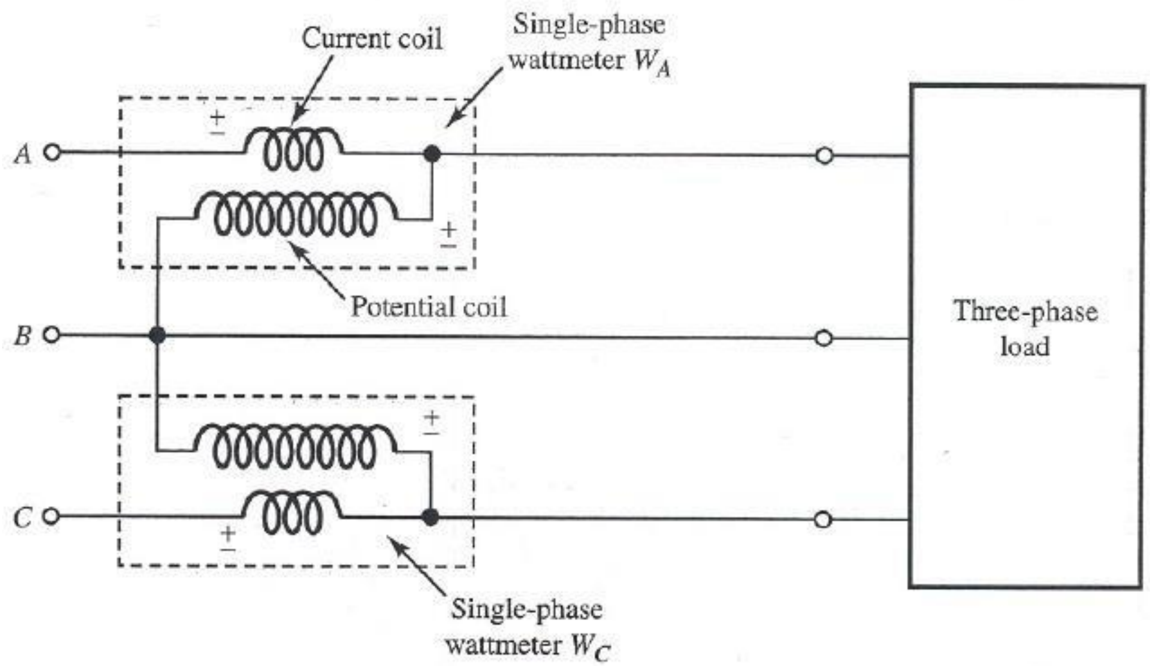


Figure 1 Connection diagram for two-wattmeter method of measuring three phase power

Two wattmeter method

This method is commonly used for the power measurement in the 3 phase circuits. Here as name suggests, only two wattmeters are used. The current coils of the two wattmeters are connected in series on any two lines. The corresponding pressure coils are connected between these lines and the third line on which no wattmeter is connected.

The two wattmeter method is used for the power measurement in the 3-phase systems, irrespective of whether the load is balanced or unbalanced, star or delta connected.

Total Power = W1 + W2

As it is a balance condition, Va = Vb = Vc = phase voltage

Three Phase power = $3V_{ph}I_{ph}\cos\Phi$

As it is a balance condition, Va = Vb = Vc = phase voltage

Ia = Ib = Ic = phase current

For resistive load $\cos\phi = 1$.

So, Three phase power = $3V_{ph}I_{ph}$

$$W_1 = V_{AB}I_A\cos(30-\Phi) = \sqrt{3}V_{ph}I_{ph}\cos(30-\Phi)$$

$$W_2 = V_{BC}I_C\cos(30+\Phi) = \sqrt{3}V_{ph}I_{ph}\cos(30+\Phi)$$

$$W_1 + W_2 = \sqrt{3}V_{ph}I_{ph}[2\cos 30^0\cos\Phi] = 3V_{ph}I_{ph}\cos\Phi = \sqrt{3}V_LI_L\cos\Phi$$

The above equation shows that the sum of the two wattmeter readings gives the total power consumed in the three-phase balanced system. We can also calculate the load power factor angle from the measurement of W1 and W2.

$$\frac{W_1}{W_2} = \frac{\cos(30-\Phi)}{\cos(30+\Phi)}$$

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{\cos(30-\Phi) - \cos(30+\Phi)}{\cos(30-\Phi) + \cos(30+\Phi)} = \frac{2\sin 30\sin\Phi}{2\cos 30\cos\Phi} = \tan 30\tan\Phi$$

$$\tan\Phi = \sqrt{3}\,\frac{W_1 - W_2}{W_1 + W_2}$$

For Unbalance Load Condition:

Measured power = W1 + W2

Calculated power = $V_aI_a + V_bI_b + V_cI_c$

$$\% \text{ Error} = \frac{\text{Calculated power} - \text{Measured power}}{\text{Calculated power}} \times 100$$

PROCEDURE:-

1. Make the connections as per the circuit diagram.
2. Switch on A.C supply.
3. For balanced load condition measured the values of wattmeters, ammeters and Voltmeter.
4. Repeat the same process for unbalance load condition.
5. Switch off all the loads and supply.

OBSERVATION TABLE:-

	VR	VY	VB	IR	IY	IB	W1	W2	Total Power = W1+W2
Balanced load									
Unbalanced load									

CONCLUSION

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EXPERIMENT NO. 8

AIM: - Study of Electrical Transducer

THEORY:-

Instrumentation is the heart of industrial applications. Instrumentation is the art and science of measuring and controlling different variables such as flow, level, temperature, angle, displacement etc. A basic instrumentation system consists of various devices. One of these various devices is a transducer. A transducer plays a very important role in any instrumentation system. An electrical transducer is a device which is capable of converting the physical quantity into a proportional electrical quantity such as voltage or electric current. Hence it converts any quantity to be measured into usable electrical signal. This physical quantity which is to be measured can be pressure, level, temperature, displacement etc. The output which is obtained from the transducer is in the electrical form and is equivalent to the measured quantity. For example, a temperature transducer will convert temperature to an equivalent electrical potential. This output signal can be used to control the physical quantity or display it. Note that any device which is able convert one form of energy into another form is called as a transducer. For example, even a speaker can be called as a transducer as it converts electrical signal to pressure waves (sound).But an electrical transducer will convert a physical quantity to an electrical one.

Types of Transducer

There are of many different types of transducer, they can be classified based on various criteria as:

Types of Transducer based on Quantity to be Measured

Temperature transducers (e.g. a thermocouple)

Pressure transducers (e.g. a diaphragm)

Displacement transducers (e.g. LVDT) • Flow transducers

Types of Transducer based on the Principle of Operation

Photovoltaic (e.g. a solar cell) • Piezoelectric • Chemical • Mutual Induction • Electromagnetic • Hall effect • Photoconductors

Types of Transducer based on Whether an External Power Source is required or not

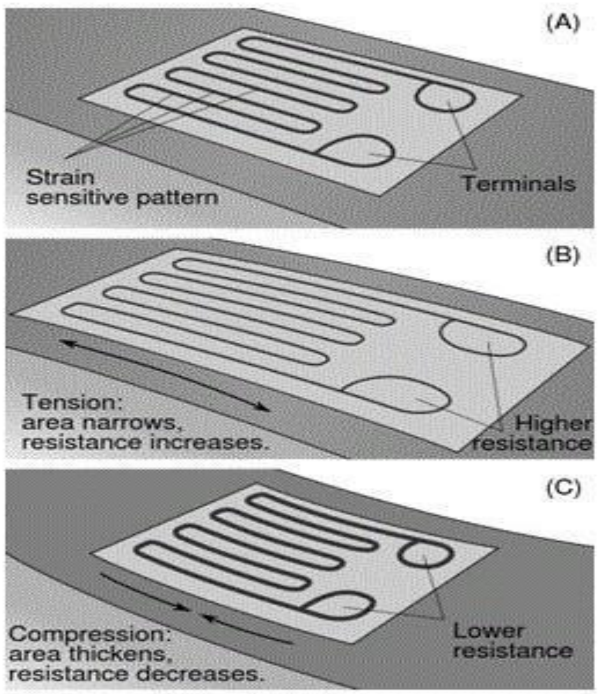
Active Transducer

Active transducers are those which do not require any power source for their operation. They work on the energy conversion principle. They produce an electrical signal proportional to the input (physical quantity). For example, a thermocouple is an active transducer.

Passive Transducers Passive Transducers

Transducers which require an external power source for their operation is called as a passive transducer. They produce an output signal in the form of some variation in resistance, capacitance or any other electrical parameter, which than has to be converted to an equivalent current or voltage signal. For example, a photocell (LDR) is a passive transducer which will vary the resistance of the cell when light falls on it.

This change in resistance is converted to proportional signal with the help of a bridge circuit. Hence a photocell can be used to



Above shown is a figure of a bonded strain gauge which is a passive transducer used to measure stress or pressure. As the stress on the strain gauge increases or decreases the strain gauge bends or compresses causing the resistance of the wire bonded on it to increase or decrease. The change in resistance which is equivalent to the change in stress is measured with the help of a bridge. Hence stress is measured.

CONCLUSION

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EXPERIMENT NO. 9

AIM: - Study of Characteristics of measuring Instruments

THEORY:-

To understand the performance characteristics of a measurement system is very critical to the process of selection. Characteristics that show the performance of an instrument are accuracy, precision, resolution, sensitivity etc. It allows users to select the most suitable instrument for specific measuring jobs.

There are two basic performance characteristics of measuring instrument:

1. Static characteristics: value of the measured variable change slowly.
2. Dynamic characteristics: value of the measured variable change very fast.

Static Characteristics

The static characteristics and parameters of measuring instruments describe the performance of the instruments related to the steady-state input/output variables only. The various static characteristics and parameters are destined for quantitative description of the instruments perfections.

Dynamic Characteristics

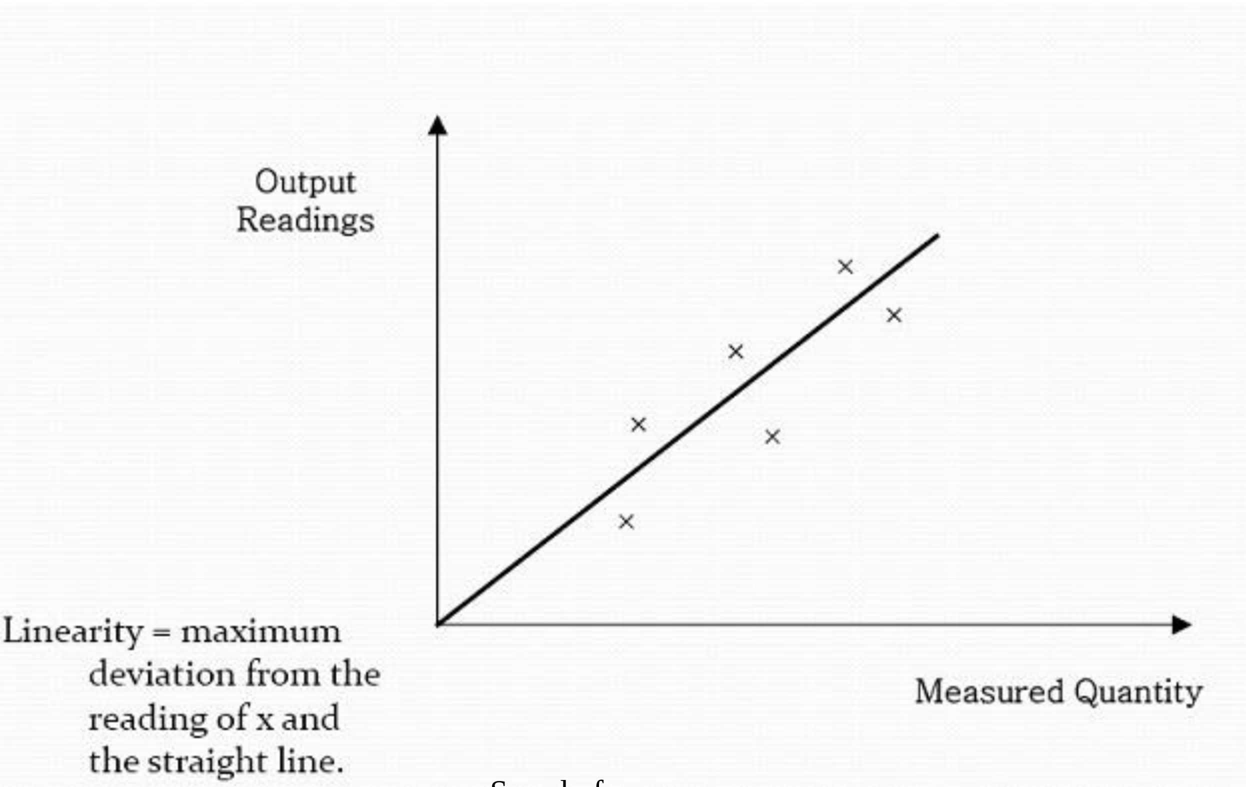
Previous characteristics assume a steady state conditions. The time response shows the behavior of the sensor or the instrument at system to the changes in the magnitude of interest by observing the signal output with time. The step response is used as a basic test and for characterizing the system

Accuracy

The degree of exactness (closeness) of measurement compared to the true value. This term is used in the manufacturer specifications for a measurement instrument or device. Accuracy of an instrument is the quality which characterizes the ability of a measuring instrument to give indications approximating to the true value of the measured variable. The specifications of the accuracy are given actually in terms of error (in other words in terms of inaccuracy). Note, that when the accuracy of some measurement device is presented with percent error, we can estimate the error after measurement.

Linearity

1. Maximum deviation from linear relation between input and output.
2. The output of an instrument has to be linearly proportionate to the measured quantity.
3. Normally shown in the form of full scale percentage (% fs).
4. The graph shows the output reading of an instrument when a few input readings are entered.



Speed of response:

Rapidity with which instrument responds to the changes in the measured variable.

Dead Zone

For the largest changes in the measured variable, the instrument does not respond.

Repeatability

When the Instrument is calibrated at different times, has to show the same at different times.

Resolution

The smallest change in a measurement variable to which an instrument will respond.

Span

The input span of a measuring devices is specified by the difference between maximum Xmax and minimum Xmin values of input variables: (Xmax - Xmin). For example, for a measuring devices with input range from -10 oC to +150 oC the input span is: +150 oC - (- 10 oC) = 160 oC.

The output span of a measuring devices is specified by the difference between maximum Ymax and minimum Ymin values of output variables: (Ymax - Ymin). For example, for a measuring devices with output range from 4 to +20 mA span is: +20 mA - 4 mA = 16 mA.

Reproducibility

The degree of closeness with which a given value is repeatedly measured. The instrument has to the show same value over long periods of time under the same operating conditions.

Drift

Slow shift in the calibration of the instrument. This may be due to the variation of metallic properties, due to chemical changes. For example coating formation on RTD elements, Thermocouple. Due to continuous exposure. Atomic structure changes occur in metals of RTDs, Thermocouples.

CONCLUSION

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EXPERIMENT NO. 10

AIM: Study of types of instruments: PMMC type of Instrument.

THEORY:

PMMC Instrument

The term PMMC is the short form of “permanent magnet moving coil”. This instrument is simple as well as most frequently used on ships with sophisticated names. These instruments are used when an exact measurement is required as well as to aid while maintaining electrical equipment. Apart from PMMC, it is also called as D’alvanometer. It is a kind of galvanometer that works on the principle of D’Arsonval.
These instruments use permanent magnets to create the stationary magnetic field in the coils, and then it is used with the moving coil that is connected to the electric source for generating deflection torque according to the Fleming left-hand rule theory.

The PMMC instrument working principle is when the torque is applied to the moving coil that is placed within the permanent magnet field, and then it gives a precise result for DC measurement.

Working Principle of a PMMC Instrument

Whenever a current caring conductor is located within a magnetic field, then it experiences a force that is perpendicular to the current & the field. Based on the rule of “Fleming left hand”, if the thumbnail of the left hand, middle and forefinger are at 90 degrees with each other.
After that the magnetic field will be in the forefinger, flow of current will be across the middle finger and finally, the force will be through the thumb finger.

Once the current flow within the coil on the aluminum former, the magnetic field can be generated in the coil in proportion to the current flow.
The electromagnetic force throughout the fixed magnetic field from the permanent magnet generates the deflection force within the coil. After that the spring generates the force to resist additional deflection; therefore it helps to balance the pointer.
So damping force can be generated within the system through the aluminum core movement of the magnetic field. It maintains the pointer stable to a point. Once it attains equilibrium by controlling & deflection torque to provide accuracy in measurement.

PMMC Instrument Construction

The construction of the PMCC instrument can be done using several parts where the permanent magnet and moving coils are essential parts. Each part of this instrument is discussed below.

Moving Coil

It is an essential component of the PMMC instrument. The designing of this coil can be done by wounding copper coils to a rectangular block among the magnetic poles. It is made with Aluminum and the rectangular block can be called Aluminum former rotated into the jeweled bearing. So it permits the coil to turn freely.

Once the current is supplied throughout these coils, then it gets a deflection within the field, then it is used to find out the voltage or current magnitude. The aluminum is a non-metallic former, used to measure the current whereas the metallic former including high electromagnetic damping is used to calculate the voltage.

Magnet System

The PMMC instrument includes two high-intensity magnets otherwise a 'U' shaped magnet-based design. The designing of these magnets can be done with Alnico & Alcomax for higher superior field intensity & coercive force. In several designs, an extra soft iron cylinder can be arranged among the magnetic poles to create the field identical; while decreasing air reluctance for increasing the strength of the field.

Control

In the PMMC device, the torque can be controlled due to the springs which are fabricated with phosphorous bronze. These springs are arranged among the two jewel bearings. The spring provides the lane to the lead current to supply in & out of the moving coil. The torque can be controlled mainly due to the delay of the ribbon.

Damping Torque

Damping torque can be generated within the PMMC instrument using the aluminum core's movement within the magnetic field.

So the pointer can be kept at rest after the early deflection. It assists in the right measurement devoid of fluctuations. Because of the movement of the coil within the magnetic field, eddy current can be generated within the aluminum former. This generates the damping force otherwise torque to resist the motion of the coil. Gradually the deflection of the pointer will be reduced and lastly, it will stop at a permanent position.

Pointer and Scale

In this instrument, the connection of the pointer can be done through the moving coil. It notices the moving coil's deflection. The magnitude of their derivation can be displayed on the scale. The pointer within the instrument can be designed with lightweight material. Thus, it can be simply deflected through the coil's movement. Sometimes, the parallax error can occur within the device which is simply decreased by properly arranging the pointer's blade.

What are the Different Reasons that Cause an Error in PMMC?

In a PMMC instrument, different errors can be occurred due to the temperature effects as well as getting older of the instruments. The errors can be caused by the main parts of the instrument like the magnet, effect of temperature, moving coil and the spring.

So, these errors can be reduced when the swamping resistance is connected in series using the moving coil. Here, the swamping resistance is nothing but the resistor which includes less temperature coefficient. This resistance can reduce the temperature effect on the moving coil.

Torque Equation

The equation involved in the PMCC instrument is the torque equation. The deflecting torque induces due to the coil's movement and this can be expressed with the equation shown below.

Td = NBLdl

Where,

'N' is the no. of turns in the coil

'B' is the density of flux within the air gap

'L' & 'd' are vertical as well as horizontal lengths of the surface

'I' is the flow of current in the coil

G = NBLd

The restoring torque can be provided to the moving coil can be done with the spring and it can be expressed as

Tc = Kθ ('K' is the spring constant)

Final deflection can be done through the equation **Tc = Td**

Substitute the values of Tc & Td in the above equation, then we can get

Kθ = NBLdl

We know that **G = NBLd**

Kθ = Gl

θ= Gl/K

I = (K/G) θ

From the above equation, we can conclude that the deflection torque can be directly proportional to the flow of current in the coil.

Advantages of PMMC Instrument

The advantages are

- The scale in the instrument can be divided properly
- It generates no losses because of hysteresis.
- It uses less power
- It is not influenced by the stray magnetic field.
- High accuracy
- It is used as a voltmeter/ammeter with appropriate resistance.
- This instrument can measure the voltage & current with different ranges
- This instrument uses shelf shielding magnet so it is applicable in aerospace

Disadvantages of PMMC Instrument

The disadvantages are

- It works with only DC
- It is expensive compare with other alternative instruments
- It is delicate
- It shows an error because of the magnetism loss in permanent magnet

Applications of PMMC Instrument

The applications are

- Ammeter
- Galvanometer
- Ohmmeter
- Voltmeter

CONCLUSION:-

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