ELECTRICAL MEASUREMENTS LABORATORY MANUAL

B.TECH
(III YEAR – I SEM)
(2023-24)

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MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

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Affiliated to JNTUH, Hyderabad, Approved by AICTE - Accredited by NBA & NAAC – 'A' Grade - ISO 9001:2015 Certified
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LIST OF EXPERIMENTS

(R20A0286) ELECTRICAL MEASUREMENTS LABORATORY

COURSE OBJECTIVES: The objectives of the course are to make the students learn about:

- To calibrate LPF Watt Meter, energy meter, P.F Meter using electro dynamo meter type instrument as the standard instrument.
- To determine unknown inductance, resistance, capacitance by performing experiments on D.C Bridges &A.C Bridges.
- To determine three phase active & reactive powers using single wattmeter method practically. Measurement of parameters of choke coil
- To determine the ratio and phase angle errors of current transformer and potential transformer.
- Measuring earth resistance, dielectric strength of transformer oil & Testing of underground cables.

Among the following experiments any 10are to be conducted:

1. Calibration and Testing of single phase energy Meter
2. Measurement of tolerance of batch of low resistances by Kelvin's double bridge
3. Measurement of voltage, current and resistance using DC potentiometer
4. Schering Bridge and Anderson bridge.
5. Measurement of parameters of a choke coil using 3 voltmeter and 3 ammeter methods.
6. Calibration of LPF wattmeter by Phantom testing
7. Calibration of dynamometer type power factor meter.
8. Measurement of reactive power using single wattmeter in three-phase circuit.
9. Measurement of Displacement with the help LVDT
10. Measurement of different ranges of temperatures using i) RTD ii) Thermo couple
11. Measurement of voltage, frequency &phase with the help of CRO
12. Measurement of load with the help of strain gauges
13. Measurement of Iron loss in a bar specimen using Epstein square.
14. Measurement of % ratio error and phase angle of given C.T. by Silsbee's method.
15. Dielectric testing of transformer oil

COURSE OUTCOMES:

At the end of the course, the student will be able to:

- Calibrate various electrical measuring/recording instruments. Get the ability to choose instruments and can test any instrument can find the accuracy of any instrument by performing experiment can calibrate PMMC instrument using D.C potentiometer.
- Accurately determine the values of inductance and capacitance using a.c bridges Accurately determine the values of very low resistances
- Measure reactive power in 3-phase circuit using single wattmeter
- Determine ratio error and phase angle error of CT
- Students should be able to test current transformers and dielectric strength of oil. Students should be able to calibrate LVDT and resistance strain gauge.

INDEX

S No	Date	Name of the Experiment	Grade	Signature of the Faculty

Date:

EXPERIMENT – 1

CALIBRATION AND TESTING OF SINGLE PHASE ENERGY METER

AIM:

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

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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:

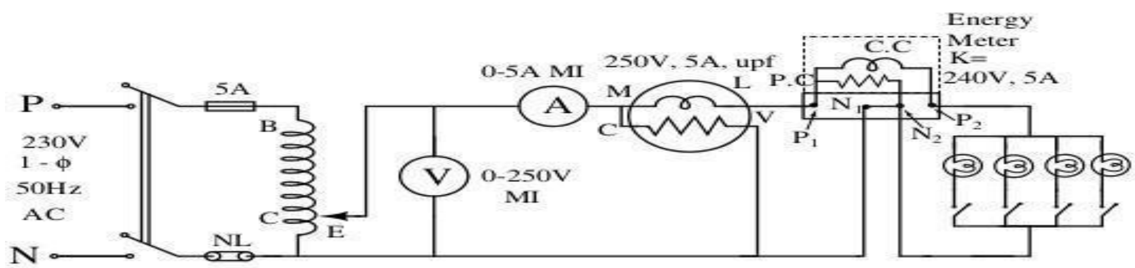


Fig – 1.1 Calibrations and Testing of Single Phase Energy Mete

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 COLUMN:

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

RESULT:

PRE LAB VIVA QUESTIONS:

1. What is the working principle of energy meter?
2. What type of controlling torque is used in energy meter?
3. What is the purpose of using shading band in energy meter?
4. How does energy meter differ from a watt meter?
5. What is the purpose of brake magnet in energy meter?
6. How braking torque can be adjusted in energy meters?
7. Which type of meter is energy meter?
8. What is creeping? How to avoid error due to creeping?
9. Why aluminum disc is preferred over copper disc?
10. Why induction type energy meter are preferred?

POST LAB VIVA QUESTIONS:

1. What is your understanding of error in energy meter?
2. Can you say on which parameters the energy meter error depends?
3. What type of transformer is used in this circuit?
4. What type of energy meter is used?

Date:

EXPERIMENT - 2

CALIBRATION OF DYNAMO METER TYPE POWER FACTOR METER

AIM:

To calibrate dynamometer type power factor meter.

APPARATUS:

S. No.	Equipment	Range	Type	Quantity
1	1-Phase Variac			
2	Power Factor Meter			
3	Ammeter			
4	Voltmeter			
5	Wattmeter			
6	Loads (1 - Ph)			
7	Connecting wires			

CIRCUIT DIAGRAM:

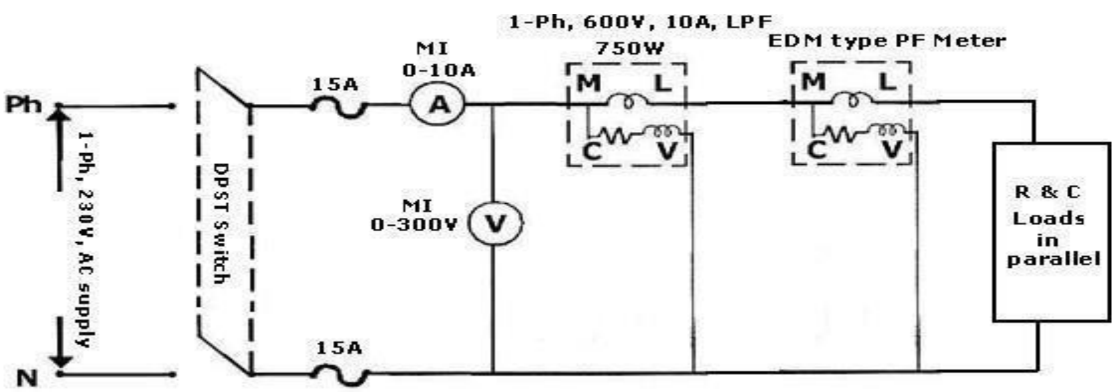


Fig – 2.1 Calibration of Dynamo Meter Type Power Factor Meter

PROCEDURE:

1. Keep the Auto transformer at Zero position
2. Make connections as per Circuit diagram shown below.
3. Switch on the 230 VAC, 50 Hz, Power supply.
4. Increase the input voltage gradually by rotating the auto transformer in clockwise direction 220V.
5. Adjust the load rheostat so that sufficient current flows in the circuit, Please note that the current should be less then 4A.

6. Note down the Voltmeter, Ammeter, Wattmeter and power factor meter readings for different voltage as per the tabular column.
7. Find out the percentage error by using equations.

TABULAR COLUMN:

S. No	Load		Voltmeter Reading (V)	Ammeter Reading (A)	Wattmeter Reading (W)	Power Factor Calculated (X) (CosØ= w/VI)	PF Meter Reading (Y)	% Error (X-Y) *100/Y
	R	L						
1								
2								
3								
4								
5.								

MODEL CALCULATIONS:

Cos Ø (X) = W / VI

$$\% \text{ Error} = \frac{X-Y}{Y} \times 100$$

RESULT:

PRE LAB VIVA QUESTIONS:

1. What is power factor?
2. Give expression for the PF.
3. What is principle of power factor meter?
4. What is the significance of power factor?
5. What are the different types of power factor meters?
6. Why is moving iron PF meters less accurate than dynamometer type?
7. How the power factor of a single phase circuit is measured?
8. Why is the controlling force not present in the power factor meter?
9. What type of meter is power factor meter?
10. What are the two different coils present in power factor meter?

POST LAB VIVA QUESTIONS:

1. What are the reasons for errors in power factor meters?
2. What are the different remedies to reduce errors in power factor meters?

Date:

EXPERIMENT - 3

CALIBRATION OF PMMC VOLTMETER AND AMMETER BY DC CROMPTON'S POTENTIOMETER

AIM:

To calibrate PMMC Voltmeter and Ammeter by DC Crompton's potentiometer.

APPARATUS:

S. No.	Equipment	Range	Type	Quantity
1	DC Crompton's potentiometer Kit			
2	Standard Cell			
3	2 Channel RPS			
4	Voltmeter			
5	Ammeter			
6	Standard Resistance Box/DRB			
7	Voltage Ratio Box			
8	Galvanometer			
9	Patch Chords			

CIRCUIT DIAGRAM:

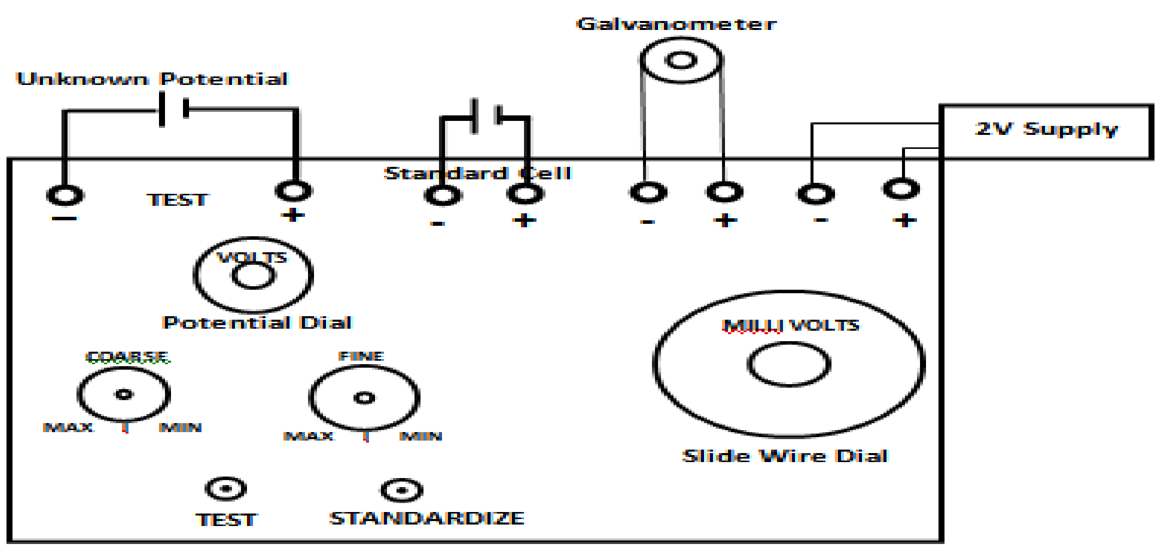


Fig – 3.1 Standardization

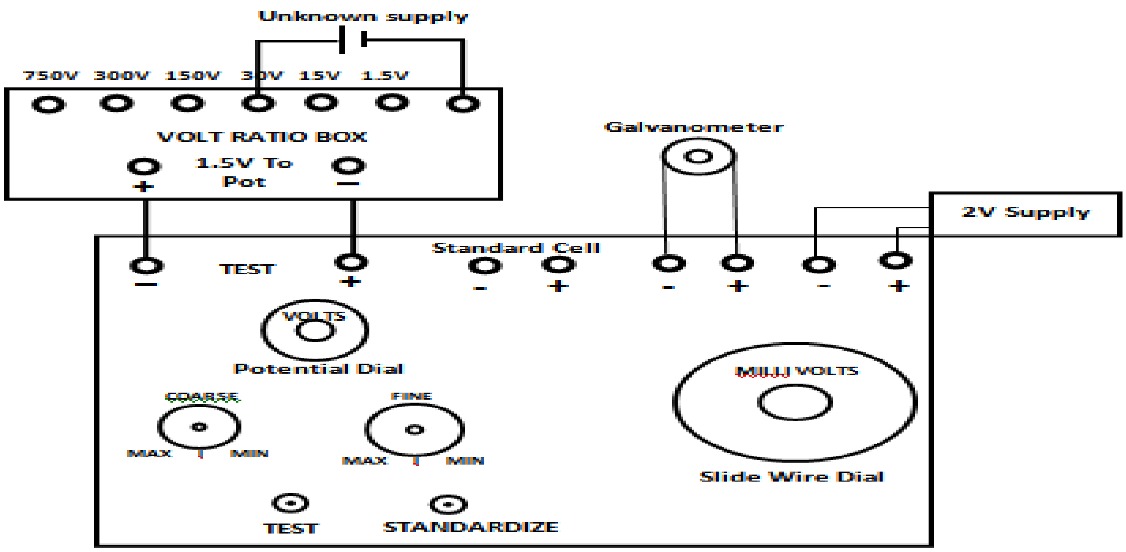


Fig – 3.2 Calibration of Voltmeter

PROCEDURE:

CALIBRATION OF AMMETER:

1. Connections are given as per the block diagram.
2. Adjust the potentiometer voltage dial to 1.0186V and switch on thesupply.
3. Observe the deflection in the galvanometer by pressing the standardization knob on the meter kit.
4. If deflection is not zero, then adjust the fine and coarse knobs until there is no deflection in the galvanometer.
5. Now the potentiometer is standardized.

CALIBRATION OF VOLTMETER:

1. Connections are given as per the block diagram.
2. Apply test voltage. Reset the potentiometer dial reading closer to the applied test voltage.
3. Now by pressing the test button observe the deflection in thegalvanometer.
4. Vary the dial reading until there is no deflection in thegalvanometer.
5. Now note down the readings of Voltmeter, Potentiometer dial and calculate the error.
6. Repeat this procedure for different test voltages and find the error in the voltmeter.

CALIBRATION OF AMMETER:

1. Connections are given as per the block diagram.
2. Apply test voltage up to 30V. Reset the potentiometer dial reading closer to the applied test voltage.

3. Now by pressing the test button observe the deflection in thegalvanometer.
4. Vary the dial reading until there is no deflection in the galvanometer.
5. Now note down the readings of Ammeter, Potentiometer dial, Resistance and calculate the error.
6. Repeat this procedure for different values of Resistance and find the error in the Ammeter.

TABULAR COLUMN: VOLTMETER CALIBRATION:

S. No	Voltage Reading (V_m)	Potentiometer Reading (V_P)	% Error
1			
2			
3			
4			

AMMETER CALIBRATION:

S. No	Resistance (R)ohm	Ammeter Reading (I_m)A	Potentiometer Reading (V_P)V	Current in the circuit (I_c)mA	% Error
1					
2					
3					

MODEL CALCULATIONS: Voltmeter Calibration

% Error in Meter $= [(V_m – V_p)*100]/V_m$

Ammeter Calibration

Current in the circuit $I_c = [V_P/R]$

% Error in Meter $= [(I_m – I_c)*100]/I_m$

RESULT

PRE LAB VIVA QUESTIONS

1. What is dc potentiometer?
2. What is ac potentiometer?
3. How DC potentiometer is made direct reading?
4. How the DC potentiometer is is standardized?
5. What is the difference between dc and ac potentiometer?
6. What is polar type potentiometer?
7. What is coordinate type potentiometer?
8. What is difference between polar and coordinate type potentiometer?
9. What is meant by standardization?
10. What is meant by calibration?

POST LAB VIVA QUESTIONS

1. What is the significance of voltage ratio box?
2. What precautions have to be followed in the case of standard cell?
3. How do you choose the standard resistance to be connected in the case of standardcell?

Date:

EXPERIMENT - 4

MEASUREMENT OF RESISTANCE USING KELVIN’S DOUBLE BRIDGE

AIM:

To find the unknown Resistance using Kelvin’s double bridge.

APPARATUS:

S. No	Equipment
1.	Educational trainer kit of Kelvin’s double bridge
2.	Unknown Resistors
3.	Connecting wires
4.	Galvanometer
5.	D.C Supply

CIRCUIT DIAGRAM:

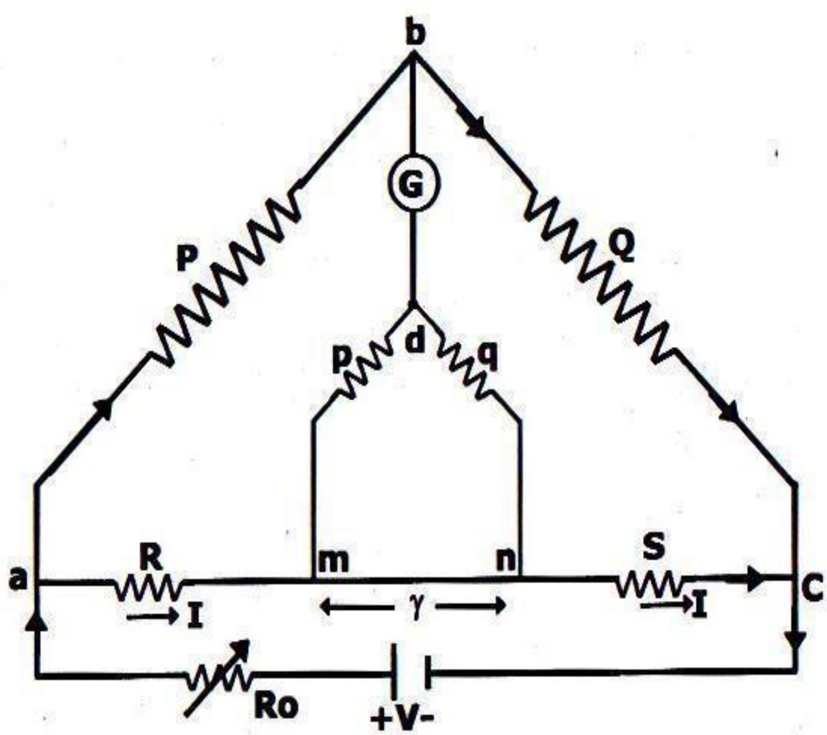


Fig – 4.1 Kelvin’s Double Bridge

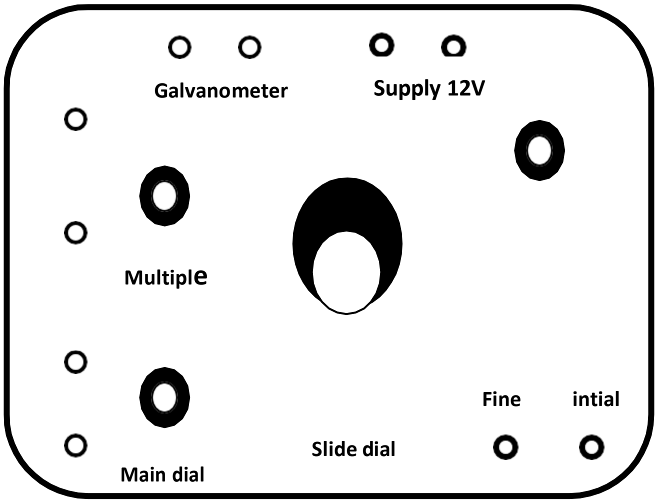


Fig – 4.2 Kelvin’s Double Bridge

PROCEDURE:

1. By setting the coil of the galvanometer in free position, the position of pointer is set in the center of the scale by adjusting the zero turning knobs.
2. A galvanometer sensitivity control switches have to increase the galvanometer sensitivity gradually as null-point approaches.
3. The two terminal unknown resistances is measured by connecting +c, +p to one end of the resistance unknown and – c, - p to the other end.
4. After unknown resistance is connected choose the suitable range multipliers depending upon the magnitude of unknown resistance.
5. Get the null point of the galvanometer by depressing the key momentarily only and by depressing the key adjusting the main dial and slide wire.
6. After getting the null point in the galvanometer by placing sensitivity knob in the min position, the resistance is calculated by formula.

TABULAR COLUMN:

S. No.	X Main dial Reading	Y Slide dial Reading	Z Multiple range used	R =unknown resistance
1				
2				
3				

S. No.	Observed Value	Calculated Value	% Error
1			
2			
3			

MODEL CALCULATIONS:

R = (x+ y)z

X = Main dial reading

Y = Slide dial reading

Z = multiplier range used for their resistance

$$\% \text{ Error} = \frac{\text{observed value} - \text{Calculated value}}{\text{Calculated value}} \times 100$$

RESULT:

PRE LAB VIVA QUESTIONS

1. What is the value of low resistance?
2. What is the value of high resistance?
3. What is the value of medium resistance?
4. What is the purpose of Kelvin's double bridge?
5. What type of bridge is used to find out the low values of resistance?
6. What type of bridge is used to find out the maximum values of resistance?
7. What is the advantage of Kelvin double bridge when compared Wheatstone bridge?
8. What is the purpose of using r0 in the circuit?
9. What are the precautions should be exercised for the safety of galvanometer.
10. How does a megger differ from ohm meter?
11. What is a megger?

POST LAB VIVA QUESTIONS

1. What happens if the current setting is in reverse direction?
2. Which method is accurate method for the measurement of resistance?
3. How to reduce error in the case Kelvin's double bridge?

Date:

EXPERIMENT – 5

DIELECTRIC OIL TESTING USING H.T. TESTING KIT

AIM: To test oil transformer determines the dielectric strength of oil.

APPARATUS:

S. No	NAME OF EQUIPMENT	SPECIFICATIONS
1	Dielectric Oil testing Kit	230 / 240V 1 - Φ 50HZ AC supply Output voltage: (0-60)KVA

CIRCUIT DIAGRAM

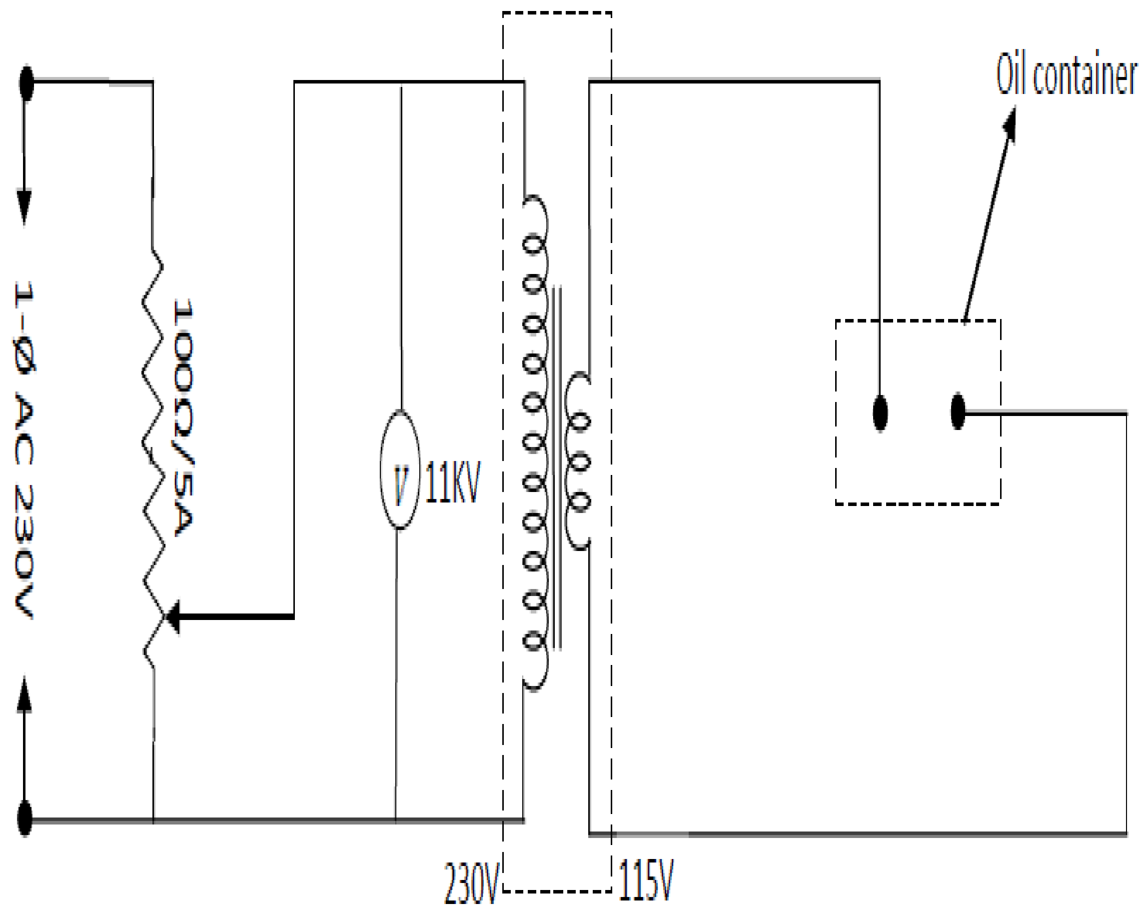


Fig – 5.1 Circuit Diagram of Testing of Transformer Oil

PROCEDURE

1. The oil is poured in a container known as test cell the electrodes are polish spheres perfectly of brass arranged horizontally a suitable gauge is used to adjust the gap.
2. While pouring the oil sample the test cell(container should)be thoroughly cleaned & the moisture & sypended particles should be avoided in fig shown below & experimental setup for finding out the dielectric strength of the give sample ofoil.
3. The voltmeter is the connected on the primary side of high voltage side transformer for calibration.
4. Adjust the gap between the spheres is to 4MM with the help of gauge then pour transformer oil till a depth slurries ar
5. e immersed.
6. Then increase the voltage gradually & continuously till a flashover of the gap is seen on the MCB apparatus note down this voltage. This voltage is known as rapidly applied voltage.
7. The breakdown of the gap has taken please mainly due to field effect. The thermal effect is main as the time of application is short.
8. Next bring the voltage back Zero & star with 40% of rapidly applied voltage & weight for one min.sec if the flashover by take occurred if not increase the voltage every time by of the rapidly applied voltage and wait for one min till the flash over is seen on the MCB trips. Note the voltage.
9. Repeat the experiment with different values of voltage.
10. The acceptable value is 30KV for 4mm & 2.5mm for 11KV the oil should be set for secondly.

TABULAR COLUMN

S. No	DIELECTRIC VOLTAGE	AVERAGE VALUE
1		
2		
3		
4		
5		

PRECAUTIONS:

It is to be noted that the electrodes are immersed vertically in the oil. It is due to the fact that when oil decomposes. Carbon particles being lighter rice up & if electrons are vertical configurations, this well bridge the gap & the breakdown will take place.

RESULT:

PRE LAB VIVA QUESTIONS:

1. What do mean by Dielectric Strength?
2. What is the necessity of oil in Transformer?
3. What is the voltage required for this test?
4. Which type of oil is used in transformer?

POST LAB VIVA QUESTIONS:

1. Why oil is used as coolant & Insulation Purpose?
2. What are the various methods of testing in transformer?
3. Which type of transformer is used for this test?

Date:

EXPERIMENT – 6

SCHERING BRIDGE AND ANDERSON'S BRIDGE

AIM:

To find the unknown Capacitance using Schering bridge and to find the self inductance of a given inductor using Anderson's Bridge.

APPARATUS:

S. No.	Name of the Equipment
1.	Educational trainer kit of Schering bridge and Anderson's bridge
2.	Galvanometer
3.	Patch chords
4.	Detector Head Phones

CIRCUIT DIAGRAM:

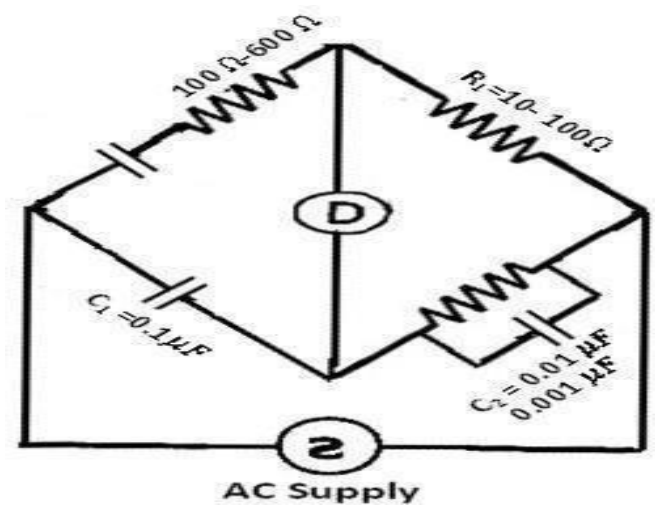


Fig – 6.1 Schering Bridge

PROCEDURE:

1. AC supply is connected to terminals marked.
2. The galvanometers are connected as detectors.
3. All dials are kept at zero positions.
4. Unknown capacitance is connected to unknown terminals.
5. Switch ON the power and adjust R_1 and R_2 for null deflection.
6. Note down R_1, R_2 and C_1.
7. Repeat the above step for 3 other unknown capacitances.

TABULAR COLUMN:

S. No.	R_1 (Ω)	R_2 (Ω)	C_1 (μF)	R (Ω)	Unknown Capacitance
1.					
2.					
3.					

MODEL CALCULATIONS:

Schering Bridge

Non Inductive resistance $R_1 =$

Variable Non Inductive resistance $R_2 =$

Variable Capacitor $C_1 =$

Unknown Capacitance $C = C_1 \times R_1/R_2$

CIRCUIT DIAGRAM:

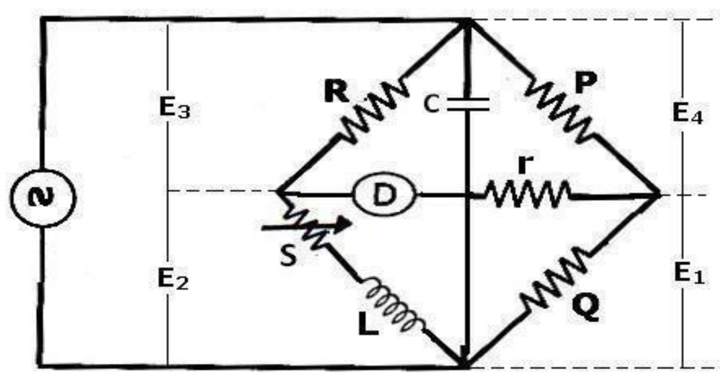


Fig – 6.2 Anderson's Bridge

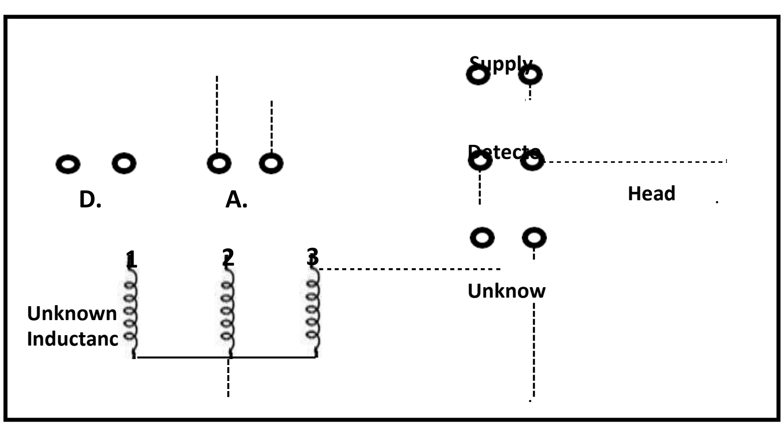


Fig – 6.3 AC Circuit

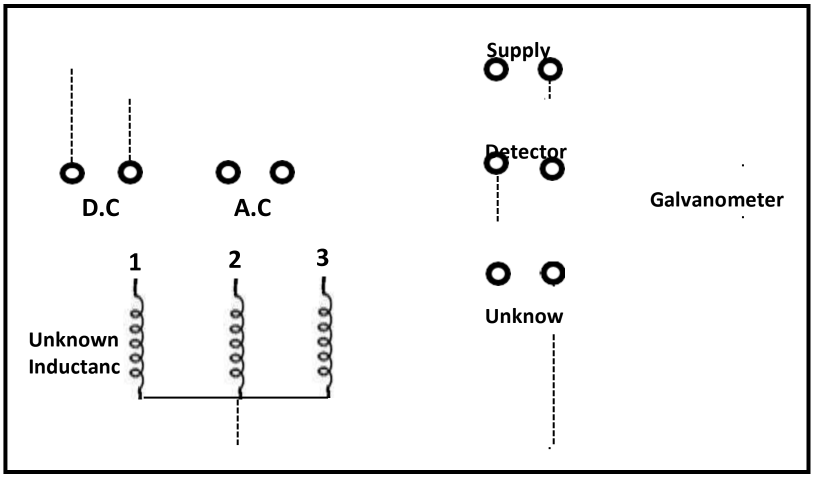


Fig – 6.4 DC Circuit

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The unknown inductance is connected to terminals marked 'L'
3. K_c/s oscillator is connected to terminals marked oscillator and headphones to respective terminals.
4. A fixed value of capacitance C= 0.01μF is selected.
5. A minimum of sound is obtained from headphones (or) constant line on CRO by varing 'S' and 'm' respectively.
6. The value of 'L' is calculated using the formula

   $L = C \times \frac{R}{P} r P + Q + PQ$ Henry.
7. The experiment is repeated for different values of C.
8. The value of inductance is verified using P = Q = R = 1000ohm.

TABULAR COLUMN:

S. No.	DC Supply			AC Supply		
	r (Ω)	R (Ω)	S (Ω)	r (Ω)	R (Ω)	S (Ω)
1						
2						
3						
4						
5						

S. No.	DC Supply	AC Supply
	L(H)	L(H)
1.		
2.		
3.		

MODEL CALCULATIONS: Anderson's Bridge:

Value of Capacitor C =

Standard resistance P = Q =1000ohm

Variable resistance r =

Value of fixed capacitor S =

Value of inductor $L = C \times \frac{R}{P} r P + Q + PQ$ mH

P = 1000Ω; Q = 1000Ω; R = 1000Ω;

S = Resistance of the unknown inductor

RESULT:

PRE LAB VIVA QUESTIONS:

1. What is the purpose of Schering Bridge?
2. What is the purpose of Anderson bridge?
3. What is the dissipation factor of a capacitor?
4. What is the condition for balance in any dc bridge?
5. What is the condition for balance in any ac bridge?
6. Anderson bridge is modification of which bridge?
7. What is the formula for dissipation factor?
8. Why there are two conditions of balance in ac bridges?
9. What are the different bridges used to measure capacitance?
10. What are the different bridges used to measure inductance?

POST LAB VIVA QUESTIONS:

1. Why is Schering bridge particularly suitable for measurement at high voltage?
2. What is the limitation of Anderson bridge?
3. What is the balanced condition for DC bridges?
4. What is the balanced condition for AC bridges?
5. What type of bridge is used for measurement of capacitance?
6. What type of bridge is used for measurement of inductance?

Date:

EXPERIMENT – 7

MEASUREMENT OF 3 - PHASE REACTIVE POWER USING SINGLE WATTMETER

AIM:

To measure 3 - phase reactive power using single phase wattmeter.

APPARATUS:

S. No	NAME OF COMPONENT	RANGE	TYPE	QUANTITY
1	Voltmeter			
2	Ammeter			
3	Wattmeter			
4	Inductive Load			
5	Three Phase Variac			

CIRCUIT DIAGRAM:

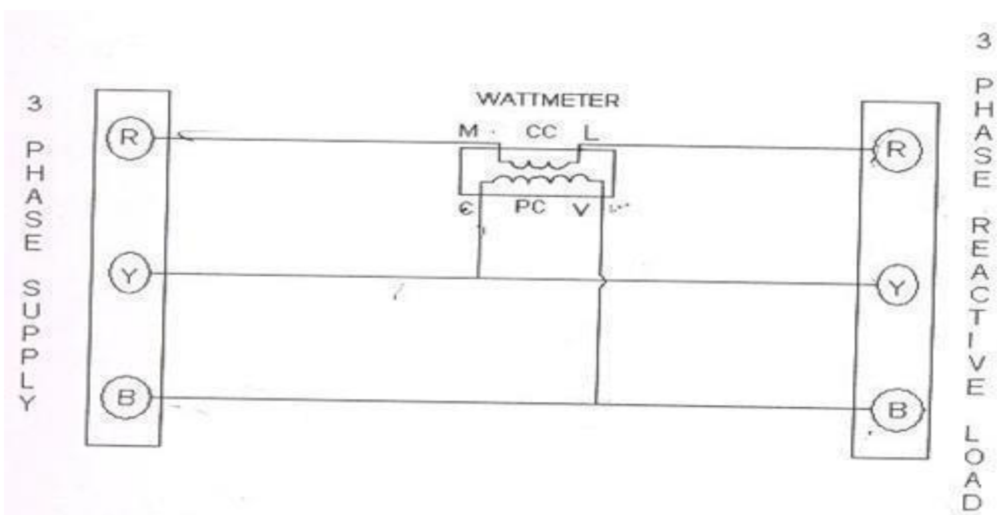


Fig – 7.1 Circuit Diagram of Measurement of 3-Phase Reactive Power using Single Wattmeter

PROCEDURE:

1. Connect the circuit as shown in fig.
2. Switch 'ON' the supply.
3. Note down the corresponding there reading and calculate 3-phase reactivepower.
4. Now increase the load of three phase Inductive load steps and note down the corresponding meter readings.
5. Remove the load and switch 'off' thesupply.

TABULAR COLUMN:

3 Phase Load	Wattmeter Reading	3 Phase Reactive Power
1 A		
2 A		
3 A		
4 A		
5 A		

MODEL CALCULATIONS:

The total 3-ϕ reactive power is $\sqrt{3}\ V_L I_L \sin\phi$

RESULT:

PRE LAB VIVA QUESTIONS

1. How do you measure power?
2. State the difference between wattmeter and an energy meter.
3. Types of wattmeters.
4. Which types of wattmeter is widely used?
5. How is the controlling torque obtained?

POST LAB VIVA QUESTIONS

1. What are the errors in dynamometer type wattmeters? State a few?
2. How many wattmeters do we require to measure 3-phase power?
3. What is reactive power? State the formula?
4. How many wattmeters are required to measure 3-phase reactive power?
5. How do we minimize the errors due to eddy currents in wattmeters?

Date:

EXPERIMENT - 8

MEASUREMENT OF PARAMETERS OF CHOKE COIL USING THREE VOLT METER AND THREE AMMETER METHOD

AIM:

To find the parameter of given choke coil by three - Voltmeter and three- Ammeter 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	2
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

CIRCUIT DIAGRAM:

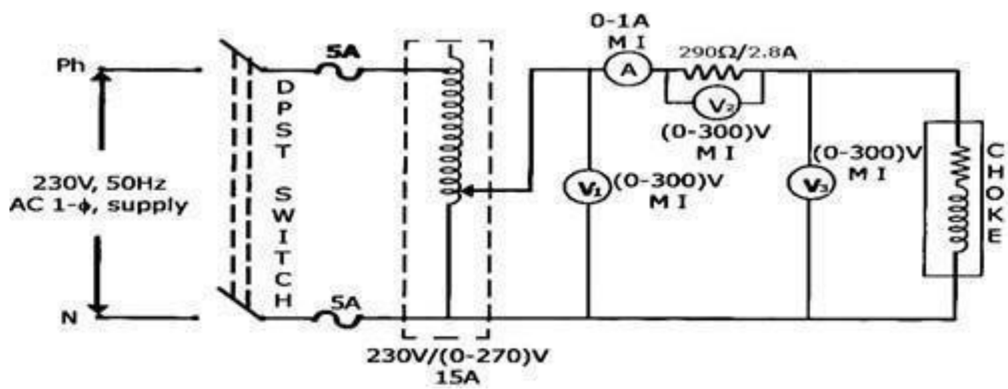


Fig – 8.1 Three Voltmeter Method

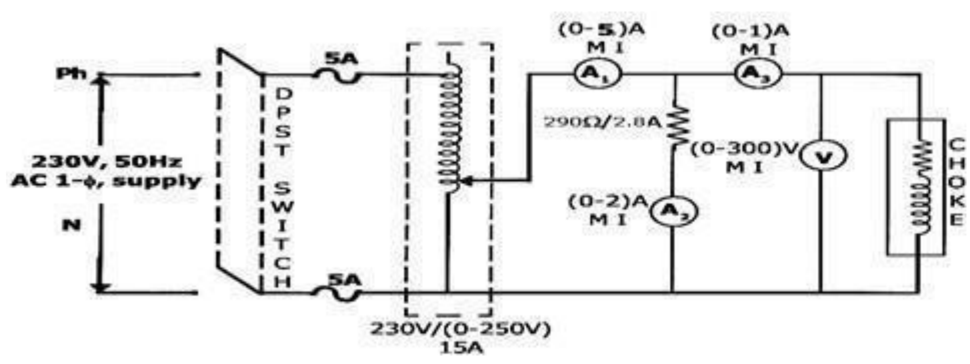


Fig – 8.2 Three Ammeter Method

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:

Three 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.

Three 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 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 COLUM: Three 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 =

Three Ammeter Method

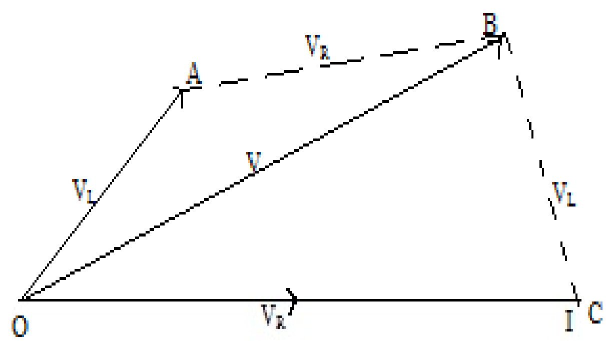
S. NO	V VOLTS	I_1 AMPS	I_2 AMPS	I_3 AMPS	CosΦ	SinΦ	R	Z	X_L	L

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

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

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

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

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

$I = V_R/R$ $Z = V_L/I$

$R = Z \cos Ø$ $X_2 = Z \sin Ø$

$L = X_L/2\prod f$

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

PRECAUTIONS:

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

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.

RESULT:

PRE LAB VIVA QUESTIONS

1. What is meant by choke coil?
2. What is the function of choke coil?
3. What are the different parameters of choke coil?
4. Explain the operation of 3-volt meter method.
5. Explain the operation of 3 ammeter method.
6. What is DPST switch?
7. What is the purpose of using auto transformer?
8 What is ideal choke coil?
9 What is the power factor of choke coil?
10 What are the different applications of choke coil?

POST LAB VIVA QUESTIONS

1. Which method is better to find choke coil parameters? Ammeter method or voltmeter method?
2. What is the disadvantage of resistance of a choke coil?

Date:

EXPERIMENT - 9

CALIBRATION OF LPF WATTMETER BY PHANTOM TESTING

AIM:

To calibrate LPF wattmeter by phantom loading method and compare the power consumed with direct loading.

APPARATUS:

S. No	Equipment	Type	Range	Quantity
1	Auto Transformer			
2	Voltmeter			
3	Ammeter			
4	LPF Wattmeter			
5	Connecting wires			

CIRCUIT DIAGRAM:

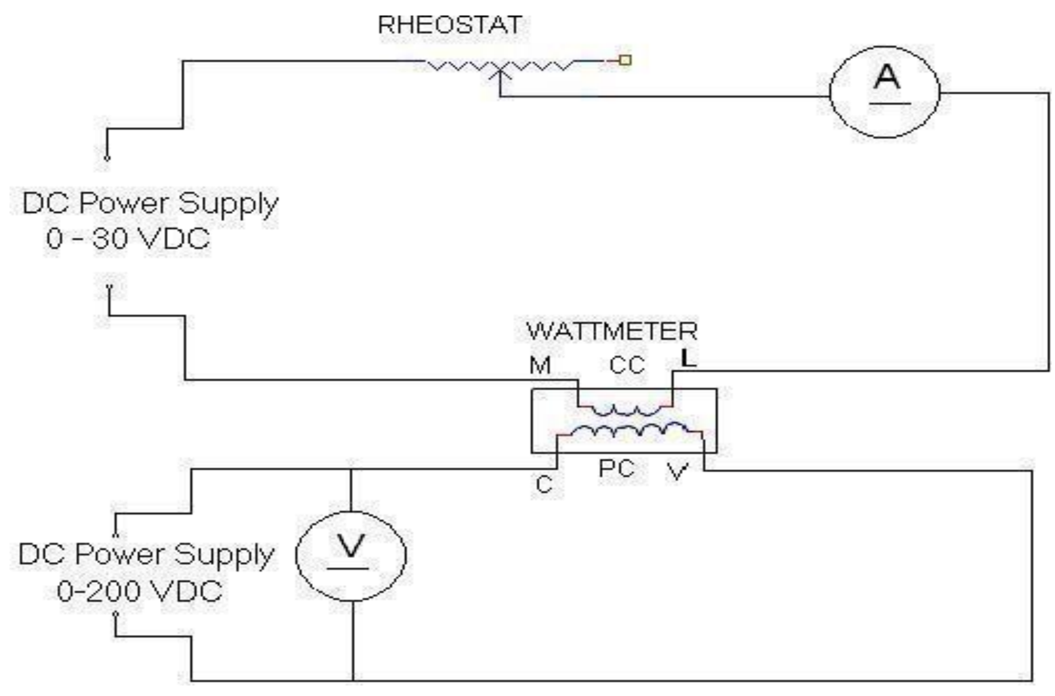


Fig – 9.1 Calibration of LPF Wattmeter by Phantom Testing

PROCEDURE:

1. Keep the Autotransformer at zero position
2. Make connections as per the Circuit diagram shown below.
3. Switch on the 230 VAC, 50 Hz. power supply.
4. Increase the input voltage gradually by rotating the Autotransformer in clockwise direction.
5. Adjust the load rheostat so that sufficient current flows in the circuit. Please note that the current should be less then potentiometer rating.
6. Note down the Voltmeter, Ammeter, Wattmeter for different voltages as per the tabular column.
7. Find out the percentage error by using above equations.

TABULAR COLUMN:

S. No	Voltage (V)	Ammeter (A)	Wattmeter (W)	VI	% Error
1					
2					
3					
4					

MODEL CALCULATIONS:

% Error = $(W_M - W_C) * 100 / W_M$

Where W_C = VI

RESULT:

PRE LAB VIVA QUESTIONS:

1. What is phantom loading?
2. What is direct loading?

POST LAB VIVA QUESTIONS:

1. Is direct or phantom loading is advantageous?

2.power is measured using phantom loading.

Date:

EXPERIMENT - 10

MEASUREMENT OF 3 - PHASE POWER BY USING SINGLE PHASE WATTMETER AND TWO CURRENT TRANSFORMERS

AIM:

To measure 3- phase power by using 1- phase wattmeter and two Current Transformers (CTs).

APPARATUS:

S. No.	Equipment	Range	Type	Quantity
1	Wattmeter			
2	Current Transformers (CTs)			
3	Voltmeter			
4	Ammeter			
5	Resistive Load			
6	Connecting wires			

CIRCUIT DIAGRAM:

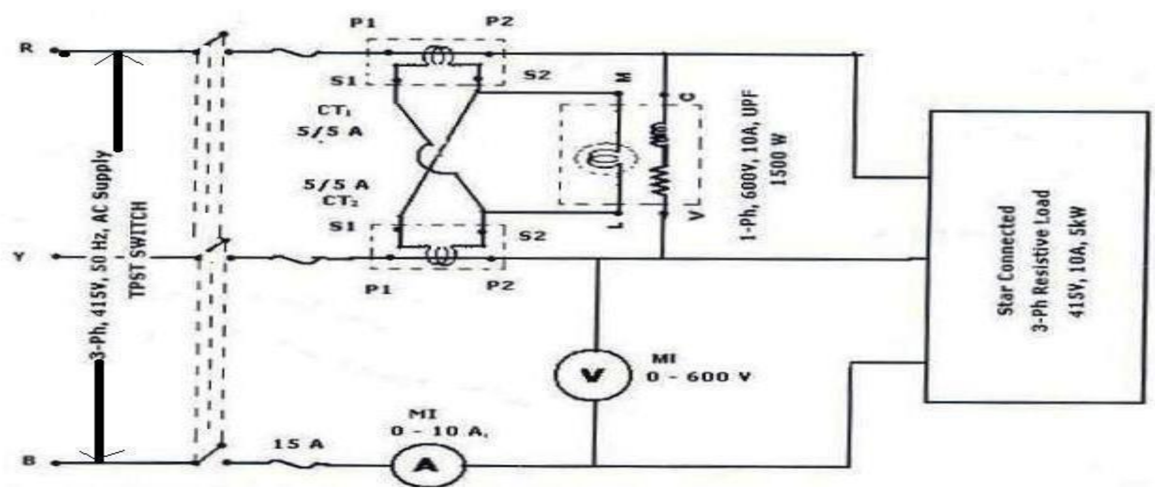


Fig - 1

PROCEDURE:

1. Connections are given as per the circuit diagram.
2. Supply is switched on.
3. Apply the different inductive loads
4. The meter readings are noted as per table given.

TABULAR COLUMN:

S. No	Load (A)	Wattmeter Reading (W_L)	Ammeter Reading (I_L)	Voltmeter Reading (V_L)	Active Power
1					
2					
3					
4					
5					

MODEL CALCULATION:

Active power = wattmeter reading*Multiplication Factor of Current Transformer* Multiplication Factor of wattmeter

Power measured by Wattmeter = $3 V_p I_p \cos \phi$

RESULT:

PRE LAB VIVA QUESTIONS

1. What is electrodynamometer type wattmeter?
2. What is meant by balanced load?
3. What is meant by unbalanced load?
4. What is instrument transformer?
5. Why instrument transformers are used?
6. What is meant by term “burden “of an instrument transformer?
7. What is meant by testing of instrument transformers?
8. What are the different testing methods for a current transformer?
9. Why the secondary of a CT should not be kept open?
10. Where a current transformer is standardized?

POST LAB VIVA QUESTIONS

1. What is the difference between current and potential transformers?
2. How to reduce the losses that occur in the instrumentaltransformers?
3. What are the precautions to be followed while doing the experiment?

Date:

EXPERIMENT – 11

C.T. TESTING USING MUTUAL INDUCTOR – MEASUREMENT OF % RATIO ERROR AND PHASE ANGLE OF GIVEN C.T. BY NULL METHOD

AIM:

Conduct an experiment on CT testing using mutual inductor for measurement of % ratio error and phase angle by null method.

APPARATUS:

S. No	Name of Component	Range	Type	Quantity
1	Standard CT			
2	Wattmeter			
3	Ammeter			
4	Rheostat			
5	Load Burden			
6	Single phase Autotransformer			

CIRCUIT DIAGRAM:

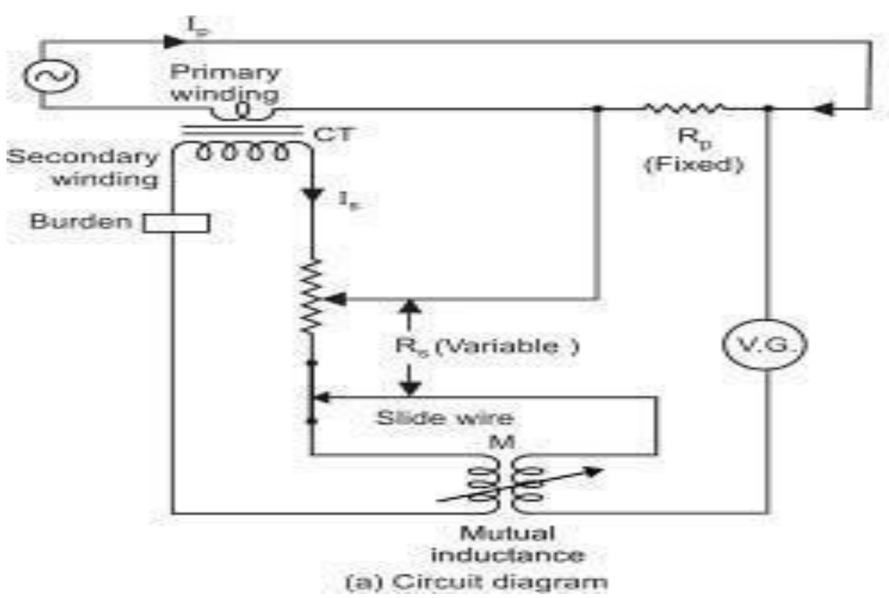


Fig – 11.1Circuit diagram of Testing Using Mutual Inductor – Measurement of % Ratio

PROCEDURE:

1. Connect the circuit as shown in the Figure.
2. Primary of CT is connected across a low voltage supply at a non conducting Resistance R_p.
3. The secondary of CT complete the circuit through a variable non-inductive resistance R_s.
4. The values of R_s & R_p are selected that the ratio of R_s to R_p is approximately equal to nominal ratio of CT.
5. The resistance R_p is adjusted so that full primary current flows while R_s is adjusted so that voltage drop across them are equal.
6. For obtaining Null deflection the magnitude & phase of both the voltage must be same.

TABULAR COLUMN:

S. No					
1					
2					
3					
4					
5					
6					

RESULT:

PRE LAB VIVA QUESTIONS

1. Difference between the CT and PT.
2. What is ratio error?
3. What is phase angle error?

POST LAB VIVA QUESTIONS

1. What is meant by mutual inductance?
2. What are types of testing of CT’s?
3. What is meant by absolute method?

Date:

EXPERIMENT – 12

P.T. TESTING BY COMAPRISON –V.G AS NULL DETECTOR MEASUREMENT OF % RATIO AND PHASE ANGLE ERROR OF GIVEN POTENTIAL TRANSFORMER

AIM:

To find measurement of % ratio and phase angle error of given potential transformer

APPARATUS:

S. No	Name of Component	Range	Type	Quantity
1	Standard PT			
2	Wattmeter			
3	Voltmeter			
4	Rheostat			
5	Load Burden			
6	Single phase Autotransformer			

CIRCUIT DIAGRAM:

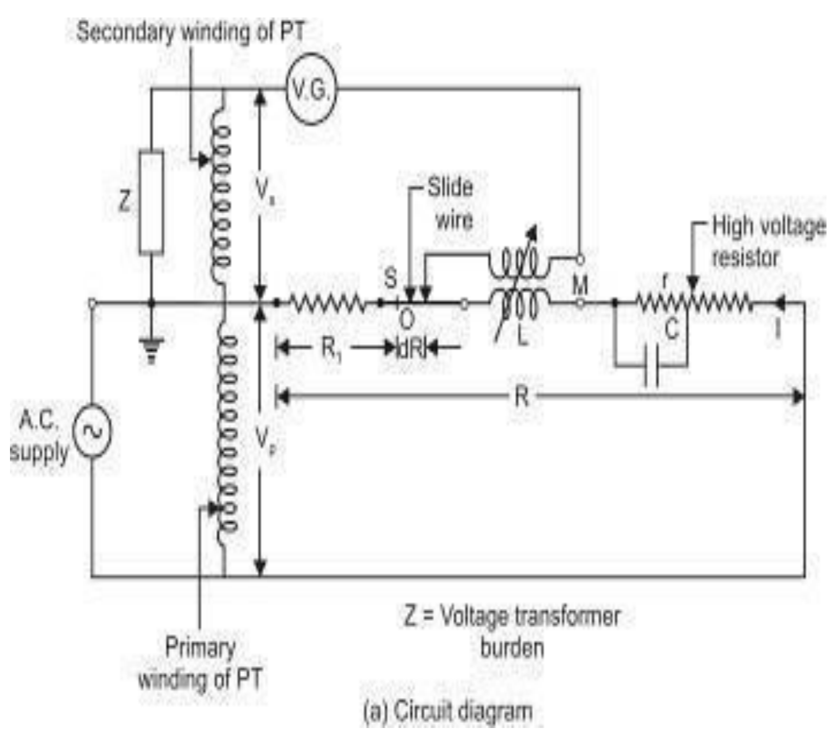


Fig – 12.1 Circuit diagram of P.T. testing by comparison

PROCEDURE:

1. Connect the circuit as shown in the Figure.
2. Primary of PT is connected across a high voltage supply at a conducting Resistance R_p.
3. The secondary of PT complete the circuit through a variable inductive resistance R_s.
4. The values of R_s & R_p are selected that the ratio of R_s to R_p is approximately equal to nominal ratio of PT.
5. The resistance R_p is adjusted so that full primary voltage flows while R_s is adjusted so that current in them are equal.
6. For obtaining Null deflection the magnitude the current must be same.

TABULAR COLUMN:

S. No	Wattmeter reading	PT Ratio	V_{2p}	V_{2q}	Nominal Ratio(q) = V_{2p} / V_{2q}

RESULT:

PRE LAB VIVA QUESTIONS:

1. Difference between the CT and PT?
2. What is nominal ratio?
3. What is phase angle error?

POST LAB VIVA QUESTIONS:

1. What is meant by mutual inductance?
2. What are types of testing of PT’s?
3. What is meant by absolute method?

Date:

EXPERIMENT – 13

LVDT AND CAPACITANCE PICKUP-CHARACTERISTICS AND CALIBRATION

AIM:

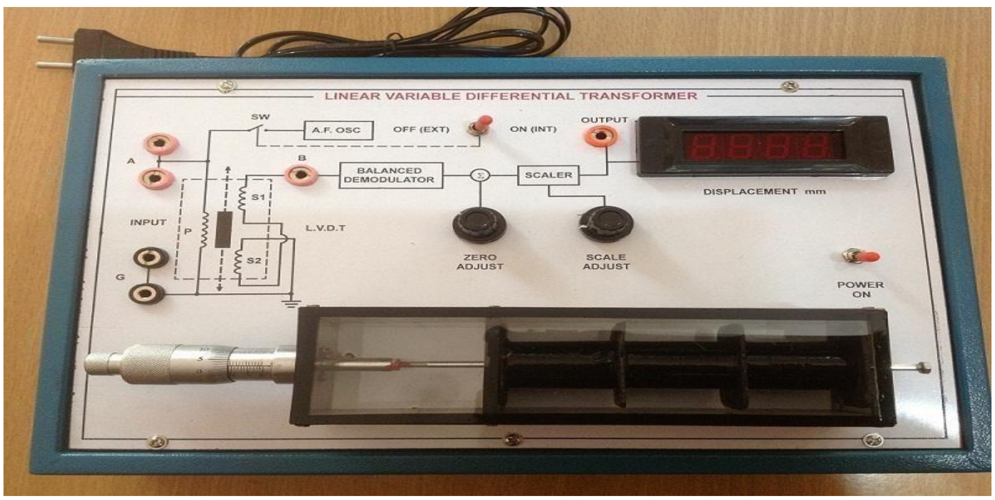
To measure the displacement using linear variable differential transformer.

APPARATUS:

S. No	Name of Equipment	Specifications
1	LVDT	Trainer Kit

CIRCUIT DIAGRAM

1) LVDT trainer kit:



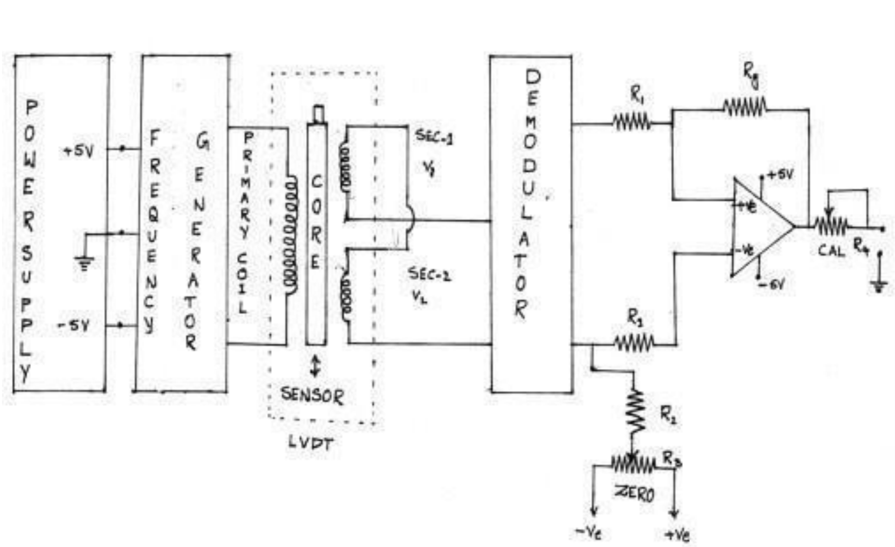
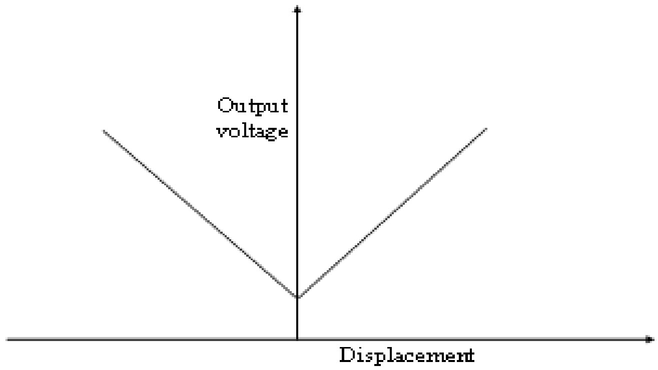


Fig – 13.1 Circuit Diagram of LVDT and Capacitance Pickup – Characteristics and Calibration

MODEL GRAPH:



PROCEDURE

1. Connections are made as per the circuit diagram.
2. Switch on the supply keep the instrument in ON position for 10 minutes for initial warm up.
3. Rotate the micrometer core till it reads 20.0 mm and adjust the CAL potentiometer to display 10.0 mm on the LVDT trainer kit.
4. Rotate the micrometer core till it reads 10.0 mm and adjust the zero potentiometer to display 20.0 mm on the LVDT trainer kit.
5. Rotate back the micrometer core to read 20.0 mm and adjust once again the CAL potentiometer till the LVDT trainer kit display reads 10.0 mm. Now the instrument is calibrated for 10mm range.
6. Rotate the core of micrometer in steps of 2 mm and tabulate the readings of micrometer, LVDT trainer kit display and multimeter reading.

TABULAR COLUMN

S. No	Micro meter Reading in MM	Output Voltage
1		
2		
3		
4		
5		

RESULT:

PRE LAB VIVA QUESTIONS:

1. What is LVDT?
2. What is transducer?
3. How many transducers are there?

POST LAB VIVA QUESTIONS

1. How many windings the transformer in LVDT have in its construction?
2. How the secondaries are connected in the transformer of LVDT?

Date:

EXPERIMENT – 14

RESISTANCE STRAIN GAUGE STRAIN MEASUREMENTS AND CALIBRATION

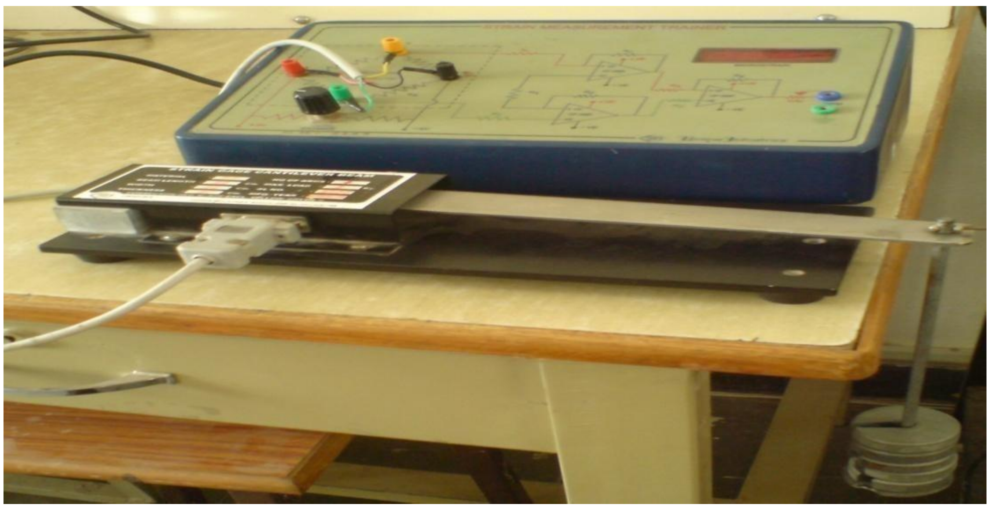
AIM:

To measure the strain using strain gauge trainer kit

APPARATUS:

S. No	Name of Equipment	Specifications
1	Strain Gauge Trainer Kit	Trainer Kit

CIRCUIT DIAGRAM: Trainer Kit:



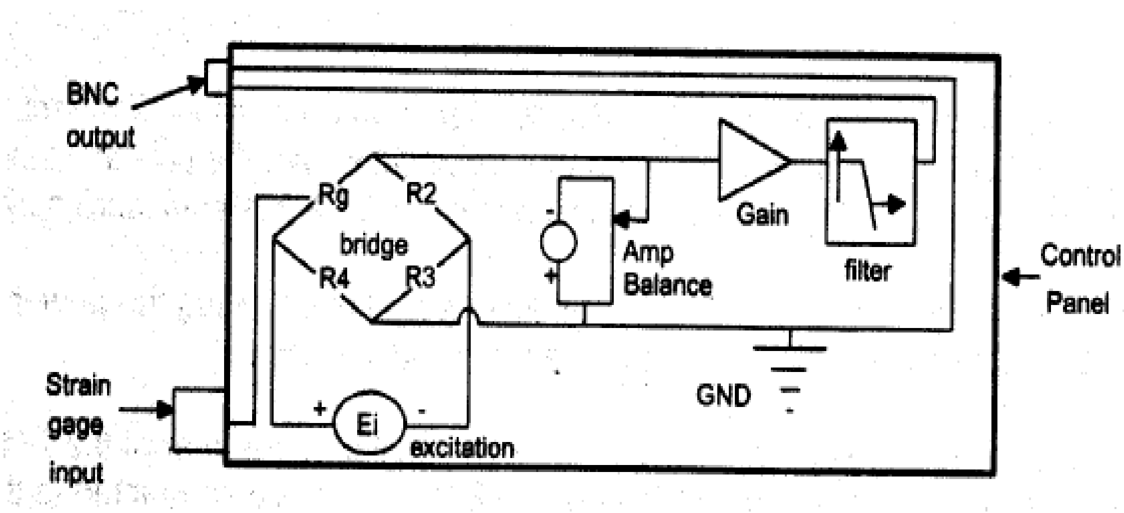


Fig – 14.1 Circuit Diagram of Resistance Strain Gauge Strain Measurements and Calibration

PROCEDURE:

1. Check connection made and Switch ON the instrument by toggle switch at the back of the box. The display glows to indicate the instrument is ON.
2. Allow the instrument in ON Position for 10 minutes for initial warm-up.
3. Adjust the ZERO Potentiometer on the panel till the display roads ‘ OOP’.
4. Apply load on the sensor using the loading arrangement provided in steps of 100g upto 1 Kg.
5. The instrument display exact microstrain strained by the cantilever beam.
6. Note down the readings in the tabular column. Percentage error in the readings. Hysteresic and Accuracy of the instrument can be calculated by comparing with the theoretical values

TABULAR COLUMN:

S. No.	Weights	Actual Reading (A)	Indicating Reading(B)	%error= A-b/a*100
1				
2				
3				
4				
5				

MODEL CALCULATIONS:

S=(6pl) BT^{2}E

P = Load applied in Kg (1 Kg) – 0.2 kg

L = Effective length of the beam in Cms. (22 Cms)

B = Width of the beam (2.8 Cms)

T = Thickness of the beam (0.25 Cm)

E = Young’s modulus (2X10^6)

S = Micro strain

Then the micro strain for the above can be calculated as follows.

$$S = \frac{6 X 1 X 22}{2.8 X 0.25 X (2 X 10^6)}$$

$$S = 3.77 X 10^4$$

S = 377 micro strain

RESULT:

PRE LAB VIVA QUESTIONS:

1. What is mean by strai?
2. What are methods to measure the strain?
3. What are units for star in?

POST LAB VIVA QUESTIONS:

1. What is meant by stress?
2. What are applications of star in measurement?
3. What is meant by calibration?

Date:

EXPERIMENT-15

TRANSFORMER TURNS RATIO MEASUREMENT USING A.C. BRIDGE

AIM:

To find the turns ratio of transformer by using A.C bridge.

APPARATUS:

S.No	Name of Equipment	Quantity
1	Transformer under test	1
2	Transformer with adjustable range (standard)	1
3	Zero position indicator(Digital AC Voltmeter)	1
4	Applied voltage to the bridge and HV winding (220 V, 50 Hz)	1
5	Induced voltage at the LV winding	1

CIRCUIT DIAGRAM:

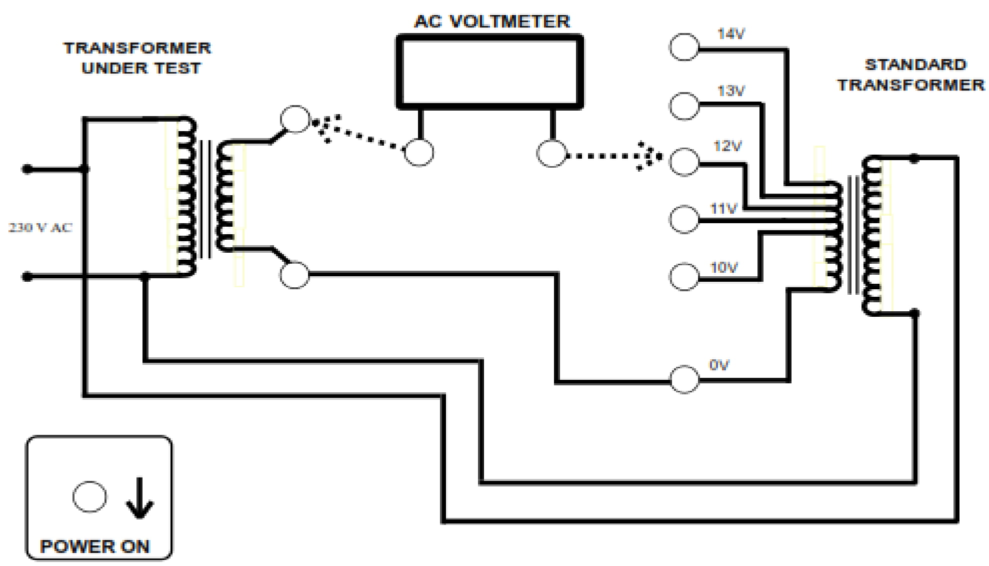


Fig – 15.1 Turns Ratio Diagram

PROCEDURE:

1. Make the connection as per the circuit diagram.
2. Apply the supply to the high voltage side of the transformers.
3. Change the tapping positions of transformer from 0v-14v and note the Ac voltmeter readings simultaneously.
4. Calculate the turns ratio using below formulae.

TABULAR COLUMN:

S. No	Tapping Positions	A.C. Bridge voltage
1	0v	
2	10v	
3	11v	
4	12v	
5	13v	
6	14v	

MODEL CALCULATION:

Va – Vb = A.C. Bridge voltage

Where, Va – Voltage across secondary winding of transformer under test

Vb - Voltage across secondary winding of standard transformer.

Va = A.C. Bridge voltage + Vb

Hence turns ratio transformer under test, N1 / N2 = 230/Va

RESULT:

PRE LAB VIVA QUESTIONS:

1. Define turns ratio of Transformer.
2. Define transformation ratio of transformer.
3. Which bridges used to measure the turns ratio?

POST LAB VIVA QUESTIONS:

1. Measurement of turns ratio is comparison method or substitution method?
2. Name the detector used in the A.C. bridge.
3. Write the formula for turns ratio.

Date:

EXPERIMENT - 16

MEASUREMENT OF % RATIO ERROR AND PHASE ANGLE OF GIVEN C.T BY COMPARISON

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:

S. NO	NAME OF COMPONENT	RANGE	TYPE	QUANTITY
1	Standard CT			
2	Testing CT			
3	Wattmeter			
4	Ammeter			
5	Rheostat			
6	Phase shifting Transformer			
7	Single phase Autotransformer			

CIRCUIT DIAGRAM:

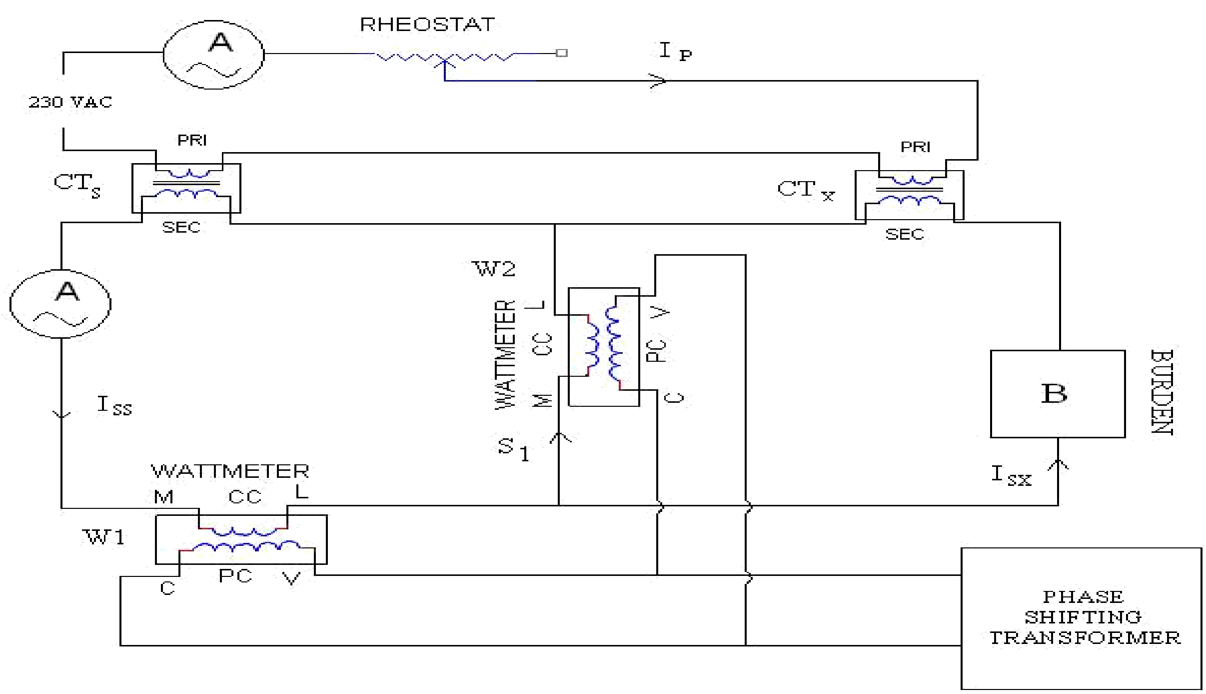


Fig – 16.1 Silsbee's Method of Testing Current Transformers

PROCEDURE:

1. The connections are made as per the circuit diagram. The burden is adjusted to have a suitable current in the phase angle is adjusted using the phase shifting transformer will wattmeter W1 reads Zero.
2. Reading of the other wattmeter (w2q) is noted.
3. A phase shift of 90 is obtained by the phase shifting transformer. The two wattmeter readings W 1p and W2p are then observed.
4. The ratio error is calculate ding the formula Rx = Rs.
5. The phase angle error is calculated using the formula.
6. The experiment is repeated by varying the burden and setting different values for Iss.
7. The average values of Rs and are then obtained.

TABULAR COLUMN:

S. No.	I_{SS}	W1q	W2q	W1p	W2p	Rx	θ_x

MODEL CALCULATION:

$$\text{Ratio error } Rx = Rs\left[1 + \frac{W2p}{W1p}\right]$$

Phase angle error $\theta_x = W_{2q} / (W1p - W2p) + \theta s$

PRECAUTIONS:

1. W2 is sensitive instrument. Its current coil may be defined for small values. It is normally designed to carry about 0.25 A for testing CTs having a secondary current of 5 Amps

RESULT:

PRE LAB VIVA QUESTIONS:

1. What is instrument transformer?
2. Why instrument transformers are used?
3. What is meant by term "burden"of an instrument transformer?
4. What is meant by testing of instrument transformers?
5. What are the different testing methods for a current transformer?
6. Why the secondary of a CT should not be kept open?
7. What is Capacitive Voltage transformer?
8. What are the applications of CVT?
9. What is formula for ratio error?
10. What is formula for phase angle error?

POST LAB VIVA QUESTIONS:

1. How to reduce ratio error in a current transformer?
2. How to reduce phase angle error in a current transformer?
3. What are the various other methods of testing CT's?
4. What are the advantages and disadvantages of this method?
5. Define burden in the case of CT.
6. What are the most important design criteria to reduce the errors in a C.T.?
7. What is the turn's compensation and why it is use?