ELECTRICAL MEASUREMENTS

LAB MANUAL

Subject Code	**:**	**A57604**
Regulations	**:**	**R09 – JNTUH**
Class	**:**	**IV Year I Semester (EEE)**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal – 500 043, Hyderabad

Department of Electrical and Electronics Engineering

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

Program Outcomes	
PO1	**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design / Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life - Long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life - long learning in the broadest context of technological change.
Program Specific Outcomes	
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.
PSO2	**Problem - Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.

MESUREMENTS LAB SYLLABUS

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

Exp. No.	Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
1	Calibration and testing of single phase energy meter	PO1,P09	PSO2,PSO3
2	Calibration of dynamo meter type power factor meter	PO1,PO9	PSO2,PSO3
3	Calibration of PMMC voltmeter and ammeter by dc Crompton's Potentiometer	PO1,PO2,	PSO2,PSO3
4	Measurement of resistance using Kelvin's double bridge	PO1,PO2,PO9	PSO2,PSO3
5	Dielectric oil testing using H.T. testing kit	PO1, PO9	PSO2,PSO3
6	Schering bridge and Anderson's bridge	PO1,PO9	PSO2,PSO3
7	Measurement of 3 - phase reactive power by using single wattmeter	PO1,P09	PSO2,PSO3
8	Measurement of parameters of choke coil using three volt meter and three ammeter method	PO1, PO2	PSO2,PSO3
9	Calibration of LPF wattmeter by phantom testing	PO1, PO9	PSO2,PSO3
10	Measurement of 3 - phase power by using 1 - phase wattmeter and two current transformers	PO1,P09	PSO2,PSO3
11	C.T. testing using mutual inductor – measurement of % ratio error and phase angle of given C.T. by null method	PO1,PO12	PSO2,PSO3
12	P.T. testing by comparison – V.G as null detector measurement of % ratio and phase angle error of given P.T.	PO1,PO2,	PSO2,PSO3
13	LVDT and capacitance pickup-characteristics and calibration	PO1, PO9	PSO2,PSO3
14	Resistance strain gauge - strain measurements and calibration	PO1, PO2	PSO2,PSO3
15	Transformer turns ratio measurement using A.C. bridge	PO1, PO2	PSO2,PSO3
16	Measurement of % ratio error and phase angle of given C.T by comparison	PO1, PO12	PSO2,PSO3

ELECTRICAL MEASUREMENTS LABORATORY

OBJECTIVE:

The objective of this lab is to teach students to know the procedures for measuring Resistance, Inductance and Capacitance of different ranges. To perform experiments to measure three phase power, frequency, core losses. To design experiments for calibration of energy meter and to know the industrial practices of Measuring earth resistance, dielectric strength of transformer oil & Testing of underground cables.

OUTCOMES:

1. Upon completion of study of the course should be able to calibrate and test single phase energy meter, calibrate PMMC voltmeter and calibrate LPF wattmeter.
2. Student should be able to measure resistance, inductance and capacitance.
3. Students should be able to measure 3-Φ active power and reactive power.
4. Students should be able to test current transformers and dielectric strength of oil. Students should be able to calibrate LVDT and resistance strain gauge.

EXPERIMENT - 1

CALIBRATION AND TESTING OF SINGLE PHASE ENERGY METER

1.1 AIM:

To calibrate and testing of single phase induction type energy meter.

1.2 APPARATUS:

S. No	Equipment	Range	Type	Quantity
1.	Energy Meter			
2.	Voltmeter			
3.	Ammeter			
4.	Resistive Load			
5.	Stop Watch			
6.	1-Ph Variac			
7.	Connecting wires			

1.3 CIRCUIT DIAGRAM:

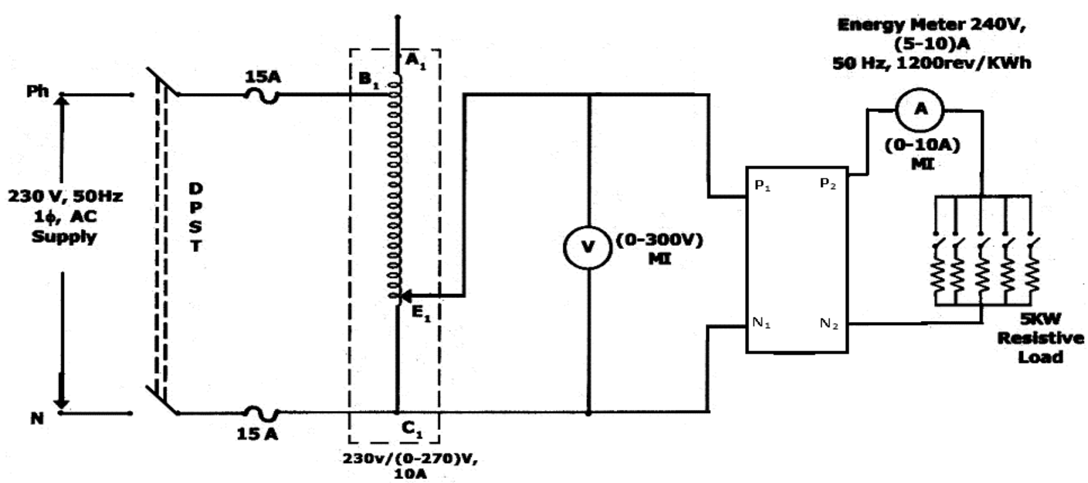


Fig – 1.1 Calibrations and Testing of Single Phase Energy Meter

1.4 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 than 4A.

6. Note down the Voltmeter, Wattmeter and power factor meter readings for different voltages as per the tabular column.
7. Note down the time (by using stop watch) for rotating the disc of the Energy Meter for 10 times. Find out the percentage error by using equations.

1.5 TABULAR COLUMN:

S. No	Applied Load (A)	Voltmeter Reading (V)	Ammeter Reading (A)	R=No of revolutions of the disc	Time (sec)	E_s	E_T	% Error
1								
2								
3								
4								

1.6 MODEL CALCULATIONS:

Energy meter constant K is defined as

$$K = \frac{\text{No. of revolutions kwh}}{\text{KWH}}$$

Energy recorded by meter under test = Rx / Kx – kWh.

Energy computed from the readings of the indication instrument = kW x t

Where Rx = number of revolutions made by disc of meter under test.

Kx = number of revolutions per k Wh for meter under test.

KW = Power in kilowatt as computed from readings watt meter indicating instruments

t = time in hours.

$$\text{Percentage Error} = \frac{(Rx / Kx - kW \times t)}{kW \times t} \times 100$$

1.7 RESULT:

1.8 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?

1.9 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?

EXPERIMENT - 2

CALIBRATION OF DYNAMO METER TYPE POWER FACTOR METER

2.1 AIM:

To calibrate dynamometer type power factor meter.

2.2 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			

2.3 CIRCUIT DIAGRAM:

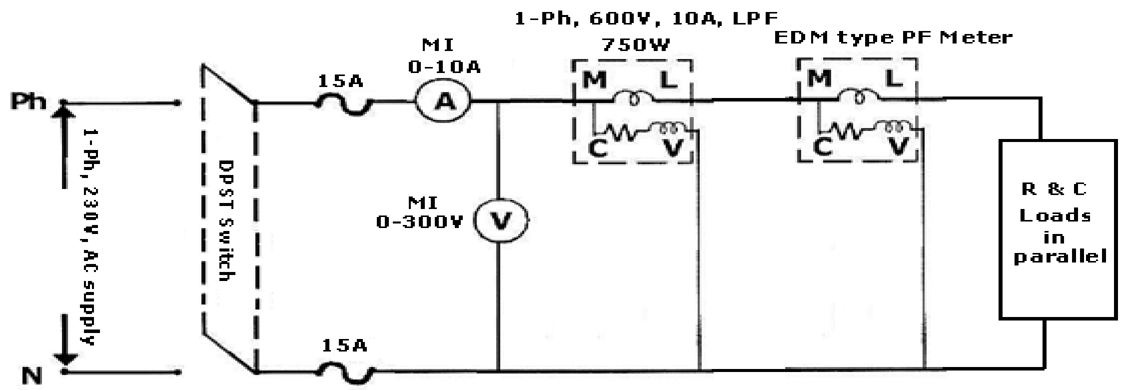


Fig – 2.1 Calibration of Dynamo Meter Type Power Factor Meter

2.4 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.

2.5 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.								

2.6 MODEL CALCULATIONS:

$$\text{Cos Ø (X)} = W / VI$$

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

2.7 RESULT:

2.8 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?

2.9 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?

EXPERIMENT - 3

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

3.1 AIM:

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

3.2 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			

3.3 CIRCUIT DIAGRAM:

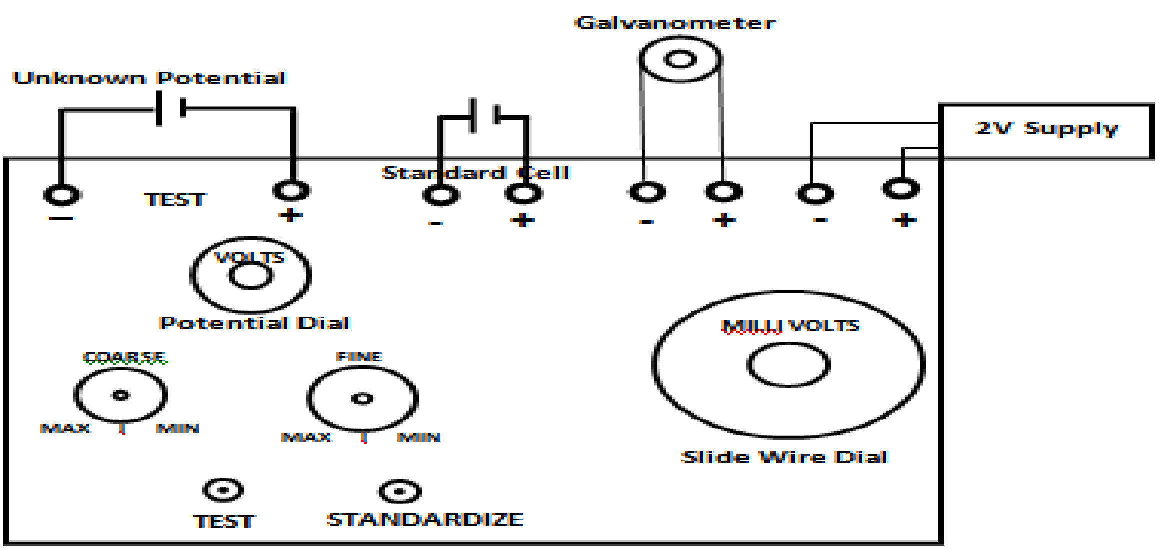


Fig – 3.1 Standardization

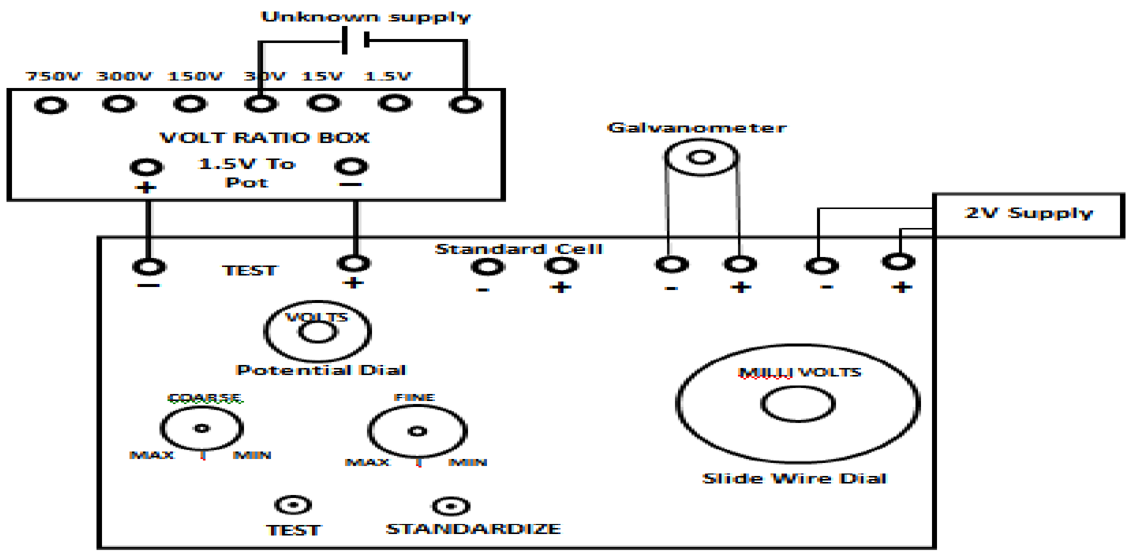


Fig – 3.2 Calibration of Voltmeter

3.4 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 the supply.
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 the galvanometer.
4. Vary the dial reading until there is no deflection in the galvanometer.
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 the galvanometer.
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.

3.5 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					

3.6 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 $= [(I_m - I_c)*100]/I_m$

3.7 RESULT

3.8 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?

3.9 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 standard cell?

EXPERIMENT - 4

MEASUREMENT OF RESISTANCE USING KELVIN'S DOUBLE BRIDGE

4.1 AIM:

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

4.2 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

4.3 CIRCUIT DIAGRAM:

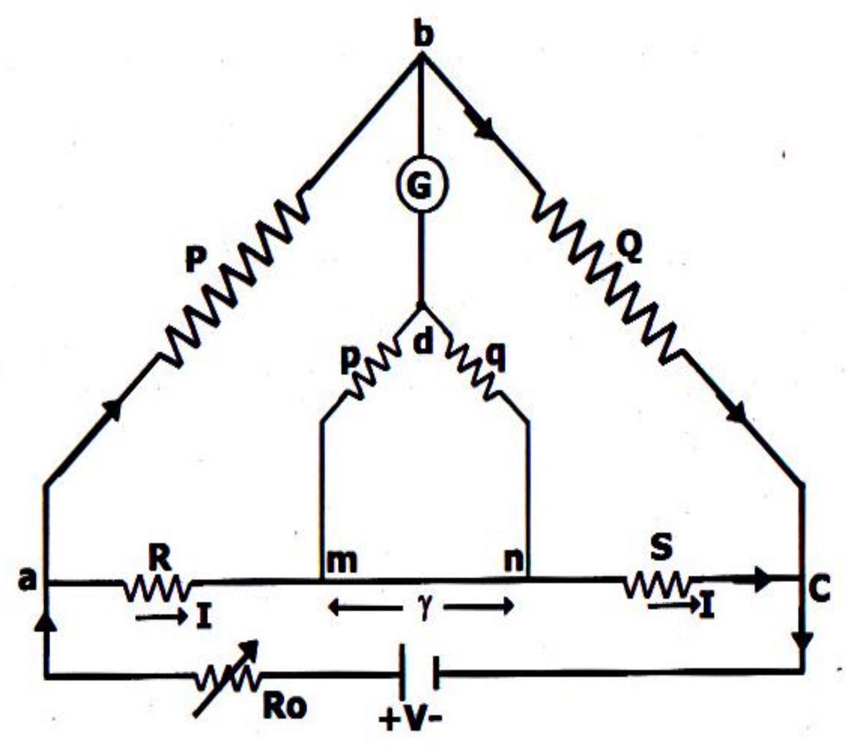


Fig – 4.1 Kelvin's Double Bridge

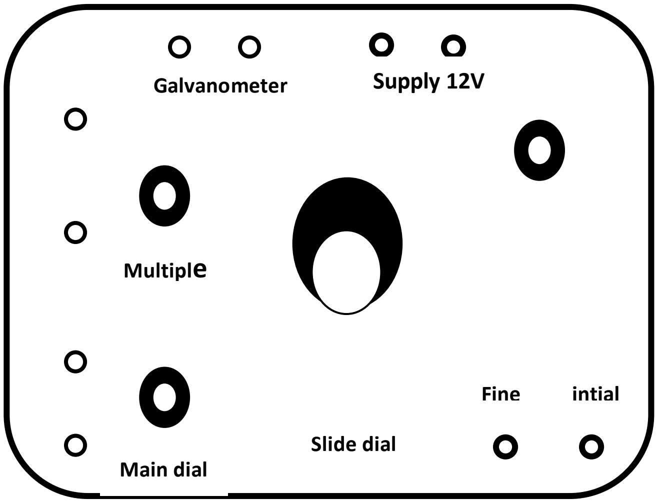


Fig – 4.2 Kelvin's Double Bridge

4.4 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.

4.5 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			

4.6 MODEL CALCULATIONS:

R = (x+ y)z

X = Main dial reading

Y = Slide dial reading

Z = multiplier range used for their resistance

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

4.7 RESULT:

4.8 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?

4.9 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?

EXPERIMENT – 5

DIELECTRIC OIL TESTING USING H.T. TESTING KIT

5.1 AIM:

To test oil transformer determines the dielectric strength of oil.

5.2 APPARATUS:

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

5.3 CIRCUIT DIAGRAM

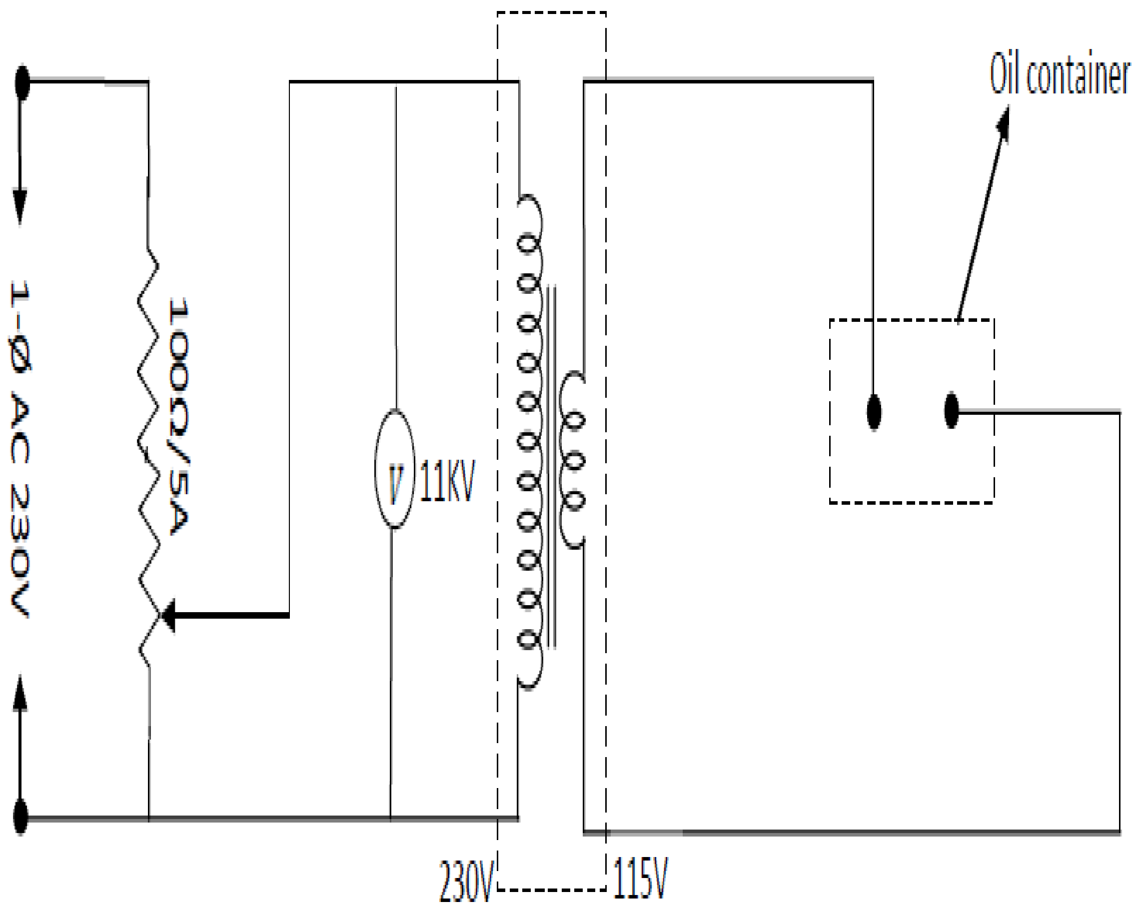


Fig – 5.1 Circuit Diagram of Testing of Transformer Oil

5.4 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 of oil.
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.

5.5 TABULAR COLUMN

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

5.6 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.

5.7 RESULT:

5.8 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?

5.9 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?

EXPERIMENT – 6

SCHERING BRIDGE AND ANDERSON'S BRIDGE

6.1 AIM:

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

6.2 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

6.3 CIRCUIT DIAGRAM:

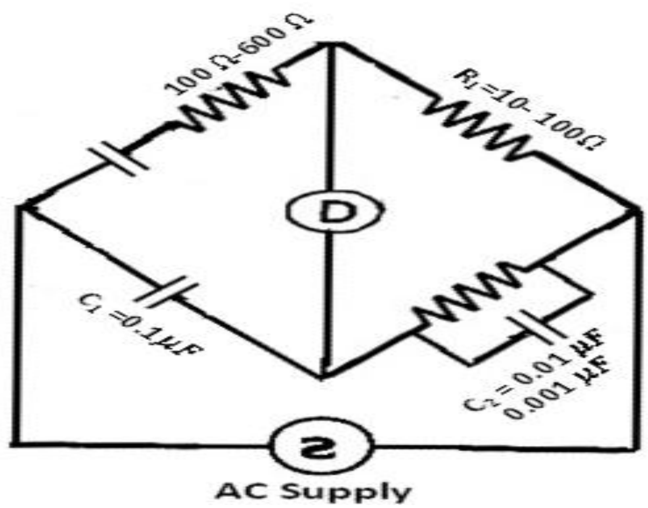


Fig – 6.1 Schering Bridge

6.4 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.

6.5 TABULAR COLUMN:

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

6.6 MODEL CALCULATIONS:

Schering Bridge

Non Inductive resistance $R_1 =$

Variable Non Inductive resistance $R_2 =$

Variable Capacitor $C_1 =$

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

6.7 CIRCUIT DIAGRAM:

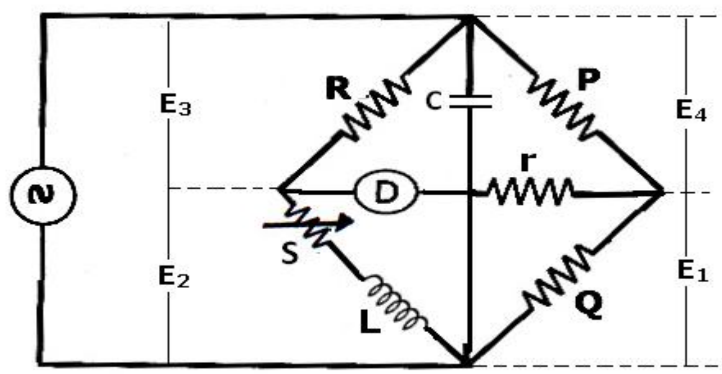


Fig – 6.2 Anderson's Bridge

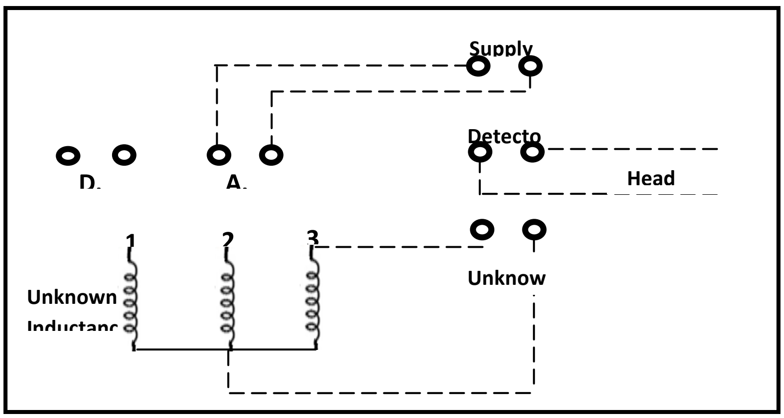


Fig – 6.3 AC Circuit

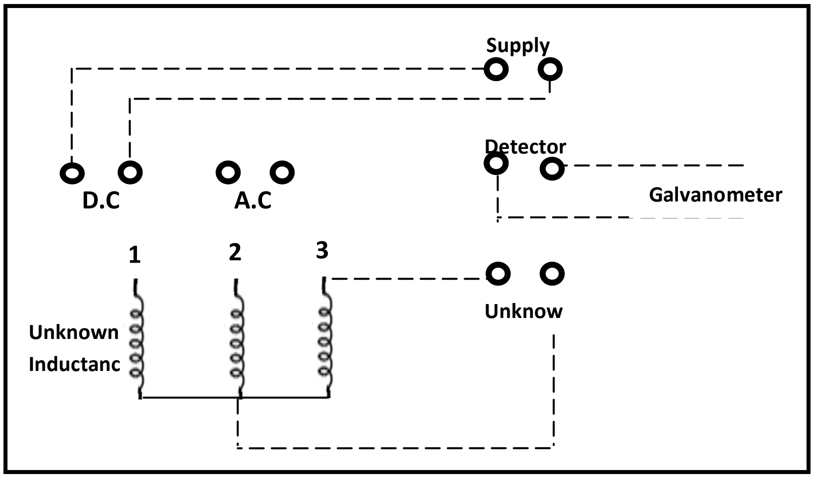


Fig – 6.4 DC Circuit

6.8 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.

6.9 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.		

6.10 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

$P = 1000\Omega$; $Q = 1000\Omega$; $R = 1000\Omega$;

S = Resistance of the unknown inductor

6.11 RESULT:

6.12 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?

6.13 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?

EXPERIMENT – 7

MEASUREMENT OF 3 - PHASE REACTIVE POWER USING SINGLE WATTMETER

7.1 AIM:

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

7.2 APPARATUS:

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

7.3 CIRCUIT DIAGRAM:

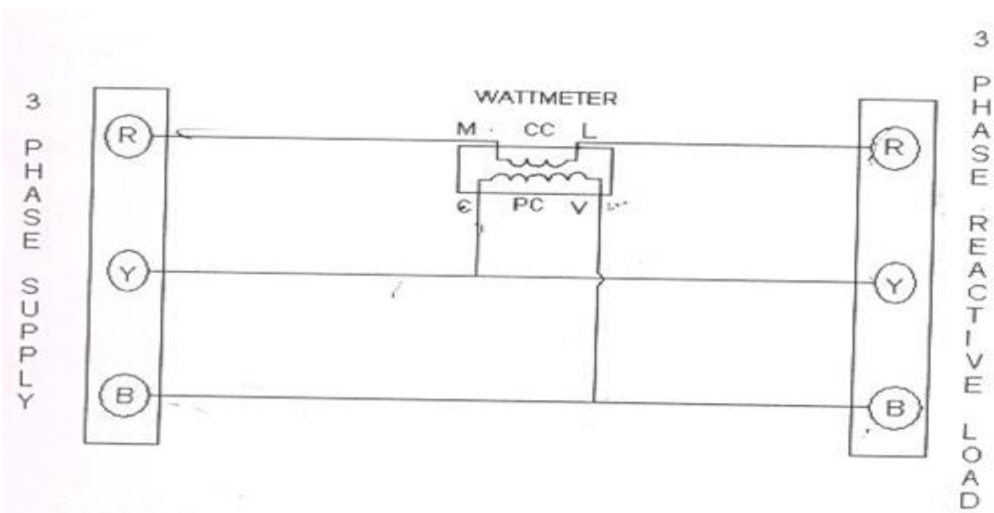


Fig – 7.1 Circuit Diagram of Measurement of 3-Phase Reactive Power using Single Wattmeter

7.4 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 reactive power.
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’ the supply.

7.5 TABULAR COLUMN:

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

7.6 MODEL CALCULATIONS:

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

7.7 RESULT:

7.8 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?

7.9 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?

EXPERIMENT - 8

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

8.1 AIM:

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

8.2 APPARATUS:

S. No.	Equipment	Range	Type	Quantity
1.	Choke Coil			
2.	1 –phase Variac			
3.	Voltmeter			
4.	Ammeter			
5.	Rheostat			
6.	Connecting wires			

8.3 CIRCUIT DIAGRAM:

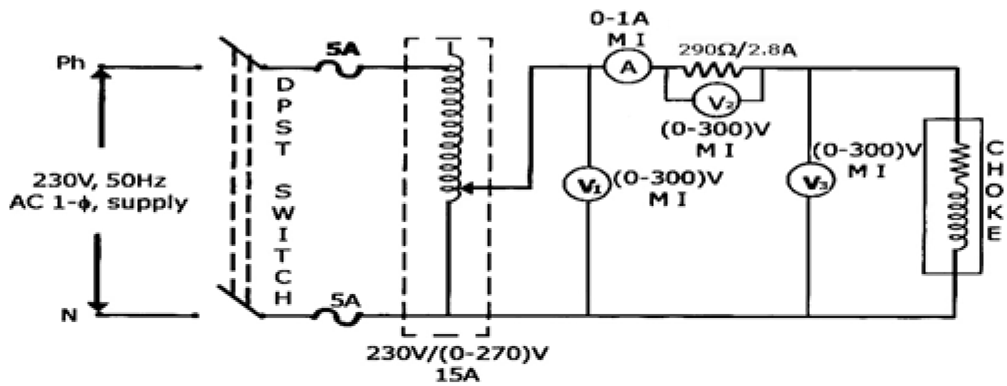


Fig – 8.1 Three Voltmeter Method

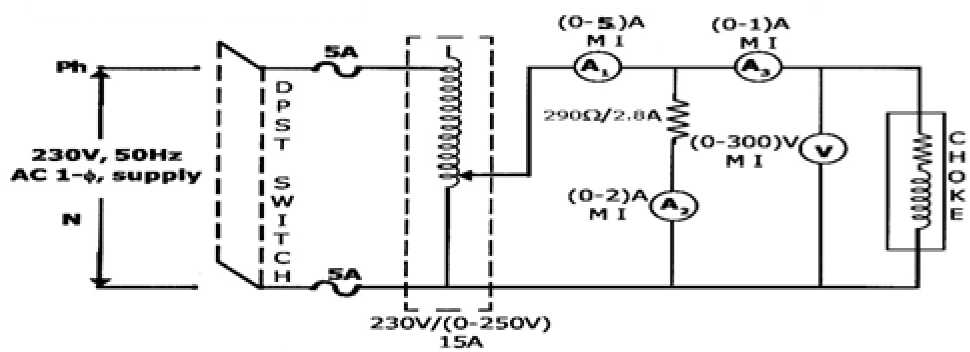


Fig – 8.2 Three Ammeter Method

8.4 PROCEDURE:

Three Voltmeter Method

1. Connect as per circuit diagram.
2. Initially the variac should be minimum output position and adjusted the rheostat at 100ohm.
3. By slowly varying the Auto Transformer the Voltmeter V_3 is adjusted to rated voltage of choke.
4. Note down the corresponding readings of V_2 & V_1.

Three Ammeter Method

1. Make the connection as per the circuit diagram.
2. Initially the variac should be minimum output position and adjusted the rheostat at 100ohm.
3. By slowly varying the Auto Transformer the Ammeter A is adjusted till the rated current is reached.
4. Note down the corresponding readings of A_2 & A_1.

8.5 TABULAR COLUM:

Three Voltmeter Method

S. No	Ammeter Reading (A)	Voltmeter Reading (V_1)	Voltmeter Reading (V_2)	Voltmeter Reading (V_3)	Power (W)	Resistance (Ω)	Inductance (mH)
1.							
2.							
3.							
4.							

Three Ammeter Method

S. No	Voltmeter Reading (V)	Ammeter Reading (A_1)	Ammeter Reading (A_2)	Ammeter Reading (A_3)	Power (W)	Resistance (Ω)	Inductance (mH)
1.							
2.							
3.							
4.							

8.6 MODEL CALCULATION:

Three Voltmeter Method

$P = (V_1^2 – V_2^2 – V_3^2)/ 2R$ $\quad$ $Cos\O = (V_1^2 – V_2^2 – V_3^2) / 2V_2V_3$

$I = V_2/R$ $\quad$ $Z = V_3/I$

$R = Z\ Cos\O$ $\quad$ $X_2 = Z\ Sin\O$

$L = X_L/2\prod f$

Three Ammeter Method

$P = [(I_1^2 – I_2^2 – I_3^2)/2]^* R$ $\quad$ $Cos\O = (I_1^2 – I_2^2 – I_3^2)/2I_2\ I_3$

$V = I_2R$ $\quad$ $Z = V/I$

$R = Z\ cos\O$ $\quad$ $X_L = Z\ sin\O$

$L = X_L/2\prod f$

8.7 RESULT:

8.8 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?

8.9 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?

EXPERIMENT - 9

CALIBRATION OF LPF WATTMETER BY PHANTOM TESTING

9.1 AIM:

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

9.2 APPARATUS:

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

9.3 CIRCUIT DIAGRAM:

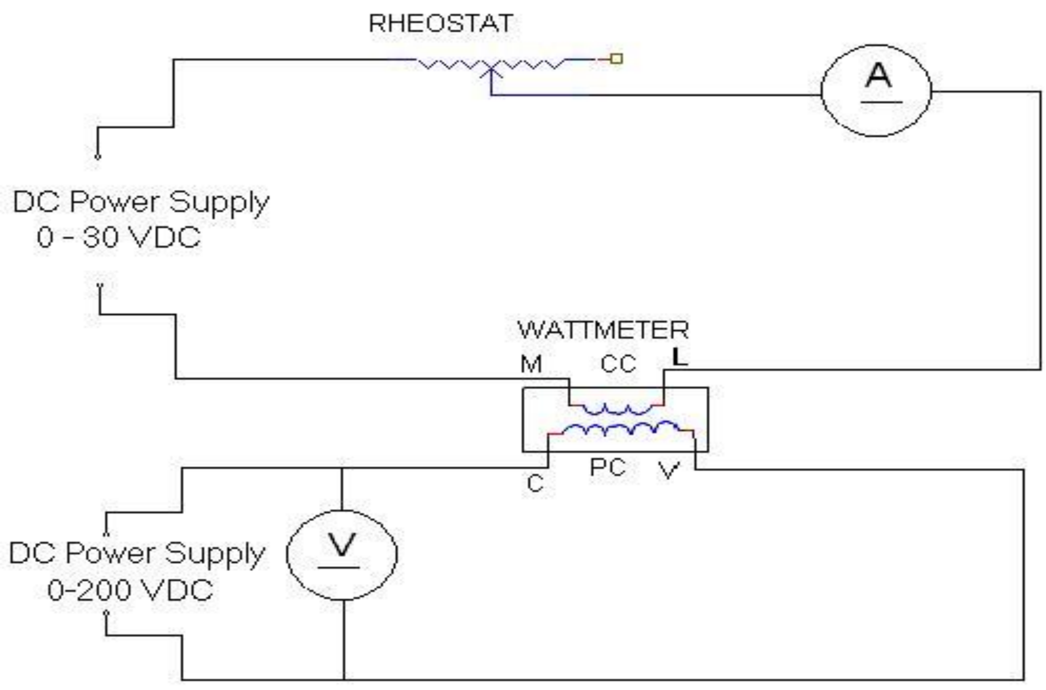


Fig – 9.1 Calibration of LPF Wattmeter by Phantom Testing

9.4 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.

9.5 TABULAR COLUMN:

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

9.6 MODEL CALCULATIONS:

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

Where $W_C = VI$

9.7 RESULT:

9.8 PRE LAB VIVA QUESTIONS:

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

9.9 POST LAB VIVA QUESTIONS:

1. Is direct or phantom loading is advantageous?
2. -----------power is measured using phantom loading.

EXPERIMENT - 10

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

10.1 AIM:

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

10.2 APPARATUS:

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

10.3 CIRCUIT DIAGRAM:

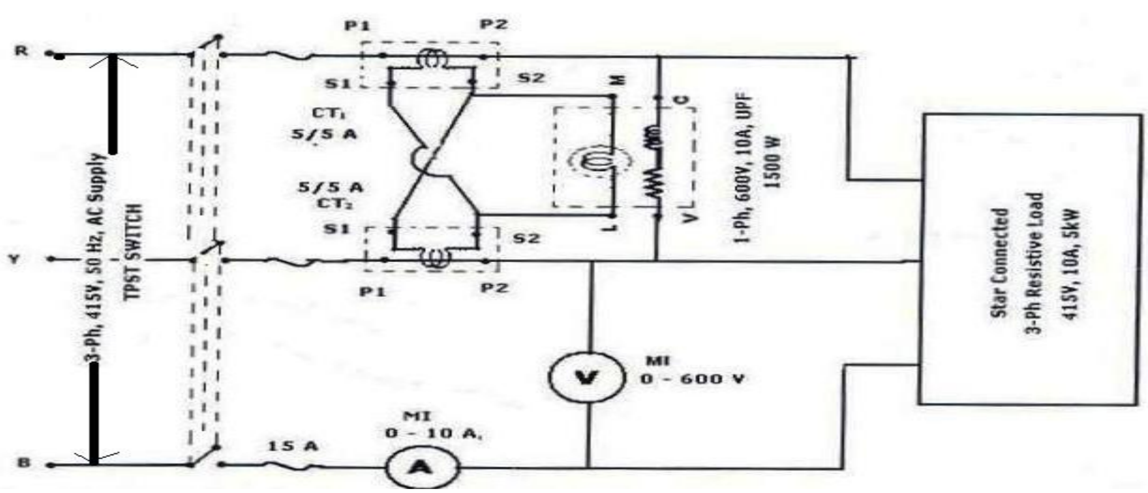


Fig - 1

10.4 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.

10.5 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					

10.6 MODEL CALCULATION:

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

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

10.7 RESULT:

10.8 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?

10.9 POST LAB VIVA QUESTIONS

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

EXPERIMENT – 11

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

11.1 AIM:

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

11.2 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			

11.3 CIRCUIT DIAGRAM:

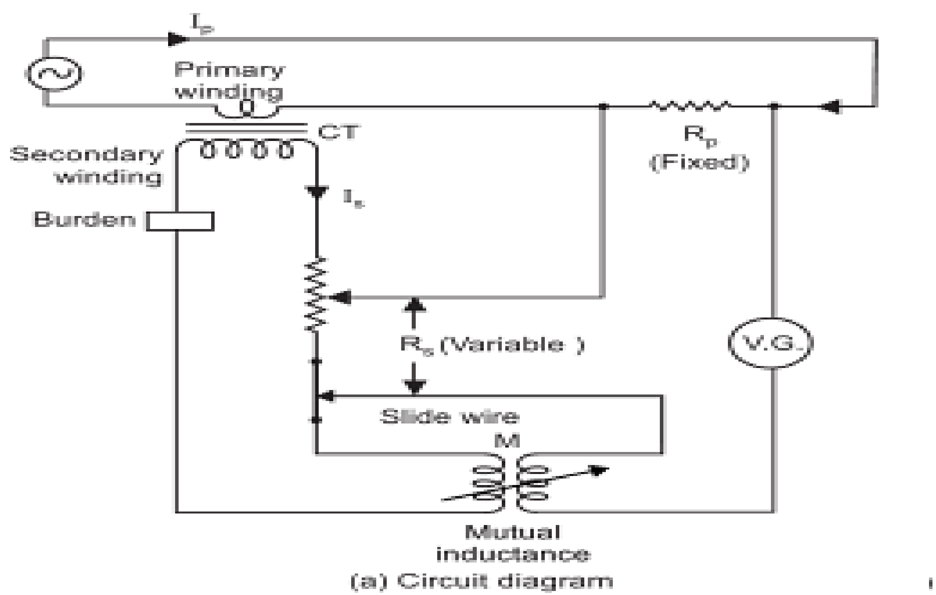


Fig – 11.1Circuit diagram of Testing Using Mutual Inductor – Measurement of % Ratio

11.4 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.

11.5 TABULAR COLUMN:

S. No					
1					
2					
3					
4					
5					
6					

11.6 RESULT:

11.7 PRE LAB VIVA QUESTIONS

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

11.8 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?

EXPERIMENT – 12

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

12.1 AIM:

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

12.2 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			

12.3 CIRCUIT DIAGRAM:

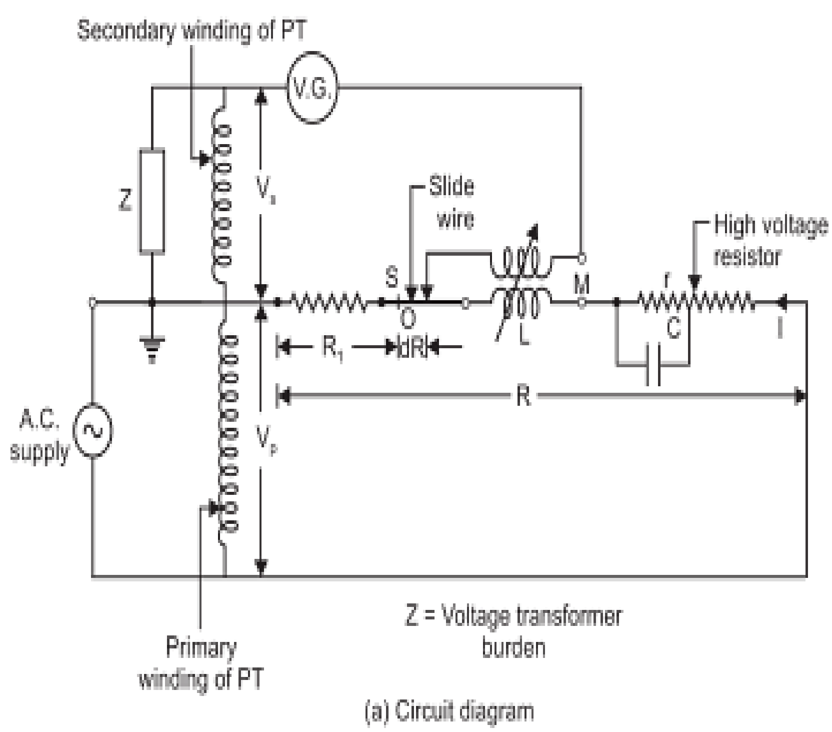


Fig – 12.1 Circuit diagram of P.T. testing by comparison

12.4 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.

12.5 TABULAR COLUMN:

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

12.6 RESULT:

12.7 PRE LAB VIVA QUESTIONS:

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

12.8 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?

EXPERIMENT – 13

LVDT AND CAPACITANCE PICKUP-CHARACTERISTICS AND CALIBRATION

13.1 AIM:

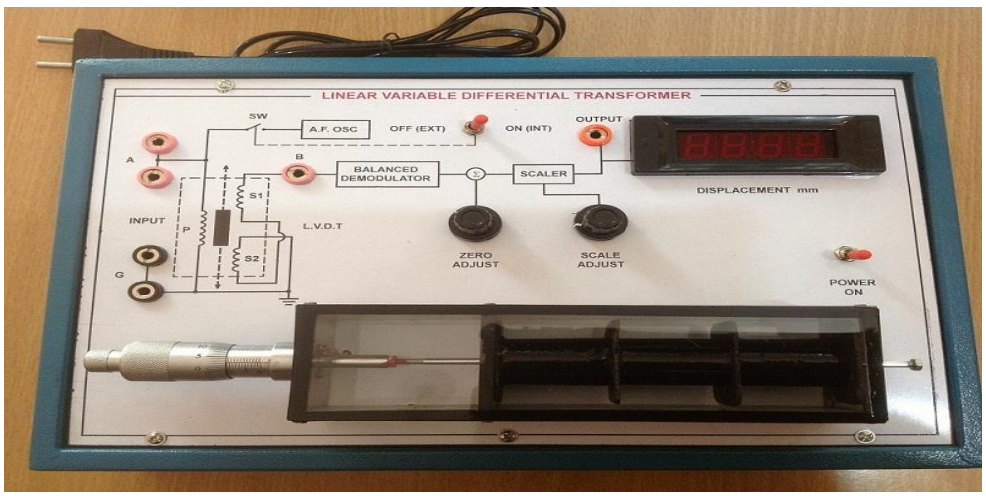
To measure the displacement using linear variable differential transformer.

13.2 APPARATUS:

S. No	Name of Equipment	Specifications
1	LVDT	Trainer Kit

13.3 CIRCUIT DIAGRAM

1) LVDT trainer kit:



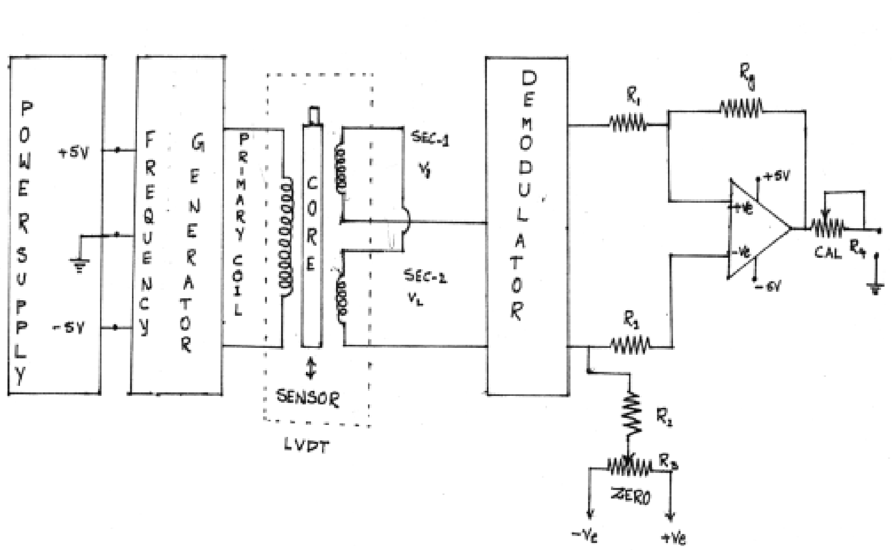
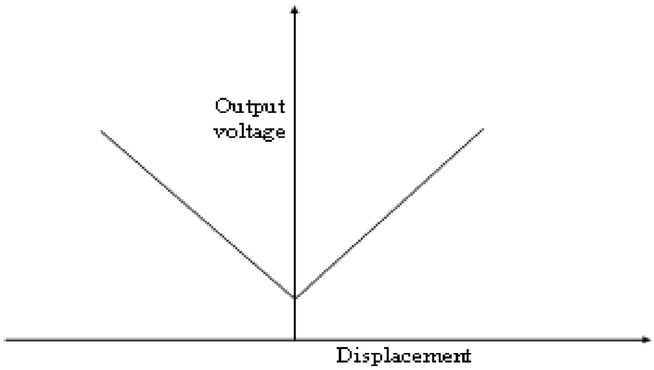


Fig – 13.1 Circuit Diagram of LVDT and Capacitance Pickup – Characteristics and Calibration

13.4 MODEL GRAPH:



13.5 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.

13.6 TABULAR COLUMN

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

13.7 RESULT:

13.8 PRE LAB VIVA QUESTIONS:

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

13.9 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?

EXPERIMENT – 14

RESISTANCE STRAIN GAUGE STRAIN MEASUREMENTS AND CALIBRATION

14.1 AIM:

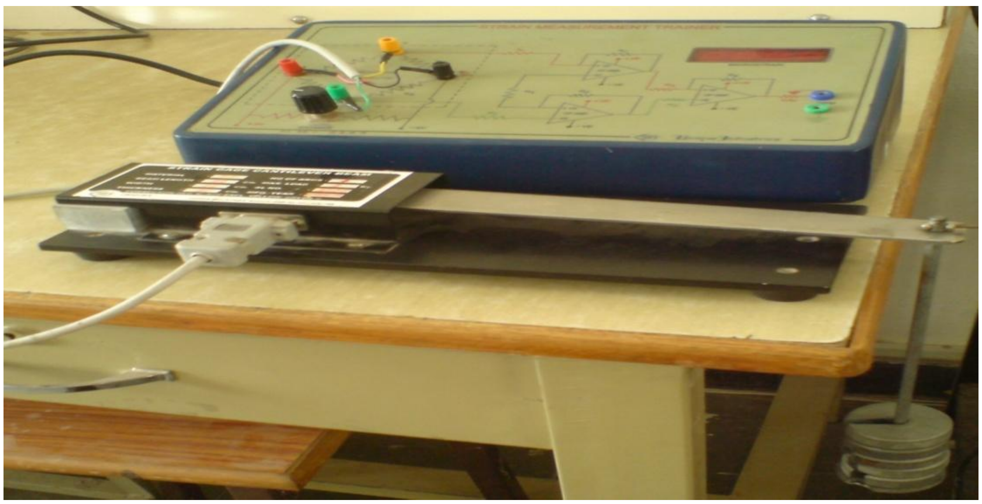
To measure the strain using strain gauge trainer kit

14.2 APPARATUS:

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

14.3 CIRCUIT DIAGRAM:

Trainer Kit:



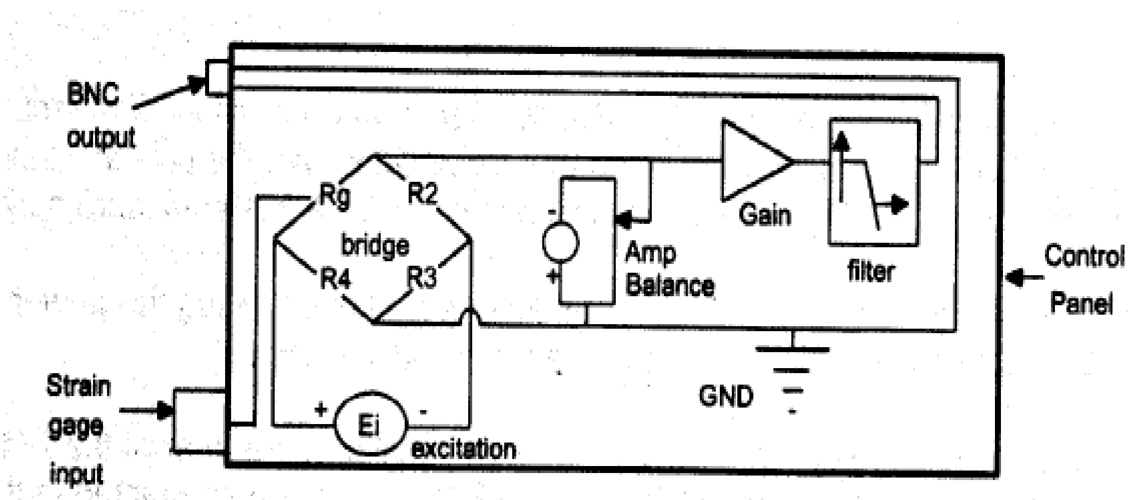


Fig – 14.1 Circuit Diagram of Resistance Strain Gauge Strain Measurements and Calibration

14.4 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

14.5 TABULAR COLUMN:

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

14.6 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

14.7 RESULT:

14.8 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?

14.9 POST LAB VIVA QUESTIONS:

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

EXPERIMENT-15

TRANSFORMER TURNS RATIO MEASUREMENT USING A.C. BRIDGE

15.1 AIM:

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

15.2 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

15.3 CIRCUIT DIAGRAM:

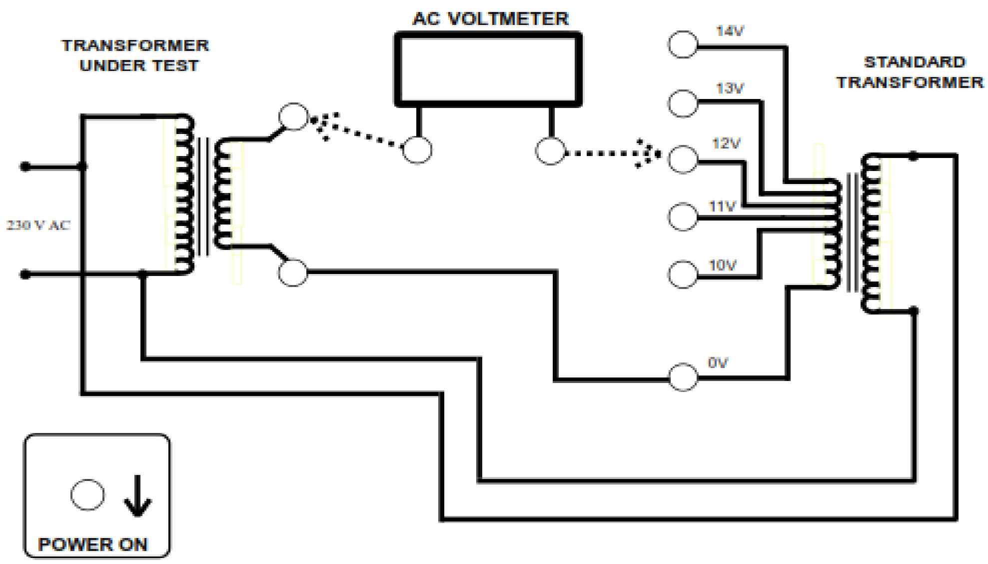


Fig – 15.1 Turns Ratio Diagram

15.4 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.

15.5 TABULAR COLUMN:

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

15.6 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

15.7 RESULT:

15.8 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?

15.9 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.

EXPERIMENT - 16

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

16.1 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.

16.2 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			

16.3 CIRCUIT DIAGRAM:

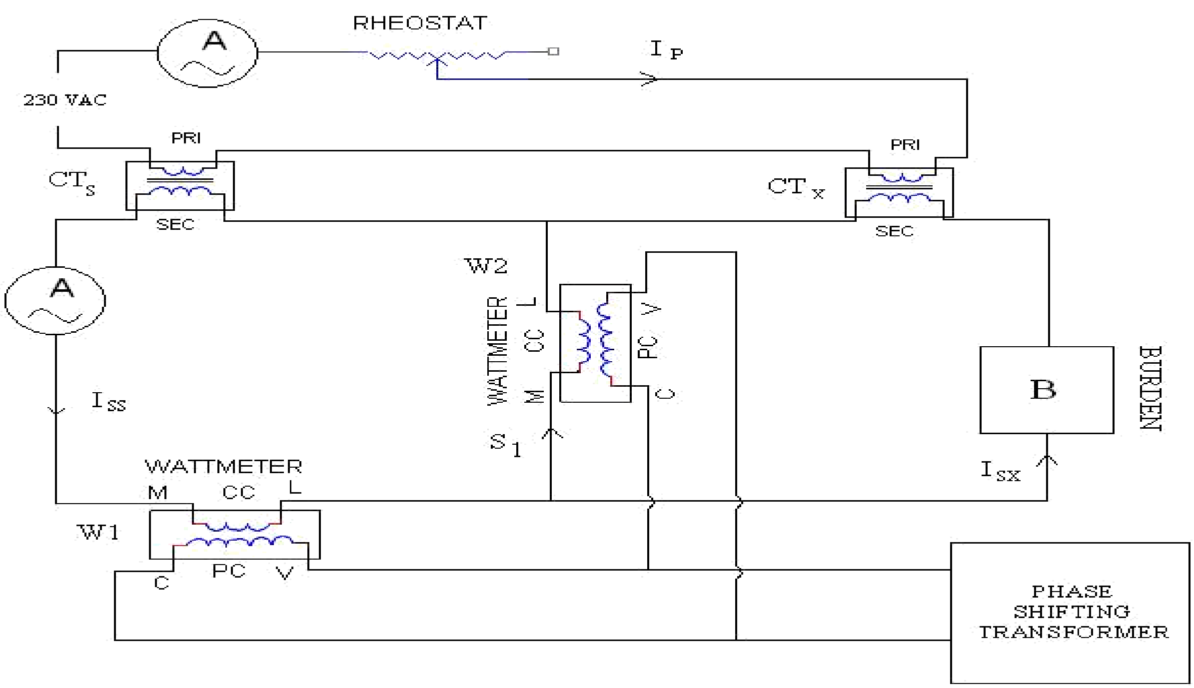


Fig – 16.1 Silsbee's Method of Testing Current Transformers

16.4 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.

16.5 TABULAR COLUMN:

S. No.	I_{SS}	W1q	W2q	W1p	W2p	Rx	θ_x

16.6 MODEL CALCULATION:

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

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

16.7 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

16.8 RESULT:

16.9 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?

16.10 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?