KG REDDY College of Engineering & Technology

DEPARTMENT

OF

ELECTRICAL AND ELECTRONICS ENGINEERING

III B.TECH I SEMESTER

REGULATION/LAB CODE**: R16/ EE505PC**

LABORATORY MANUAL

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

DEPARTMENT VISION

To become a renowned department imparting both technical and non-technical skills to the students by implementing new engineering pedagogy's and research to produce competent new age electrical engineers.

DEPARTMENT MISSION

- To transform the students into motivated and knowledgeable new age electrical engineers.
- To advance the quality of education to produce world class technocrats with an ability to adapt to the academically challenging environment.
- To provide a progressive environment for learning through organized teaching methodologies, contemporary curriculum and research in the thrust areas of electrical engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEO's):

- **PEO 1:** Apply knowledge and skills to provide solutions to Electrical and Electronics Engineering problems in industry and governmental organizations or to enhance student learning in educational institutions
- **PEO 2:** Work as a team with a sense of ethics and professionalism, and communicate effectively to manage cross-cultural and multidisciplinary teams
- **PEO 3:** Update their knowledge continuously through lifelong learning that contributes to personal, global and organizational growth

PROGRAM OUTCOMES (PO's):

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural science and engineering sciences.

PO 3: 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.

PO 4: 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.

PO 5: Modern tool usage: create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO 6: 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.

PO 7: Environment sustainability: understand the impact of the professional engineering solutions in the societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: 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.

PO 11: 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.

PO 12: Lifelong learning: recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broader context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO's):

PSO-1: Apply the engineering fundamental knowledge to identify, formulate, design and investigate complex engineering problems of electric circuits, power electronics, electrical machines and power systems and to succeed in competitive exams like GATE, IES, GRE, OEFL, GMAT, etc.

PSO-2: Apply appropriate techniques and modern engineering hardware and software tools in power systems and power electronics to engage in life-long learning and to get an employment in the field of Electrical and Electronics Engineering.

PSO-3: Understand the impact of engineering solutions in societal and environmental context, commit to professional ethics and communicate effectively.

COURSE OUTCOMES (CO’s):

Upon completion of this course, the student will be able to:

CO 1. Measure the electrical parameters using measuring instruments

CO 2. Calibration and testing of measuring instruments

CO 3. Test the transformer oil dielectric strenth

CO 4. Test the Current transformer and Potential transformer

EE505PC: ELECTRICAL MEASUREMENTS & INSTRUMENTATION LAB

B.Tech III Year I Sem

L	T	P	C
0	0	3	2

The following experiments are required to be conducted as compulsory experiments

1. Calibration and Testing of single phase energy Meter.
2. Calibration of dynamometer power factor meter.
3. Crompton D.C. Potentiometer – Calibration of PMMC ammeter and PMMC voltmeter.
4. Kelvin's double Bridge – Measurement of resistance – Determination of Tolerance.
5. Dielectric oil testing using H.T. testing Kit.
6. Schering bridge & Anderson bridge.
7. Measurement of 3 - Phase reactive power with single-phase wattmeter.
8. Measurement of displacement with the help of LVDT.

In addition to the above eight experiments, at least any two of the experiments from the following list are required to be conducted.

9. Calibration LPF wattmeter – by Phantom testing.
10. Measurement of 3-phase power with single watt meter and two CTs.
11. C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given CT by Null method.
12. PT testing by comparison **– V. G.** as Null detector – Measurement of % ratio error and phase angle of the given PT
13. Resistance strain gauge – strain measurements and Calibration.
14. Transformer turns ratio measurement using AC bridges.
15. Measurement of % ratio error and phase angle of given CT by comparison.

Instructions to the students:

A. Do's

1. Attend the laboratory always in time
2. Attend in formal dress
3. Submit the laboratory record and observation in every lab session
4. Use the laboratory equipment properly and carefully
5. Attend the lab with procedure for the experiment
6. Switch off the laboratory equipments immediately after the completion of the experiment
7. Place the bags outside
8. Leave the footwear outside

B. Don'ts

1. Don't make noise in the laboratory
2. Don't miss handle lab system
3. Don't use cell phone in the lab

CONTENTS

S. No	Name of the Experiment	Page No
1	Measurement of 3 - Phase reactive power with single-phase wattmeter	
2	Dielectric oil testing using H.T. testing Kit	
3	Crompton D.C. Potentiometer – Calibration of PMMC ammeter and PMMC voltmeter	
4	Calibration and Testing of single phase energy Meter	
5	Kelvin's double Bridge – Measurement of resistance – Determination of Tolerance	
6	Schering bridge & Anderson bridge	
7	Calibration of dynamometer power factor meter	
8	Measurement of displacement with the help of LVDT	
9	Calibration LPF wattmeter – by Phantom testing	
10	Resistance strain gauge – strain measurements and Calibration	
11	Measurement of 3-phase power with single watt meter and two CTs	
12	C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given CT by Null method	
13	PT testing by comparison – V. G. as Null detector – Measurement of % ratio error and phase angle of the given PT	
14	Transformer turns ratio measurement using AC bridges	
15	Measurement of % ratio error and phase angle of given CT by comparison	

EXPERIMENT -1

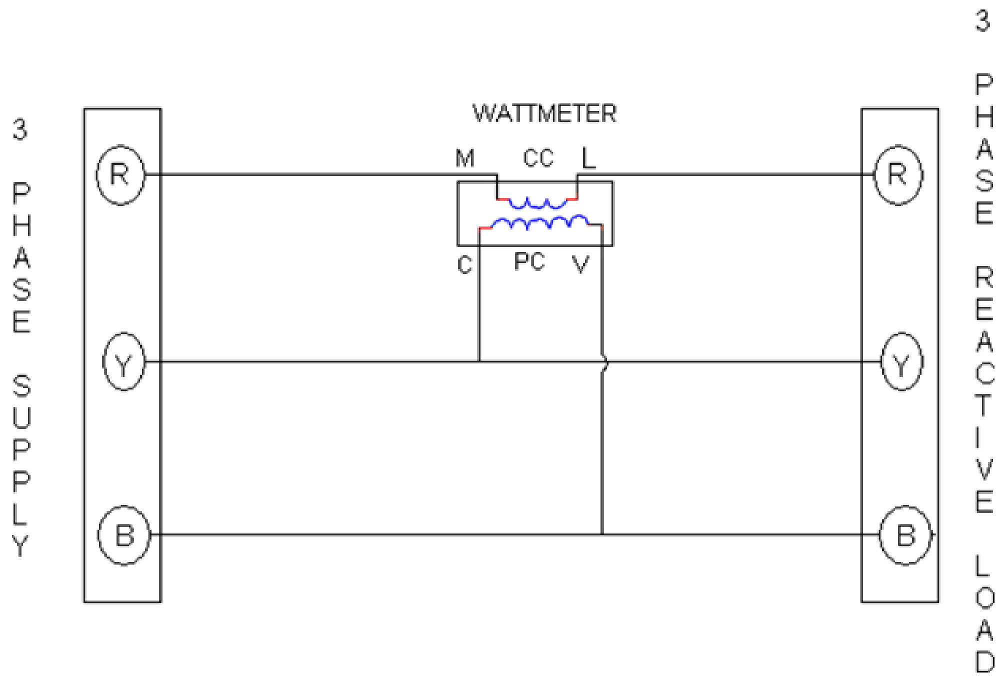
MEASUREMENT OF 3-PHASE REACTIVE POWER USING SINGLE WATTMETER

AIM: To measure 3-phase reactive power using single phase wattmeter

APPARATUS:

S.NO	Equipment	Range	Type	Quantity
1	Single Phase Wattmeter			
2	Three Phase inductive load		AC	2

CIRCUIT DIAGRAM:



THEORY: Three phase reactive power can be measured by two wattmeter method which is universally adopted Method. The difference between higher reading wattmeter and lower wattmeter reading yields VL ILsinφ. so, the total 3 reactive power is √3 V L I L sinϕ.

Reactive power in a balance 3-ϕ load can also be calculated by using single wattmeter. In this method, the current coil of the wattmeter is connected in any on line and the pressure coils across the other two lines. Let us assume that the Current coil is connected in R phase and pressure coil is connected across 'Y' and 'B' phases. Assuming phases. Assuming phase sequence RYB and an inductive load of an angle 'ϕ' the phasor diagram for the circuits is as follows.

Here current through current coil = I_R

Voltage across pressure coil = V_{YB}

The phase current lag the corresponding phasor voltages by an angle Ǿ

The current through wattmeter P1 is I and a voltage across its pressure

coil is V I leads V By an angle (30- Ǿ).

Reading of P1 wattmeter, P = VI cos (30- Ǿ) = √3 VI cos (30- Ǿ)

The current through wattmeter P2 is I and voltages across its pressure coil is V I lags V by an an angle (30 + Ǿ)

Reading of P2 wattmeter, P = VI cos (30 + Ǿ) =

√3 VI cos (30 + Ǿ) Sum of reading of two

Wattmeters

P1+P2 = √3 VI [cos (30- Ǿ) - cos (30 + Ǿ)]

= 3VI cos Ǿ

this is total power consumed by load P = P1 + P2

Difference of readings of two Wattmeters

P1 – P2 = √3 VI [cos (30- Ǿ) - cos (30 + Ǿ)]

= √3 VI sin Ǿ

PROCEDURE:

1. Connect the circuit as shown in fig.
2. Switch 'ON' the supply.
3. Note down the corresponding there reading and calculate 3-□ 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.

TABULAR COLUMNS:

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

PRECAUTIONS:

1. Reading must be taken without parallax error.
2. Measuring instruments must be connected properly & should be free from errors.
3. All connections should be free from loose contacts.
4. The direction of currents should be identified correctly

RESULT:

EXPERIMENT -2

DIELECTRIC OIL TESTING USING H.T TESTING KIT

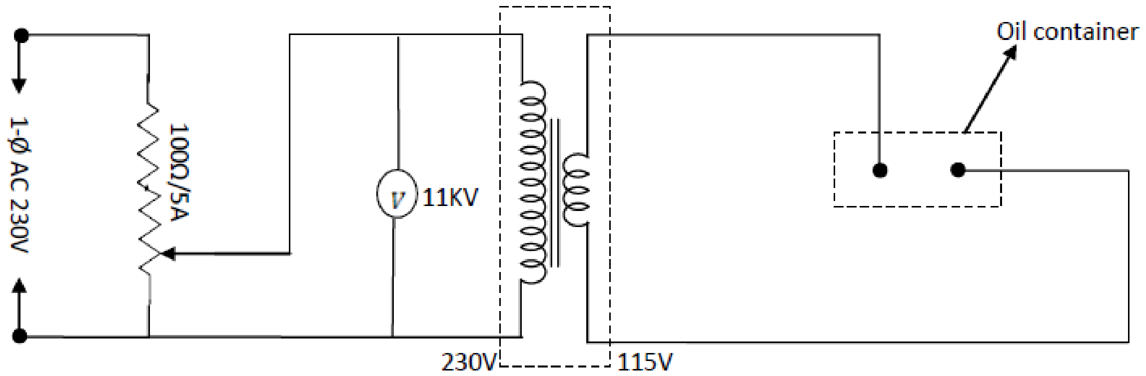
AIM: To determine the dielectric strength of oil.

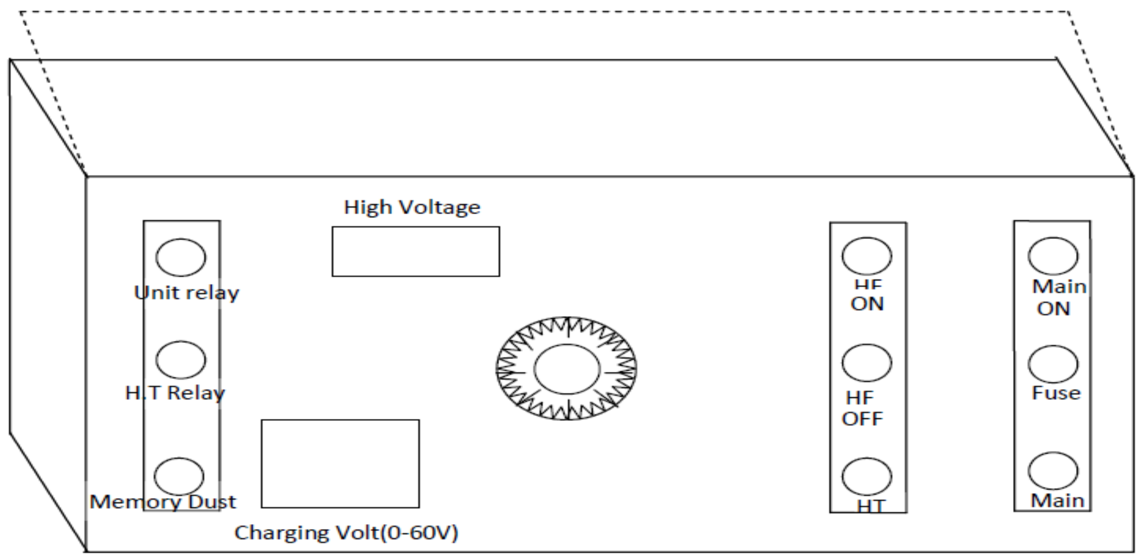
APPARATUS: - Transformer oil test kit.

NAME PLATE DETAILS:-

Input voltage: 230/240V 1-Φ 50HZ AC supply
Output voltage: (0-60) KVA
Capacity: 1 KVA

CIRCUIT DIAGRAM:





THEORY:

The oil transformer kit is used to determine the dielectric strength of oil these are generally used in substations. It contains two electrodes of a small gap between there when ever break down voltage occurs there will be a spark is observed at the high voltage side of the transformer. For calibration the gap in between the two electrodes is 4MM. the voltage that is obtained when flash over occurs is rapidly applied voltage.

PROCEDURE:

1. Adjust the gap between electrodes to 2.5mm by the gauge provided with punch marks for 'GO'

2. Fill the cup with oil and place it on the HT electrodes. Close the hood properly, so as to operate the interlock micro switch which acts as a safety precaution for the operator.

3. Switch on the main supply, the corresponding lamp will glow.

4. Press the HT 'ON' puss button the contractor will operate and HT ON lamp will glow. If the contractor dosen't operate, it means that the variac brush arm is not at ZERO position or the hood interlock micro switch is not closed as mentioned in '2'. The zero interlocking of the variac is the at the safety feature against switching on the unit directly at higher voltage. This will be indicated by the voltmeter reading also.

5. Raise the voltage by turning the variac knob in clockwise direction. In case the oil sample fails the unit will trip to lower down the voltage turn the variac knob anticlock and bring it to zero position before start of further tests.

TABULAR COLUMN:

S. No.	Dielectric voltage	Average value

PRECAUTIONS:

1. Reading must be taken without parallax error.
2. Measuring instruments must be connected properly & should be free from errors.
3. All connections should be free from loose contacts.

RESULT:

EXPERIMENT -3

CROMPTON D.C. POTENTIOMETER – CALIBRATION OF PMMC AMMETER AND PMMC VOLTMETER

AIM: To Determine Error given by voltmeter with DC potentiometer.

APPARATUS:

S.NO	Equipment	Range	Type	Quantity
1	RPS	(0-30)v		1
2	Voltmeter	(0-30)v	MC	1
3	Volt Ratio box			1
4	Standard cell	0.0186		1
5	Connecting wires			set
6	Potentiometer			1

CIRCUIT DIAGRAM:

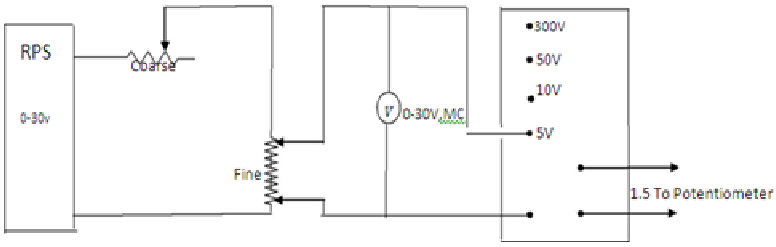


figure:1

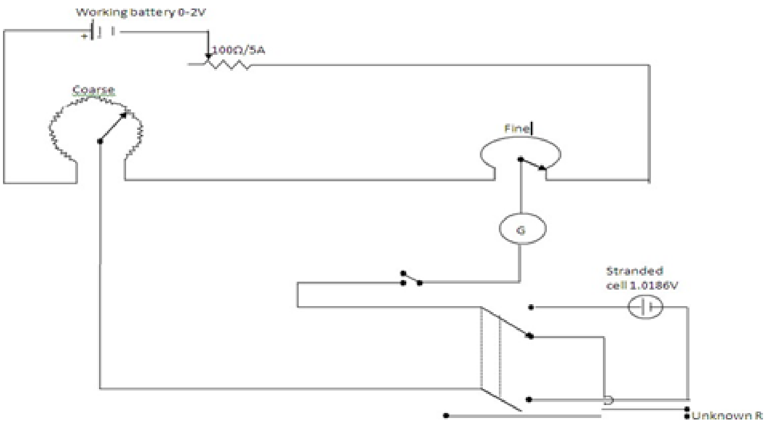


figure:2

THEORY:

There are two types of potentiometers.

1. D.C potentiometer
2. A.C Potentiometer.

The potentiometer is extensively used for a calibration of voltmeters and ammeters and has infect became the standard for the calibration of these instrument. The principle of operations of all potentiometers is based on the circuit, all the resistors in a potentiometer with the exception of slide wires are made of manganin. This is because manganin has a high stability a low temperature coefficient and has freedom frothermo electric effect against copper.

The slide wire is usually made of platinum sliver alloy and the sliding contacts are of a copper gold sliver alloy .this combination of materials for slide wire and sliding contacts results in a good contact, freedom from thermo electric emf and minimum wear of slide wire.

PROCEDURE:-

1. Connect the circuit elements as per the circuit diagram.
2. Standardize the given potentiometer.
3. Apply the voltage to potentiometer terminal.
4. Adjust the dial resistor for zero deflection of galvanometer.
5. Compare the obtained value.

$$\%Error = \frac{\text{Instrument reading} - \text{actual reading}}{\text{Actual reading}}$$

TABULAR COLUMN:-

S.No	Voltmeter(V)	Potentiometer Output	Potentiometer input		

PRECAUTIONS:

1. Avoid loose connections.
2. Avoid Parallax Errors.

RESULT:

EXPERIMENT -4

CALIBRATION AND TESTING OF SINGLE PHASE ENERGY METER

AIM: To calibrate the given energy meter using a calibrated wattmeter.

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Variac, single phase	10 A	AC	
2	Voltmeter	300 V	AC	
3	Ammeter	0-10A	AC	
4	Rheostat		AC	
5	Wattmeter	LPF	AC	
6	Single phase energy meter	10A	AC	

THEORY:

The calibration of energy meter may become inaccurate during its vigorous use due to various reasons. It is necessary to calibrate the meter to determine the amount of error i.e. its reading so that same meter can be used for correct measurement of energy.

In this method precision grade indicating instruments are used as reference standard. These indicating instruments are connected in the circuit of meter under test. The current and voltages are held constant during the test. The numbers of revolutions made by the test are recorded. The time taken is also measured.

Energy recorded by meter under test = RX / KX kWh.

Energy computed from the readings of the indicating instrument = kW × t

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

KX = number of revolutions per kWh for meter under test,

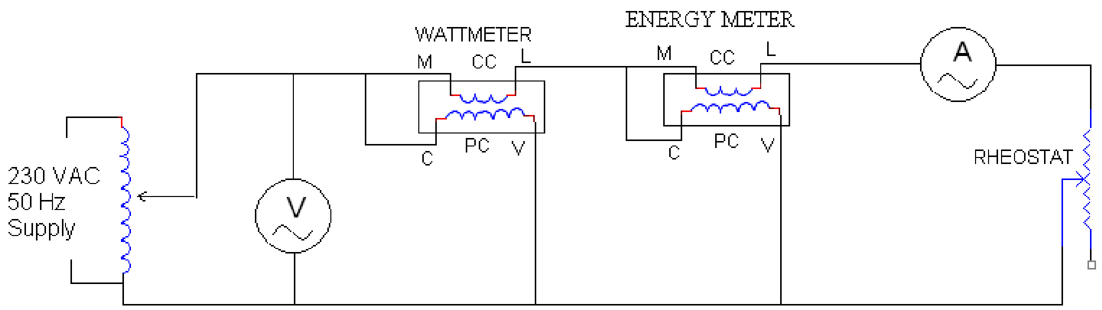
kW = power in kilowatt as computed from readings of indicating

instruments t = time in hours.

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

Before conducting any of these tests on a watt hour meter its potential circuit must be connected to the supply for one hour in order to enable the self heating of the potential coil to stabilize.

CIRCUIT DIAGRAM:



PROECEDURE:

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 Auto transformer 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 4A.
6. Note down the Voltmeter, Ammeter, 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 above equations.

TABULAR COLUMN:

S. No.	Voltage (V)	Current (I)	R = No of revolutions of the disc	Time (t) in hours	Energy meter reading in KWh= No. revolution (R)/meter constant (K)	Wattmeter Reading in kW × t	% Error

RESULT:

EXPERIMENT-5

KELVIN’S DOUBLE BRIDGE – MEASUREMENT OF RESISTANCE – DETERMINATION OF TOLERANCE

AIM: To determine the value of the resistance f the given wire using Kelvin’s Double Bridge

APPARATUS:

S.NO	Equipment	Range	Type	Quantity
1	Kelvin’s Double Bridge			
2	DC Power supply		AC	
3	Rheostat			
4	Standard resistance boxes			
5	Galvanometer			
6	Connecting Wires			

THEORY:

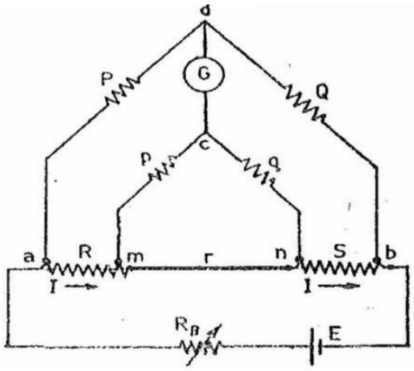
The KDB is a modification of the wheat stone Bridge (WB) and provides increased accuracy in the measurement of low resistance’s. The resistance’s of the lead and contact resistance of which is a major source of error in the WB is overcome in this method.

The KDB incorporates the idea of a second set of ratio arms – hence the name Double Bridge – and the use of four – terminal resistor for the law resistance arms. As shown in the figure the first of ratio arms is P & Q. The second set of ratio arms, P and V, is used to connect the galvanometer to point D at the appropriate potential between points M and N to eliminate the effect of connecting lead of resistance R between the known resistance R and the Standard resistance S. The ratio P/Q is made equal to p/q. under balance conditions there is no current through the galvanometer, which means that the voltage drop between a and b, Eab is equal to the voltage drop E and I between a and c

The last equation indicates that the resistance of connecting lead, r has no effect on the measurement. Provided that the two sets of ratio arms equal ratios. The last but one equation above, shows that the error that is introduced in case the ratios are not exactly equal it indicates that it is desirable to keep as possible in order to minimize the errors in case there is a difference between ratios. P/Q and p/q.

The effect of thermo electric emfs can be eliminated by making another measurement with the battery connections revered. The true value of R being the mean of the two readings.

CIRCUIT DIAGRAM:



Where: P, p, Q, q – Known decade resistances
R – Unknown resistance whose value is to be determined
S – Standard resistance
Rb – Regulating resistance
G – Galvanometer
K – Key switch.

PROCEDURE:

1. The connections as per the circuit diagram.
2. Keep Q = q = 1000 ohms and S = 1 ohm. The ratio P/Q should

   a. always be kept equal to p/q. as Q =q, we must keep P = p.

   b. To start with P and p may be kept at zero position.
3. Switch on the DC power supply and adjust the voltage to about 2 volts with the regulating resistance cut in fully.
4. Adjust P and p simultaneously to get balance. If a light spot
5. Galvanometer is used, then increases the sensitivity in steps and

   a. get exact balance in the direct portion. Bring back the sensitivity

   b. Knob of the galvanometer to the starting position.
6. Note the value of P.

7. Repeat steps (3) and (4) reversing the DC power supply polarity.
8. Repeat steps (3) to (5) above fo
9. Q = q = 100 ohms, 10 ohms, 1 ohms choosing suitable values for S
    a. So that the value of p at balance is obtained in hundreds.
10. The unknown resistance is calculated in each case using the Formula R = P/Q.S

TABULAR COLUMN:

S.No	Main dial	Slide wire	Multiplier

PRECAUTIONS:

1. In the case of a light spot galvanometer, the sensitivity knob of the galvanometer should be in the shorted position when the bridge isunbalanced. It should be brought back to shorted position from thedirect position, immediately after obtaining balance.
2. The DC power regulating resistance (R b) should be cut in fully to Start with and adjusted later if necessary to get larger deflection.

RESULT:

EXPERIMENT-6

SCHERING BRIDGE

AIM: To determine the value of given capacitor and to obtain its dissipation factor.

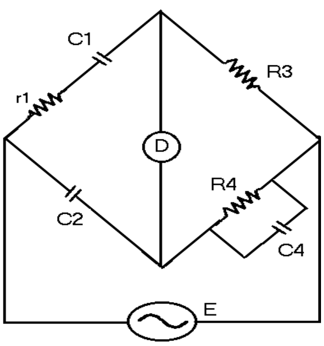
APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Schering Bridge			
2	CRO		AC	2
3	connecting wires			
4	Digital Voltmeter			
5	Probes			

THEORY: Alternating current bridge methods are of outstanding importance for measurement of electrical quantities, measurement of Inductance, Capacitance, Storage Factor, Loss Factor, etc. may be made conveniently and accurately by employing AC bridge network. The AC Bridge is a natural outgrowth of the Wheatstone bridge. An AC bridge, in its basic form, consists of four arms, a source of excitation and a balanced (Null detector). In an AC bridge each of the four arms is impedance, battery and the galvanometer of the Wheatstone bridge are replaced respectively by an AC source and a detector sensitive to small alternating potential difference.

SCHERING BRIDGE FOR LOW VOLTAGE:

The connection diagram for low voltage Schering Bridge is shown in below figure. It consists of the following components.



Let, C1 = unknown Capacitor

C2 = standard Capacitor

r1 = Series resistance representing loss in capacitor C1

R3 & R4 = A variable non inductive resistance

C4 = Variable Capacitor

At balance condition, we obtain following equation

$$r1 = \frac{C1}{C2} \times R3 \quad \text{and}$$

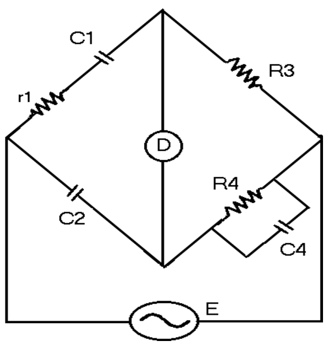
$$C1 = \frac{R4}{R3} \times C2$$

Two independent balance equations are obtained if C and R4 are chosen

as a variable element. Dissipation factor=D1 = ωC1r1= ωCR4

Values of capacitor C1 and its dissipation factor are calculated from the values of bridge element at balanced condition.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect diagram of Schering bridge for capacitance measurement as shown in fig
2. Select any one standard capacitor (known) from given capacitor bankC

3. Standard capacitance C2 are given below:

CS1 = 0.1μfd

CS2 = 0.01μfd

CS3 = 0.001μfd

4. Then connect any one unknown capacitance from bank Cx1, Cx2, Cx3 Now plug in the headphone in to the socket adjust pot R3 and R4 to get minimum sound on head phone.

5. Simultaneously connect to the multimeter terminals connect to the bridge as shown in the fig. Null detector and select the range 2 v AC to get minimum reading.

6. Now remove the headphone and further adjust the resistance R3 and R4 till you get minimum reading. measure resistance of R3 and R4 by using Ohm meter.

7. After null position, unknown capacitor C calculated by using standard formula which is given below

$$C = \frac{R4}{R3} \times C \text{ (Standard Capacitor)}$$

LIST OF COMPONENTS:

1. Standard Capacitors:

CS1 = 0.0011μfd, CS2 = 0.01μfd and CS3 = 0. 1μfd

2. Helical pot R3 = 10 k

3. Helical pot R4 = 5k, r1 = 100 Ohm C = 0.1μfd

Unknown Capacitors:

Cx1 = 0.001μfd, Cx2 = 0.01μfd and Cx3 = 0. 1μfd

RESULT:

ANDERSON'S BRIDGE

AIM: To determine the values of the inductance of a given decade inductance box.
APPARATUS:

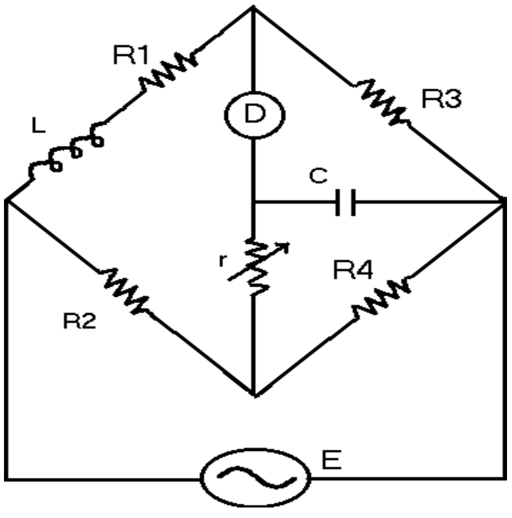
S. NO	Equipment	Range	Type	Quantity
1	Anderson's Bridge			
2	Audio Oscillator	2V,1KHz		
3	CRO			
4	Ohmmeter			

THEORY: This is modified version of Maxwell's bridge in which self-inductance is measured in comparison with a capacitance. This method, using Anderson Bridge, is helpful in determining accurately inductance values over a wide range. The bridge network as shown in fig

L is the Unknown inductance and R1 its resistance. C is a Standard capacitor.

R2, R3 and R4 are known non-inductive resistors. r is the variable resistor.

The detector normally used is headphone. The balancing of the bridge is done follows:

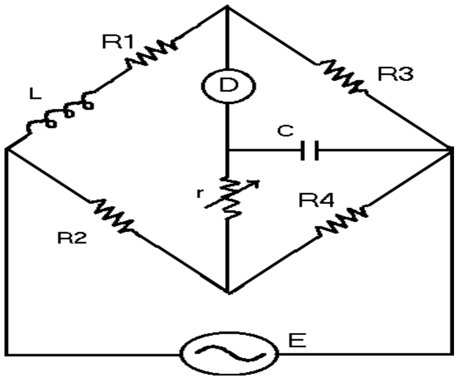


The bridge is first balanced using d.c supply and head phone as detector. Resistance R2, R3 and R4 are properly adjusted so that balance condition is obtained. and balancing of the bridge is again obtained by adjusting resistance r

R3

L = C ------- [r (R3xR4) + (R3+R4)]R4

CIRCUIT DIGRAM:



PROCEDURE:

1. Connect diagram of Anderson's bridge for inductance measurement as shown in fig
2. Select any one standard inductance (unknown) from given inductance bank
3. Now plug in the headphone in to the socket adjust pot **r** and to get minimum sound on headphone.
4. Measure the Resistance of the r by using Ohmmeter.
5. After null position, unknown inductor L calculated by using standard formula which is given below.

The self-inductance is calculated using the formula

R3

L = C ------- [r (R3xR4) + (R3+R4)]R4

RESULT:

EXPERIMENT-7

CALIBRATION OF DYNAMOMETER TYPE POWER FACTOR METER

AIM: To calibrate a given single phase power factor meter

APPARATUS:

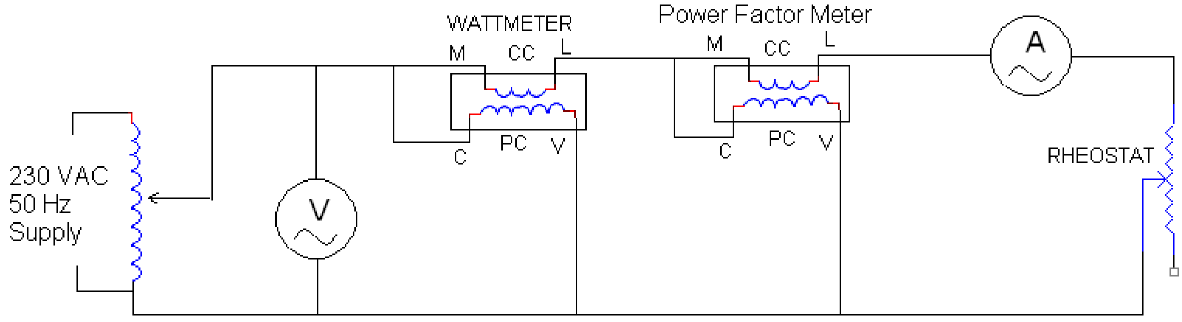
S. No	Equipment	Range	Type	Quantity
1	Variac, single phase,	10A	AC	
2	Voltmeter	300V	AC	
3	Ammeter	0-10A	AC	
4	Rheostat			
5	Wattmeter, LPF,	300V	AC	
6	Dynamometer type power factor meter	10A	AC	

THEORY: The error made by the Power factor meter can be calculated by nothing down the readings various meters and error can be calculated by using

Actual reading = Power factor meter reading
Theoretical reading Cos Φ = P /VI

$$\text{Since percentage of error} = \frac{\text{Actual reading - Theoretical reading}}{\text{Theoretical reading}} \times 100$$

CIRCUIT DIAGRAM



PROCEDURE:

1. Keep the Auto transformer 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 Auto transformer 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 4A.
6. Note down the Voltmeter, Ammeter, Wattmeter and power factor meter readings for different voltages as per the tabular column.
7. Find out the percentage error by using above equations.

TABULAR COLUMN:

S. No.	V AC	I AC	Wattmeter reading	Power Factor meter Reading	Theoretical P/VI	% Error

PRECAUTIONS:

1. Instruments used should be of proper range.
2. All the connections should be tight.

RESULT:

EXPERIMENT-8

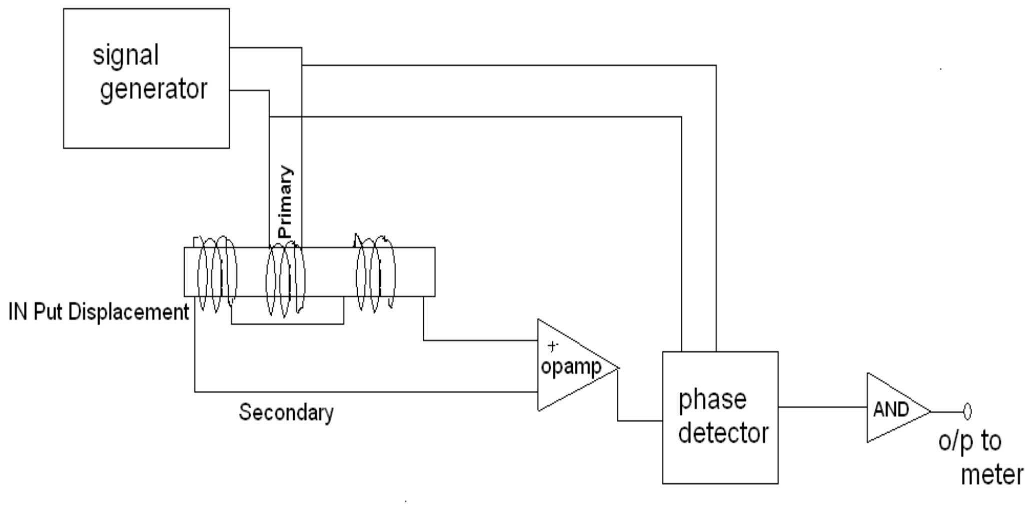
MEASUREMENT OF DISPLACEMENT WITH THE HELP OF LVDT

AIM: To measure displacement using linear variable differential Transformer (LVDT)

APPARATUS:

1. LVDT
2. CRO
3. Function Generator
4. Connecting Wires

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the terminals marked “PRIMARY” on the front panel of the instrument to the terminals marked “PRIMARY” on the transducer itself with the help of the flexible wires provided along with observe the color code for the wires provided &the color of binding posts.
2. Identically establish connections from terminals marked “SECONDARY”. Observe the Color of the binding posts.
3. Keep post marked “MAX” in most anticlockwise position.
4. The magnetic core may be displaced &the pointer can be brought to zero position. If the dim is not indicating zero, use potentiometer marked “min” to get a zero on DPM at zero mechanical position. If the error is displaced in both directions the meter must show indications with appropriate polarity. Now displace the core to 19mm polarity in one of the directions. Adjust the “max” plot to get an indication of 19mm on DPM under this condition. Now setup is ready for experiment you may again check for zero position also.
5. Now the core can be displaced by a known amount in the range of +19mm & -19mm & the meter reading can be entered in the table given below. It may be noted that by exchanging the second terminals (or) the primary. The polarity of the meter indication can be reversed for the given direction of the I/P displacement.

6. For LVDT provided with the dial gauge adjust the magnetic core carefully by rotating the central knob in clockwise direction operates the control knob very carefully.
7. Plot the graph between i/p displacement &o/p displacement between X-axis &Y-axis respectively.

TABULAR COLUMN:

S.NO	INPUT DISPLACEMENT		OUTPUT DISPLACEMENT	
	-VE	+VE	-VE	+VE

PRECAUTIONS:

1. While connecting lead wire from pond to the transducer make proper, connections following color code, avoid shorting of the excitation of source terminals.
2. One of the cores with a gentle fashion by operating the knob for core moment very carefully.

RESULT:

EXPERIMENT-9

CALIBRATION OF LPF WATTMETER BY PHANTOM LOADING

AIM: To calibration of LPF wattmeter by phantom loading

APPARATUS:

S. No	Equipment	Range	Type	Quantity
1	Ammeter	0-10A	AC	
2	Voltmeters	300V	AC	
3	Rheostat		AC	
4	Variac,single phase,	10A	AC	
5	LPF wattmeter		AC	
6	Power factor meter			

THEORY:

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

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

Wattmeter reading = Actual reading

Theoretical reading $P = V\ I \cos\Phi$

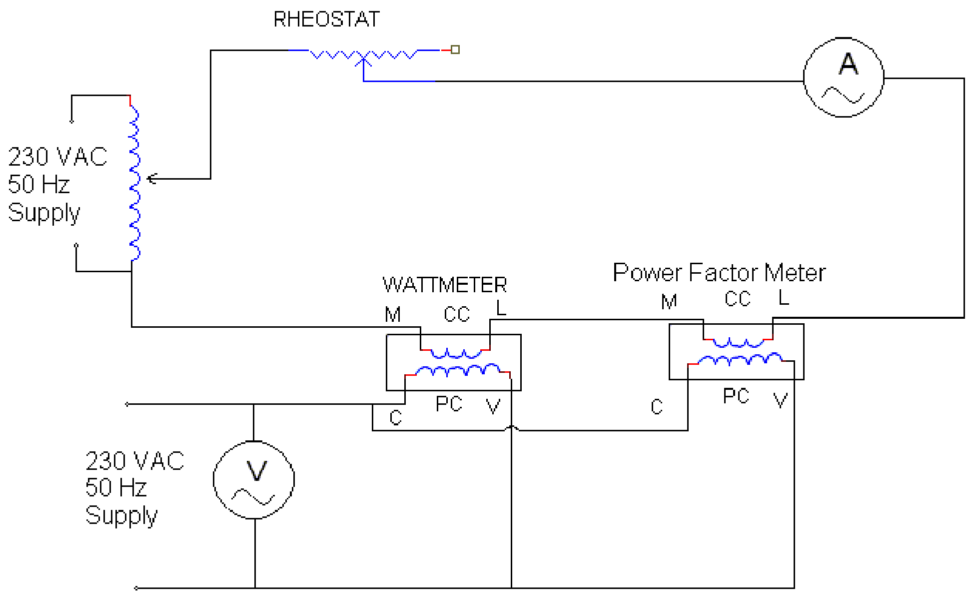
P = Voltmeter reading X Ammeter reading X power factor reading

Actual reading - Theoretical reading

Since percentage of error = ------------------- ----------------------- X 100

Theoretical reading

CIRCUIT DIAGRAM:



PROCEDURE:

1. Keep the Auto transformer 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 Auto transformer 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, Ammeter, Wattmeter and power factor meter readings for different voltages as per the tabular column.
7. Find out the percentage error by using above equations.

TABULAR COLUMN:

S. No.	I in AMPS	V in volts	Wattmeter Reading	Power factor	% Error

RESULT:

EXPERIMENT-10

RESISTANCE STRAIN GAUGE-STRAIN MEASUREMENTS AND CALIBRATION

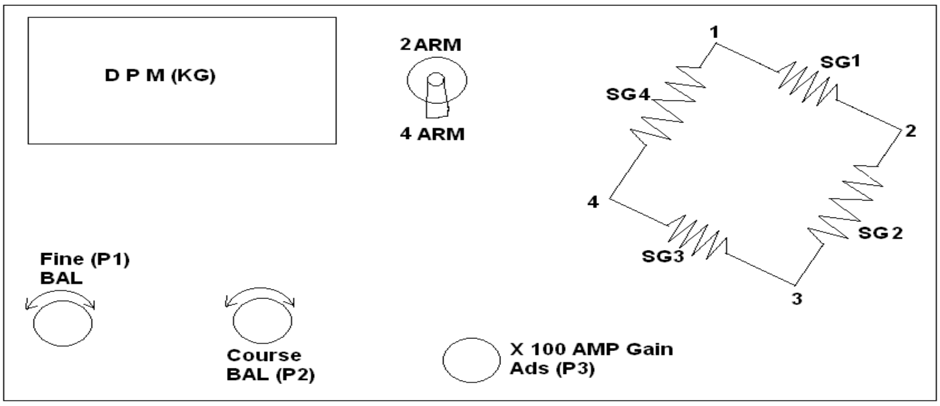
AIM:

To measure different loads using resistance wire strain gauge.

APPARATUS:

1. Strain gauge.
2. Loads.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Ensure that the instrument is switched off.
2. Connect the flexible wires provided with the strain gauge cantilever beam between terminals, 1-1, 2-2, 3-3 and 4-4. You may observe the color code provided for the flexible wires and the color of the binding posts. If terminals 1 and 3 are interchanged, only the output polarity will be changed.
3. Amplifier gain pot may be kept in the position of 100.
4. Keep the switch W_2 in the down word position [four arm position].
5. Turn on the mains supply, by gently moving the balance pot P1 and P2, obtain initial balance on the meter and wait for 5 minutes to allow the strain gauge temp to stable.
6. Apply a weight of 1kg on the cantilever and adjust the gain pot so that reading of 1 is obtained on the DPM, Now remove the weight and check for bridge balance.
7. You can add weights up to 5kg and enter results in the table.
8. Plot a graph of applied load versus the indicated meter readings.
9. For 2 arms position keep switch SW2 in up word position from terminal no. 4 , in this case only two strain gauges SG1 and SG2 contribute to the output while two internal resistances of 350 ohms each from two remaining arms of the bridge. The sensitivity of two arms operation is 50% of four Arm Bridge.

TABULAR COLUMN:

SL .NO	WEIGHT ON THE CANTILEVER	DPM READINGS

PRECAUTIONS:

1. All the dimensions must be consistent. One may calculate the stress and strain and then E out to verify with the external value. Excitation voltage of the bridge can be measured across the terminals 1 and 3 of the bridge.
2. Make the connections the binding posts and terminals very carefully.
3. Provide a warm up time of about 10 – 15 min before taking readings.
4. Ensure that the cantilever arrangement is successfully fixed to the table
5. Operate the gain control knob very carefully.

RESULT:

EXPERIMENT-11

MEASUREMENT OF 3 PHASE POWER WITH SINGLE WATT METER AND 2 CTs

AIM: To measurement of 3 phase power with single watt meter and 2 no s of current transformers.

APPARATUS:

S.NO	Equipment	Range	Type	Quantity
1	Wattmeter	300v 10A	LPF	
2	Current transformers		AC	2

THEORY:

This method makes of two current transformers of ratio 1:1 to add the phase currents from two phases in the current coil of the wattmeter. The connections are shown in the figure. The potential coil of wattmeter is connected across the some phases.

Voltage across potential coil circuit of

wattmeter $V_{13} = V_1 – V_2 = \sqrt{3}\ V_P$

Current through current coil of

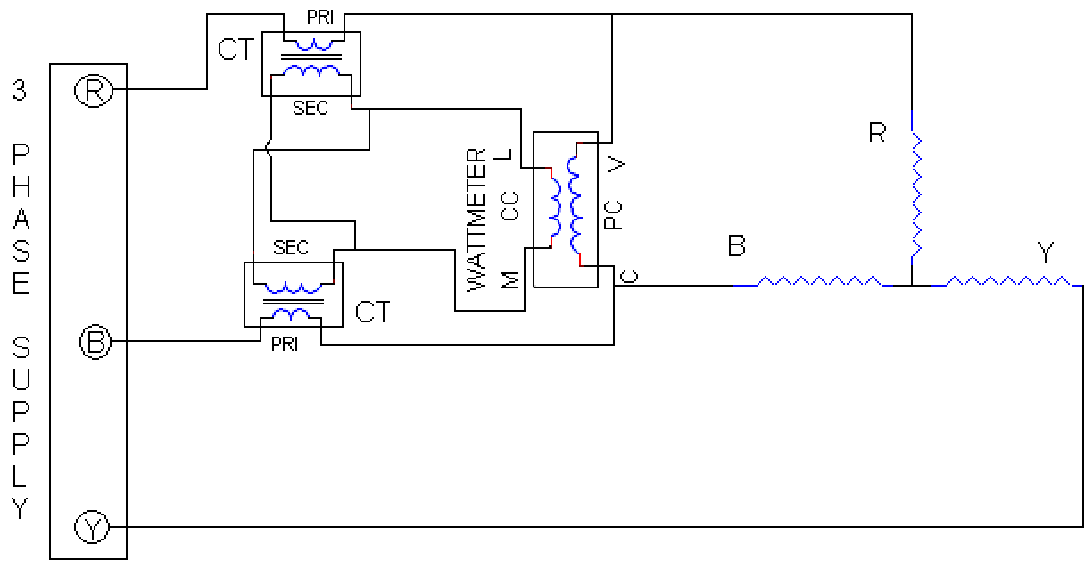
wattmeter $I = I_1 – I_2 = \sqrt{3}Ip$

Since each of the two vectors is displaced 30º in same direction from the corresponding phase vector so that their phase difference phase is equal to the load power factor angle

Since power measured by wattmeter

$\sqrt{3}\ V_P\ VI_P \cos Ǿ = 3\ VpIp \cos Ǿ$

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit as shown in fig.
2. Switch ‘ON’ the supply.
3. Note down the corresponding the reading and calculate 3-□ power.
4. Now increase the load of three phase load steps and note down the Corresponding meter Readings.
5. Remove the load and switch ‘off’ the supply

TABULAR COLUMN:

Voltage in (volts)	Current in (amps)	Wattmeter reading in (watts)	Wattmeter X MFW X MFCT(watts)

PRECAUTIONS:

1. Instruments used should be of proper range.
2. All the connections should be tight.

RESULT:

EXPERIMENT-12

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

AIM: To determine the percentage ratio error and the phase angle error of the given current transformer using mutual inductor by null method.

APPARATUS:

Current Transformer

Ammeter-2

Rheostat -2

Vibration galvanometer

Mutual Inductor

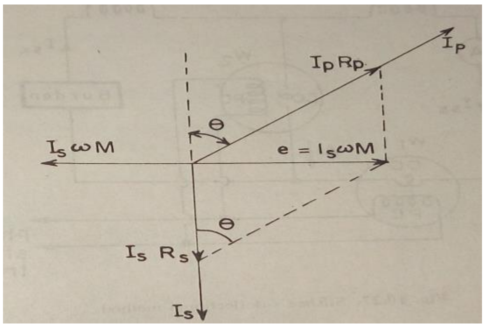
THEORY: This is an absolute method using null technique. R_s and R_p are low resistance, non-inductive shunts. R_s is variable while R_p is fixed. R_s has a slide wire for fine adjustment of resistance. The voltage drop across resistance R_p is matched against voltage drop across R_s. A vibration galvanometer is put in the circuit to indicate the balance conditions. Assuming, for the moment that there is no pahse difference between I_p and I_s the vibration galvanometer will indicate zero deflection if $I_pR_p = I_sR_s$ or $I_p/I_s = R_s/R_p$.

Therefore R_s and R_p should be so choose that the ratio R_s/R_p is nearly equal to the nominal ratio of the current transformer. Resistance is adjusted the two voltage drops equal . In order to obtain zero deflection the magnitude and also the phase of the voltage drops should be same. Thus a mutual inductance M is put to compensate for phase difference between Ip and Is as without any phase compensating device it will be impossible to obtain with resistance alone.

$\tan\theta = I_s\omega M/I_sR_s = \omega M/R_s$ and $\cos\theta = I_sR_s/ I_pR_p$

From these relations we have, phase angle $\theta = \omega M/R_s$ rad.

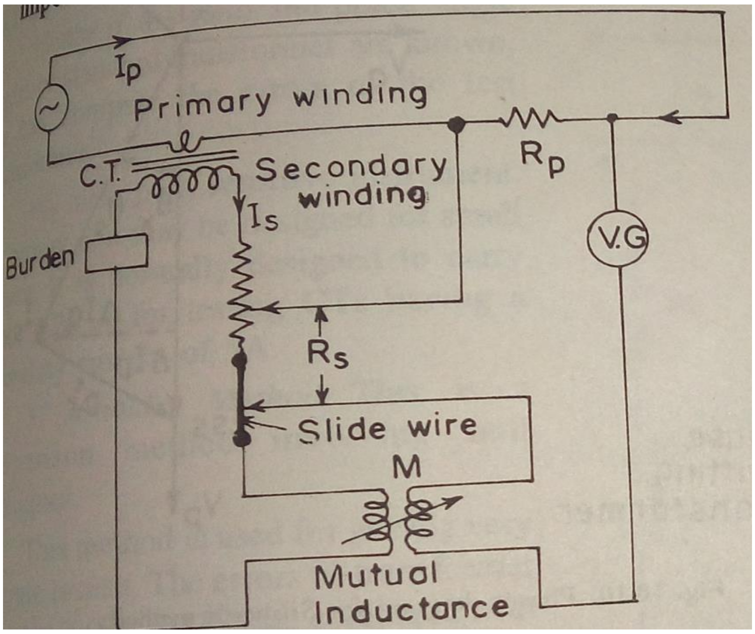
Actual ratio $R = I_p/I_s = R_s/(R_p \cos\theta) = R_s / R_p$ as θ is very small



PROCEDURE:

1. The connections are made as shown in the circuit diagram.
2. Choose the Rp and Rs values such that their ratio is equal to the nominal ratio of CT.
3. Vary the Rheostat in order to obtain the zero deflection.
4. Vary the mutual inductor for phase difference between primary current and secondary current.
5. Calculate the actual ratio and phase angle using formulas.

CIRCUIT DIAGRAM:



TABULAR COLUMN:

S.No	R_s	R_p	I_s	I_p	M	R	θ

RESULT:

EXPERIMENT-13

PT TESTING BY COMPARISON – V. G. AS NULL DETECTOR MEASUREMENT OF % RATIO ERROR AND PHASE ANGLE OF THE GIVEN PT

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

APPARATUS:

Standard PT (one for which the error are known)

Testing PT

Wattmeter, UPF-2 nos.

Ammeter (MI type)-1 nos.

Voltmeter (MI type)-2 nos.

Rheostat

Phase shifting transformer

THEORY:

This is a comparison type of test employing deflectional methods. Here the ratio and phase angle of the test transformer **x** are determined in terms of that of a standard transformer **S** having same nominal ratio.

These errors are as follows say:

Error PT	Ratio Error	Phase Angle Error
S	R_s=	Θ_s=
X	R_x=	Θ_x=

The two transformers are connected with their primaries in parallel. A burden is put in the secondary circuit of test transformers.

W1 is a wattmeter whose potential coli is connected across the secondary of standard transformer.

The pressure coil of wattmeter W2 is so connected that a voltage Δv which is the difference between the secondary voltages of standard and test transformer.

The current coil of two watt meters is connected in series and is supplied from phase shifting transformer. They carry a constant current I.

PROCEDURE:

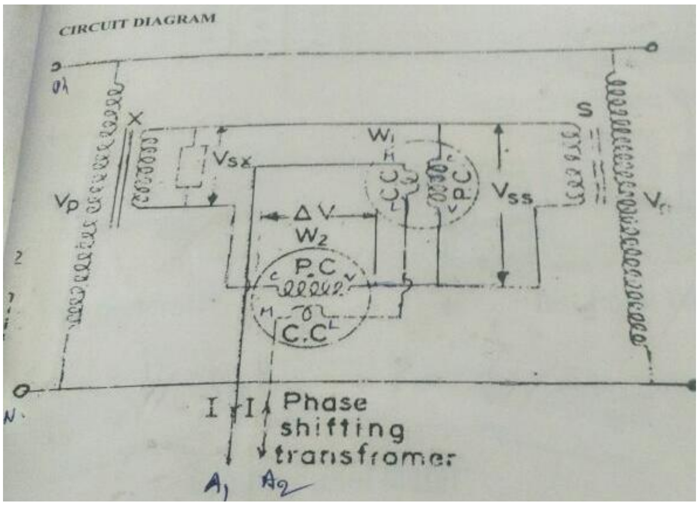
1. The connections are made as shown in the circuit diagram.
2. Switch on the main supply, apply 200 volts to primaries of potential transformers.
3. Noted down the voltages across the burden(Vsx), pressure coil of W2(Δv) and secondary of standard PT(Vss)
4. Adjust the phase shifting transformer until W1 reads zero at this condition note down the reading of wattmeter W2(W2q).
5. Now apply 90^0 of phase shift and noted down the readings of W1 and W2 (W1p & W2p).
6. Apply different voltages to the primaries of potential transformers and repeat the same procedure.

Actual ratio of standard transformer Rs = Vp/Vsx…………..1

Actual ratio of Test transformer Rx= Vp/Vsx……………….2

The actual ratio of transformer under test Rx= Rs (1+W2p/W1p)

The phase angle of test transformer Θ_x= (W2q/W1p)+ Θ_s



TABULAR COLUMN:

S.No	Vsx	W1q	W2q	W1p	W2p	Rx	Θ_x

PRECAUTIONS:

W2 is sensitive instrument. Its current coil may be defined for small values. It is normally designed to carry about 0.25A

RESULT:

EXPERIMENT-14

TRANSFORMER TURNS RATIO MEASUREMENT USING AC BRIDGES

AIM: - To measure transformation ratio of transformer using A.C Bridge Model.

EQUIPMENT REQUIRED:-

A.C Bridge Model

20MHz Dual beam CRO.

Patch Cards.

THEORY:

A. <u>INTRODUCTION:-</u>

Transformer is a device working on statically induced emf principle. If A.C input is applied to primary winding of transformer, certain voltage is induced in secondary winding of transformer by induction. The ratio of primary volts applied to the secondary volts induced is known as transformer motion ratio ‘K’. This ratio depends on physical number of turns provided in primary and secondary coils of transformer. As such turns ratio.

$$\mathbf{K} = \frac{VP}{VS} = \frac{NP}{NS}$$

where Np and Ns are number of turns in primary and secondary. Also Inductance of winding is proportional to the square of number of turns.

Hence $L \alpha N^2$

$$\text{Or } K = \frac{Vp}{Vs} = \frac{Np}{Ns} = \sqrt{\frac{LP}{LS}}$$

Where Lp and LS are primary and secondary inductances. Therefore, by measuring self inductance of primary and secondary windings of transformer using A.C bridge, the transformer ratio is calculated.

<u>A.C.BRIDGE:-</u>It consists of four arms of impedance, a sine wave generator, Detector or Headgear set. The sine wave generator is provided with frequency selection switch from 1KHz to 40KHz. Low frequency signal is used for measuring primary inductance (Lp) and high frequency for secondary inductance (Ls). Thus by measuring primary and secondary inductances of transformer with A.C Bridge, the turn’s ratio is decided.

Unknown primary or secondary winding inductance is connected between terminals of inductor(L). Decade capacitance terminals are connected between terminals of capacitor©. Variable resistance R4 terminals connected to potentiometer P1 & P2 signal output from oscillator is applied at bridge as input signal. When bridge is at balance,

Z1. Z4 = Z2 . Z3

Or Z1 = Z2. Z3 $Z4$

= Z2 . Z3 . Y4.

Equating imaginary ports L = R2 R3 C Henrys.

At balance the single tone heard in head –gear set is as minimum. If digital voltmeter in 0-200mv range is used, meter shows minimum value for a particular capacitor value selected by rotating rotary switch. For higher or lower value of capacitor than this meter shows increment in reading. Always put P1 and P2 pots at maximum position.

PROCEDURE:-

1. Connect output sockets capacitor of rotary switch to variable 'C' sockets.
2. Connect output socket of P1 and P2 pots to variable R4 sockets.
3. Connect primary winding sockets of transformer to inductor (L) sockets.
4. Connect sine wave output of signal generator to AC. Input socket of bridge
5. Connect digital milli voltmeter 0-200 range (A.C) across Galvanometer sockets.
6. Now on power. Select 1KHz frequency of signal generator.
7. Put P1 and P2 at maximum position. This will balance real part (1KE) is series with inductor (L).
8. Now, starting form 1µF, slowly increase 'C' value by rotating rotary switches. At one position of value 'C' the reading of DVM is minimum. Note this value as 'C'.
9. Calculate the value of primary inductance Lp using formula Lp = R2 R3 C Henry .
10. Repeat the measurement twice and take the average of all three readings of Lp value.
11. Now connect secondary winding of transformer I to inductor terminals (L). Connect sine wave output of signal generator to AC. input socket of bridge. Repeat the measurement twice and take the average of all three readings Lp value. And note inductance of secondary Ls select 40 KHz range of signal for Ls measurement. Start balancing the bridge from the lower range of capacitor.

12. Repeat Steps 4 to 11 for transformer 2 and tabulate all readings.

13. Calculate turns ratio K =√ Ls/ Lp

TABULAR COLUMN:

Sl.No	Transformer	Inductance of Primary winding	Inductance of secondary winding	Transformation ratio $K = \sqrt{Lp}$
1.				
2.				
3.				

RESULT:

EXPERIMENT-15

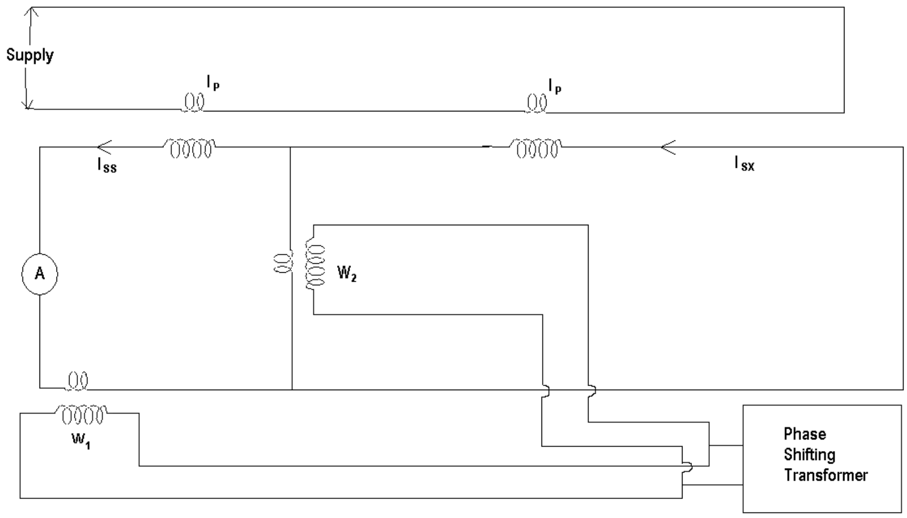
MEASUREMENT OF % RATIO ERROR AND PHASE ANGLE OF GIVEN CT BY COMPARISON

AIM: To measure the % ratio error and phase angle of given CT

APPARATUS:

1. Precision CT
2. Commercial CT Watt meters (LPF)
3. Rheostat
4. Phase shifting Transformer

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connections are made as shown.
2. The Supply switch to the autotransformer is closed with the rheostat cut out.
3. The current through the CT primaries is gradually increased using autotransformer.
4. The current I_D, difference between I_{SS} & I_{SX}, should be zero.
5. If it is twice that of I_{SS} or I_{SX}, the supply switch is opened and connections to any one of the CT secondaries are reversed.
6. The current I_P through the CT primaries is made equal to a fixed value using autotransformer.
7. The burden in the form of Rheostat is introduced in the secondary circuit of the CT to be compared. And is slowly cut in till I_D is equal to fixed value.
8. Wattmeter W_S is made to indicate zero using phase shifter.
9. Readings of Ammeter and Wattmeter W_{D2} are noted.
10. W_S is adjusted to indicate maximum reading by means of Phase shifter and the reading of the Ammeters and Wattmeter W_{D1} are noted.
11. Voltage applied to wattmeter potential coils is also noted.
12. This procedure is repeated for different primary currents like 15 A & 20 A.
13. The readings and results are tabulated as shown.

TABULAR COLUMNS:

Sl. No.	I_P (A)	I_{SS} (A)	I_{SX} (A)	I_D (A)	W_S (W)	W_{D1} (W)	W_{D2} (W)	Ratio Error	Phase Angle error

RESULT: