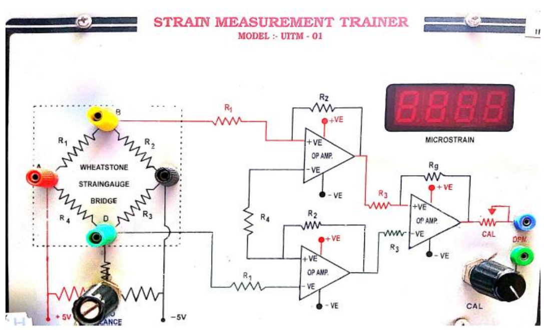
MEASUREMENTS & SENSORS LAB

III B.Tech-I SEMESTER

STUDENT OBSERVATION RECORD



DEPARTMENT

OF

ELECTRICAL AND ELECTRONICS ENGINEERING

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

VEMU INSTITUTE OF TECHNOLOGY

DEPT.OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION OF THE INSTITUTE

- To be a premier institute for professional education producing dynamic and vibrant force of technocrats with competent skills, innovative ideas and leadership qualities to serve the society with ethical and benevolent approach.

MISSION OF THE INSTITUTE

- To create a learning environment with state-of-the art infrastructure, well equipped laboratories, research facilities and qualified senior faculty to impart high quality technical education.
- To facilitate the learners to foster innovative ideas, inculcate competent research and consultancy skills through Industry-Institute Interaction.
- To develop hard work, honesty, leadership qualities and sense of direction in rural youth by providing value based education.

VISION OF THE DEPARTMENT

- To produce professionally deft and intellectually adept Electrical and Electronics Engineers and equip them with the latest technological skills, research & consultancy competencies along with social responsibility, ethics, Lifelong Learning and leadership qualities.

MISSION OF THE DEPARTMENT

- To produce competent Electrical and Electronics Engineers with strong core knowledge, design experience & exposure to research by providing quality teaching and learning environment.
- To train the students in emerging technologies through state - of - the art laboratories and thus bridge the gap between Industry and academia.
- To inculcate learners with interpersonal skills, team work, social values, leadership qualities and professional ethics for a holistic engineering professional practice through value based education.

PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

Programme Educational Objectives (PEOs) of B.Tech (Electrical and Electronics Engineering) **program are:**

Within few years of graduation, the graduates will

PEO 1: Provide sound foundation in mathematics, science and engineering fundamentals to analyze, formulate and solve complex engineering problems.

PEO 2: Have multi-disciplinary Knowledge and innovative skills to design and develop Electrical & Electronics products and allied systems.

PEO 3: Acquire the latest technological skills and motivation to pursue higher studies leading to research.

PEO 4: Possess good communication skills, team spirit, ethics, modern tools usage and the life-long learning needed for a successful professional career.

PROGRAM OUTCOMES (POs)

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 sciences, 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 modeling 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 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.

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	**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 (PSOs)

On completion of the B.Tech. (Electrical and Electronics Engineering) degree, the graduates will be able to

PSO-1: Higher Education: Apply the fundamental knowledge of Mathematics, Science, Electrical and Electronics Engineering to pursue higher education in the areas of Electrical Circuits, Electrical Machines, Electrical Drives, Power Electronics, Control Systems and Power Systems.

PSO-2: Employment: Get employed in Public/Private sectors by applying the knowledge in the domains of design and operation of Electronic Systems, Microprocessor based control systems, Power systems, Energy auditing etc.

DO'S & DONT'S IN LABORATORY

1. Avoid contact with energized electrical circuits.
2. Disconnect the power source before servicing or repairing electrical equipment.
3. When it is necessary to handle equipment that is plugged in, be sure hands are dry and, when possible, wear nonconductive gloves and shoes with insulated soles.
4. Never exceed the permissible values of current, voltage, and / or speed of any machine, apparatus,wire, load, etc.
5. If it is not unsafe to do so, work with only one hand, keeping the other hand at your side or in your pocket, away from all conductive material. This precaution reduces the likelihood of accidents that result in current passing through the chest cavity.
6. If water or a chemical is spilled onto equipment, shut off power at the main switch or circuit breaker and unplug the equipment.
7. If an individual comes in contact with a live electrical conductor, do not touch the equipment, cord or person. Disconnect the power source from the circuit breaker or pull out the plug using a leather belt.
8. Do not make circuit changes or perform any wiring when power is on.
9. Do not wear loose-fitting clothing or jewelry in the lab. Rings and necklaces are usual excellent conductors in contact with your skin.
10. It is wise in electrical labs to wear pants rather than shorts or skirts. Ties are also dangerous.
11. Powered equipment can be hot! Use caution when handling equipment after it has been operating.
12. Do your wiring, setup, and a careful circuit checkout before applying power.
13. Use wires of appropriate length. Do not allow them to drape over your equipment. Avoid splices, which create live surfaces. When running a pair of wires to adjacent terminals, twist the wires together so they don't dangle. This also neatens your work and will save time.
14. Do not touch anything if your hands are wet. The "one-hand" approach is safest.
15. If you can't keep your hand in your pocket, do not touch any metal object with free hand.
16. Do not pull wires out until you are absolutely sure that the circuit is completely dead. Shocks can occur if an inductive load (motor or transformer) is disconnected while conducting.
17. Don't depend on switches to de-energize a circuit. Pull the plug out from the socket/outlet.
18. If you are working on high voltage circuits, have a co-worker along with you who knows how to break the circuit to get you free and how to give you mouth-to-mouth resuscitation and closed chest heart massage.
19. When you are mentally or physically tired, avoid work on energized circuits.
20. Be sure you understand the function and wiring of an instrument before using it in a circuit.
21. Do not make circuit changes or perform any wiring when power is on.
22. When in doubt, turn power off.
23. All the connection should be tight.
24. Do not touch the live terminals.
25. Select proper type (i.e. A. C. or D. C.) and range of meters.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

III B.Tech. I-Sem (EEE)

MEASURMENTS LABORATORY(19A02706)

COURSE OUTCOMES

C317.1	Calibrate various electrical measuring instruments.
C317.2	Accurately determine the values of inductance and capacitance using AC bridges.
C317.3	Compute the coefficient of coupling between two coupled coils.
C317.4	Accurately determine the values of very low resistances

Name: ____________________________________

H.T.No: ____________________________________

Year/Semester: ______________________________

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B. Tech III-I Sem. (EEE) **L T P C**
0 0 4 2

(20A02503P) MEASUREMENTS & SENSORS LABORATORY

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

B.Tech (EEE)– III-I Sem L T P C

0 0 3 1.5

(20A02503P) MEASUREMENTS AND SENSORS LAB

List of 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 voltmeter

4. Kelvin's double Bridge – Measurement of low resistance – Determination of Tolerance

5. Determination of Coefficient of coupling between two mutually coupled coils

6. Determination of Capacitance using Schering Bridge

7. Determination of Inductance using Anderson bridge

8. Measurement of 3-phase reactive power with single-phase wattmeter

9. Measurement of parameters of a choke coil using 3-voltmeter and 3-ammeter methods

10. Determination of Inductance using Maxwell's bridge

11. Determination of Capacitance using DeSauty bridge

12. Calibration of LPF wattmeter – by Phantom loading

13. Wheatstone bridge – measurement of medium resistances

14. LVDT and capacitance pickup – characteristics and Calibration

15. Resistance strain gauge – strain measurement and Calibration

16. Transformer turns ratio measurement using AC Bridge

17. AC Potentiometer – Calibration of AC Voltmeter, Parameters of Choke coil

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

List of Experiments to be conducted

MEASURMENTS LABORATORY

S.NO.	NAME OF THE EXPERIMENT
1	Calibration and Testing of single phase energy Meter
2	Calibration Of Dynamometer Type Power Factor Meter
3	Crompton D.C. Potentiometer Calibration Of PMMC Ammeter And PMMC Voltmeter
4	Kelvin's Double Bridge – Measurement Of Very Low Resistance Values Determination Of Tolerance
5	Determination Of Co-Efficient Of Coupling Between Two Mutually Coupled Coils
6	Schering Bridge & Anderson Bridge For Measurement Of Capacitance And Inductance Values
7	Measurement Of 3- Ph Reactive Power With Single Phase Wattmeter
8	Measurement of Parameters of a Choke Coil Using 3 Voltmeter and 3 Ammeter Methods
9	LVDT and Capacitance Pickup – Characteristics and Calibration
10	Resistance Strain Gauge – Strain Measurement and Calibration
Additional Experiments	
11	Measurement of 3-Φ Power using Two-wattmeter method
12	Calibration of LPF Wattmeter – by Phantom Testing.

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

NEAR PAKALA, CHITTOOR-517112

(Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapuramu)

List of Experiments to be conducted

CONTENTS

ELECTRICAL MEASURMENTS LABORATORY

GENERAL INSTRUCTIONS FOR LABORATORY CLASSES

DO‘S

1. Without Prior permission do not enter into the Laboratory.
2. While entering into the LAB students should wear their ID cards.
3. The Students should come with proper uniform.
4. Students should sign in the LOGIN REGISTER before entering into the laboratory.
5. Students should come with observation and record note book to the laboratory.
6. Students should maintain silence inside the laboratory.
7. Circuit connections must be checked by the lab-in charge before switching the supply

DONT‘S

8. Students bringing the bags inside the laboratory..
9. Students wearing slippers/shoes insides the laboratory.
10. Students scribbling on the desk and mishandling the chairs.
11. Students using mobile phones inside the laboratory.
12. Students making noise inside the laboratory.
13. Students mishandle the devices.
14. Students write anything on the devices

MEASURMENTS LABORATORY

SCHEME OF EVALUATION

S.No	Experiment Name	Date	Marks Awarded				Total 30(M)
			Record (10M)	Observation (10M)	Viva Voce (5M)	Attendance (5M)	
1	Calibration and Testing of single phase energy Meter						
2	Calibration Of Dynamometer Type Power Factor Meter						
3	Crompton D.C. Potentiometer Calibration Of PMMC Ammeter And PMMC Voltmeter						
4	Kelvin's Double Bridge – Measurement Of Very Low Resistance Values Determination Of Tolerance						
5	Determination Of Co-Efficient Of Coupling Between Two Mutually Coupled Coils						
6	Schering Bridge & Anderson Bridge For Measurement Of Capacitance And Inductance Values						
7	Measurement Of 3- Ph Reactive Power With Single Phase Wattmeter						
8	Measurement of Parameters of a Choke Coil Using 3 Voltmeter and 3 Ammeter Methods						
9	LVDT and Capacitance Pickup – Characteristics and Calibration						
10	Resistance Strain Gauge – Strain Measurement and Calibration						
11	Measurement of 3-Φ Power using Two-wattmeter						

	method						
12	Wheatstone bridge – measurement of medium resistances						

Signature of Lab In-charge

Exp. No.: 01 **Date:**

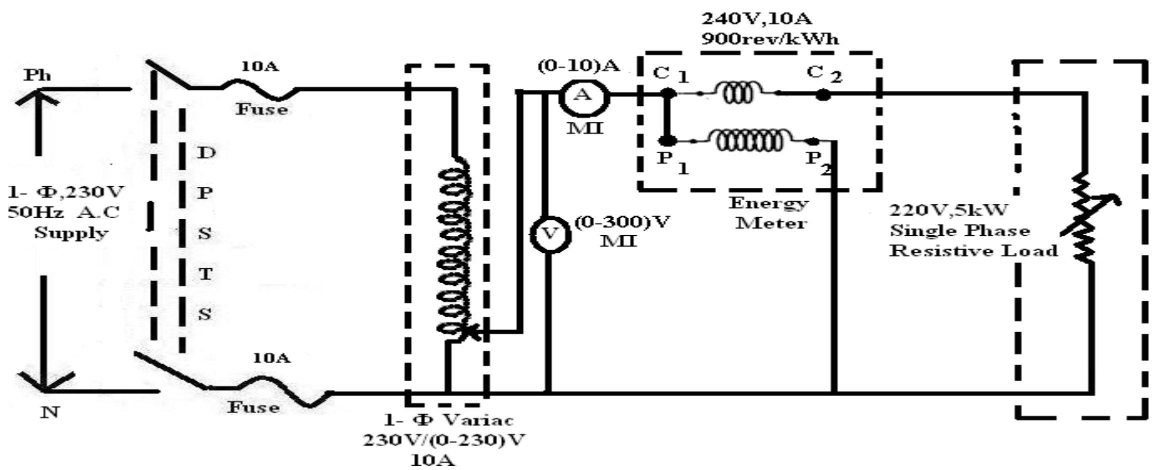
CALIBRATION & TESTING OF SINGLE PHASE ENERGY METER

AIM: To calibrate the Single Phase Energy Meter.

APPARATUS:

S.NO	ITEM NAME	RANGE
1	Single phase Energy Meter	300V/5-10A.
2	Digital Ammeter.	0-10A
3	Wattmeter.	300V/5A.
4	Digital Energy Meter.	80-270V AC / 50mA-6A
5	Digital Voltmeter.	0-300V.
6	1-ϕ Auto Transformer.	0-270V/5A

CIRCUIT DIAGRAM:



THEORY:

The energy expended in a circuit in a known interval of time is measured with an energy meter to be calibrated .The rated voltage is applied across the voltage coil ,a small current is passed through the current coil .The disk rotates ,the time required for a definite number of rotations is noted .The standard wattmeter reading is noted . This is true power in the circuit.

- **The indicated power is computed as follow ws,**

Let K=Energy meter constant in revolutions/Kwh.

We have indicated power Wi = K’ R/t. where K’ = 1000x3600/K and a unit of K’ = watt.

- **Actual power WA = wattmeter reading,**

If Wa and Wi are the same there is no error .If however, Wi is not equal to Wa it implies that there is error.

- **We have percentage error = Wi-Wa/Wa x100,**

The percentage error may be positive or negative .the experiment is conducted by passing deferent currents, starting from 5% of full load and increasing in steps till full load is reached.

PROCEDURE:

1. Make connections as per circuit diagram.
2. Keep auto transformer at zero position and switch ON MCB.
3. Switch ON supply by pressing green switch
4. Adjust the auto transformer such that voltmeter reads at rated voltage i.e.230V.
5. Low load adjustment:- Adjust 10% of rated current to flow through energy meter by varying the load
6. Note down the time taken by disc to rotate known number of revolutions using stop watch.
7. Calculate time taken theoretically.
8. Top Load adjustment:-90% of rated current is (8-9) A is made to flow.
9. Note down the time taken by disc to rotate known number of revolutions (say5) using stop watch.
10. Calculate time taken theoretically.
11. Repeat the same procedure for deferent values.

Model graphs:

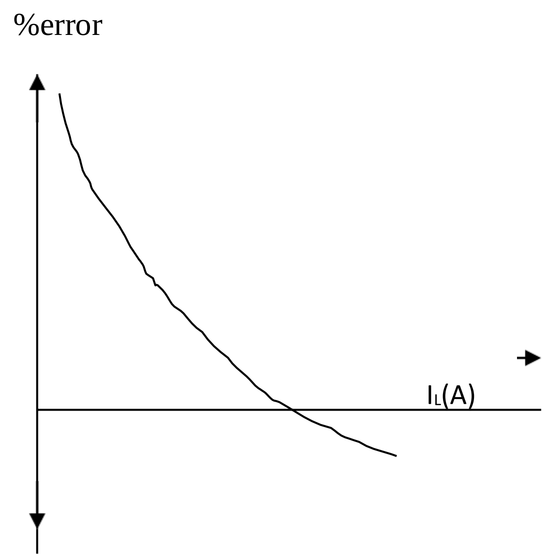


TABLE:

S. No	Current in amps I_L(A)	Voltage in volts V(V)	No.of Rev or Pulses	Time taken for 20 pulses (T)		Actual Energy= VI_LT (Wh)	Total energy recorded = (Wh)	% error
				Secs	Hrs			

CALCULATIONS:

Actual Energy Consumed = P*t /60*60

Where 'P' is Power in Watts and 'T' is in seconds.

Energy Recorded = No. of Revolutions/ [Revolutions per Kilo watt]

Sample Calculations

Voltage =

Current =

Time for 20 pulses =

Energy measured (actual) = VI_LT=

Energy recorded = $\frac{\text{No.of pulses}}{\text{meter constant t}}\, wh$=

$$\%error = \frac{\text{energy measured by energy meter} - \text{actual energy consumed}}{\text{actual energy consumed}} x100$$

RESULT:

Viva Questions

1. What are the different torques existing in energy meter?
2. What is the use of breaking magnet?
3. What are the different possible errors in the energy meter?
4. How the energy meter constant is expressed?
5. What is phantom loading?
6. How do you compensate the frictional error?
7. What is creeping, and how it can be adjusted?
8. State the number of compensation devices?
9. Why the meter reads less under over load?
10. What is R.S.S. meter and why it is not used in the measurement?

Exp. No.: 02 **Date:**

CALIBRATION OF DYNAMOMETER TYPE POWER FACTOR METER

AIM:

To test and calibrate the given 3 phase electro dynamometer type power Factor meter.

APPRATUS:

S. No	Item Name	Specifications	Quantity
1	Dynamometer Power Factor meter	1-Ph, 10A, 300V	1
2	Ammeter	0-10A, MI	1
3	Wattmeter	0-10A, 300V, UPF	1
4	Voltmeter	0-300V, MI	1
5	Capacitive Load	1-Ph, 10A, 300V	1
6	Connecting Wires	-----------	As per required

CIRCUIT DIAGRAM:

PROCEDURE:

1. Connect the circuit as per circuit diagram.

2. Start the motor using starter.

3. Load the motor in steps from low power factor to meet unity power factor (from no load to full load).

4. Observe all the meter readings in each step.

5. Calculate the power factor at each from the power factor meter and from the wattmeter and voltmeter and ammeter.

6. Remove the load and switch of the supply.

7. Graph is plotted between %error and calculated values.

FORMULAE:

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

True Value $\cos\varphi = W / VI$

TABULAR COLUMN:

CALCULATIONS:

RESULT:

Exp. No.: **Date:**

Crompton D.C. Potentiometer – Calibration of PMMC Ammeter and PMMC Voltmeter

AIM: Standardization of DC potentiometer and measuring of unknown emf's.

APPRATUS:

S.NO	ITEM NAME	RANGE
1	Standard cell	1.0180V
2	Battery	DC.2V
3	Galvanometer	100-0-100 or 50- 0- 50 range

CIRCUIT DIAGRAM:

DC Crampton's Potentiometer:-

THEORY:

Potentiometer is an instrument for measuring an unknown emf or potential difference by balancing it wholly or in p[art by a known potential difference produced by the flow of current in network of a ckt of known character electromotive forces are measured directly with a potentiometer in terms of emf of a standard cell. By using in addition a standard resistance current can also be measured from potentiometer measurement of current and voltage. Power can be calculated and if time is also measured energy can be calculated.

PROCEDURE:

1. Give the connections as per the terminals indicated in the potentiometer with Reference the polarity (connect the galvanometer standard cell and battery to their.

2. Initially for Standardize the potentiometer for a given standard cell voltage i.e., set the potential dials to exact volt. of standard cell,(Function key in STD mode

3. (ie,1.018v, 1 volt at Main Dial ,18 Mill Volts at Slide Dial & keep constant) by varying the Rheostat course and fine Rheostat .

4. When the Galva key pressed, the Galvanometer should not deflection with slide wire key pressed and zero series resistance then the potentiometer has been standardize for use.

5. In the above case maintain the sensitivity of Galvanometer from low range to high range, Shunt Power Switch (SC, 1/1000, 1/100, 1/10, 1) which is kept aside of the Galvanometer by, Keep the toggle switch in AC Mains.

6. At the top of the Galvanometer the pointer is to be kept in free position when functioning, and in lock position when it is not functioning.

MEASURING THE UNKNOWN VOLTAGE(EMF):

1. Connect the supply to be measured to appropriate terminals on the potentiometer by Maintain the polarity, (Function key in STD mode

2. Turn the Function key from STD mode E1 or E2, which is the unknown emf's Connection.

3. By keeping the Rheostat Constant, vary the Main Dial as well as Slider Dial until get The reading null point zeros in the galvanometer.

4. In the above case maintain the sensitivity of Galvanometer from low range to high Range, Shunt Power Switch (SC, 1/1000, 1/100, 1/10, 1) which is kept aside of the Galvanometer by, Keep the toggle switch in AC Mains.

5. Standardized the potentiometer and measure the unknown voltage.

PRECAUTIONS:

1. A variable high resistance should be connected in series with the galvanometer to protect the galvanometer and standard cell for initial adjustment.

2. Connections should always be marked with due care of polarity.

3. Precautions for standard cell should be strictly observed.

4. Standardize the potentiometer at intervals during prolonged test to compensate for any slight drift in the battery voltage.

TABLE:

RESULT:

Exp. No.: **Date:**

Kelvin's Double Bridge – Measurement of very low Resistance values

Determination of Tolerance

AIM: To determine the unknown resistance that is low resistance between 0.2 to 11 Ω.

APPARATUS:

S.NO	ITEM NAME
1	DC supply
2	Unknown resistance
3	Galvanometer
4	Kelvin's double bridge consisting of 1. Main dial 2. Slide wire 3. Range switch

CIRCUIT DIAGRAM:

THEORY:

The bridge is suitable for measurement of low resistances in the range 0.2 Ω to 11Ω .Main dial: there are 10 coils of 0.01 Ω or 10 m Ω each arranged on the dial. Slide wire: 100 divisions of slide wire are equal to 0.01 Ω or 10 m Ω each main division is equal to 0.00002 Ω or 0.02m Ω. The reading to the left zero is to be subtracted from the main dial reading and that to be right of zero is to be added to the main dial reading. Range switch: a range multiplier switch finishes multiplying ratio of x100, x1, x0.1 and x0.01. The value of unknown resistance is given by sum of main dial and slide wire reading multiplied by range used the choice of which depends upon the magnitude of unknown resistance. The spot reflecting galvanometer of low resistance is recommended to be connected to terminals. Marked GALVONMETER on the bridge. It operates on 220V AC mains. The coil is set free by turning the pointed know in the free position. The spot of light is set in the center of scale by using the zero adjuster.

PROCEDURE:

1. Set the galvanometer to null position.
2. Connect the unknown resistance at given terminals.
3. Set the current switch.
4. Adjust main dial and slide wire and get null point in galvanometer.
5. The sum of main dial and slide wire multiplied by range used gives the valued of unknown resistance.

TABLE:

CALCULATIONS:

Unknown resistance = range (main dial + slide wire)

GRAPH:

PRECAUTIONS:

1. While connection +p and –p on bridge to unknown resistance only the potential lead supplied with bridge should be used.

2. Only that portion of resistance is measured which is enclosed between potential points.

3. Avoid continuous flow of current in the bridge. Instead pass current for short while away.

4. The potentiometer for consisting the current of DC source is 1K – 3W wire wound and is easily replicable if it is given some trouble.

RESULT:

Viva questions.

Kelvin Double Bridge:-

1) What is a four terminal resistance?

2) Why we have to take readings in normal and reverse directions?

3) What is the measurement range of Kelvin double bridge?

4) What is the accuracy of Kelvin double bridge?

5) What is its advantage over Wheatstone bridge?

6) Why high current source is preferred in this method?

Exp. No.: DETERMINATION OF CO-EFFICIENT OF COUPLING BETWEEN TWO MUTUALLY COUPLED COILS

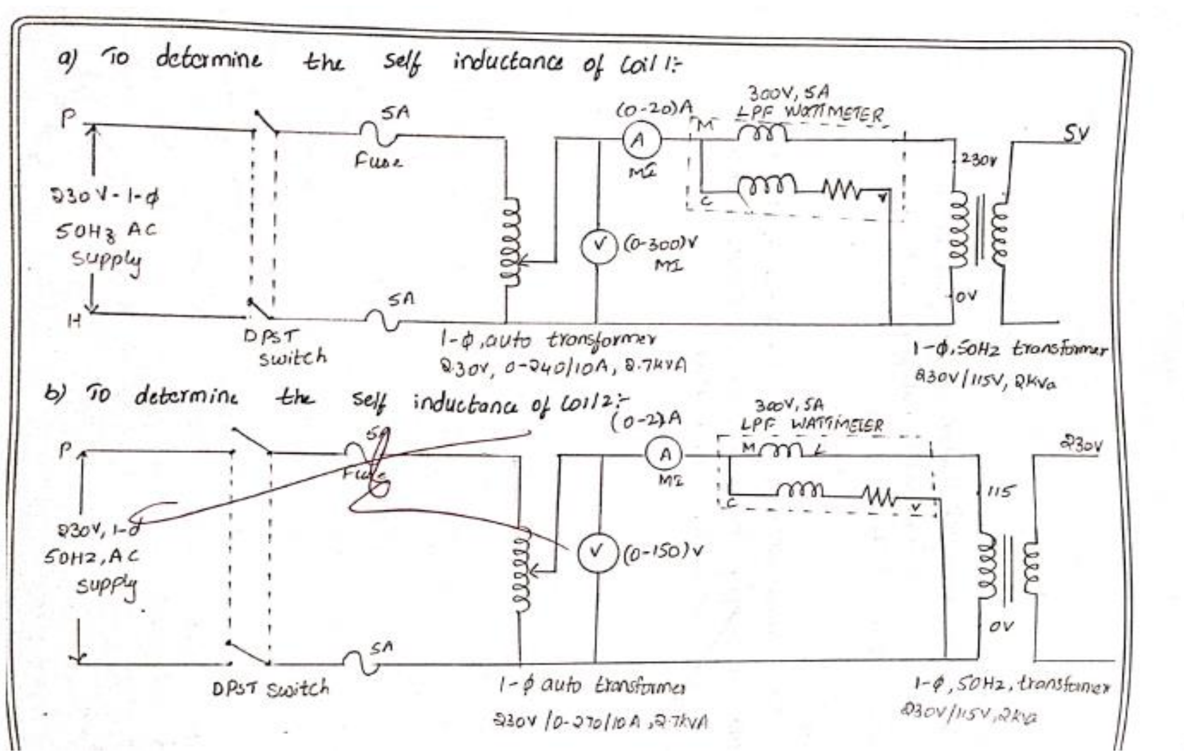
Date:

AIM: To determine self and mutual inductance and coefficient of coupling of magnetically coupled circuit..

APPARATUS:

S. No	Apparatus	Type	Range	Quantity
1	Voltmeter	MI	(0-300)v	1
2	Ammeter	MI	(0-2)A	1
3	Wattmeter	L.P.F	300V ,2 A	1
4	Auto transformer	_	230/(0-270)v	1

CIRCUIT DIAGRAM:



PROCEDURE:

PRECAUTIONS:

1. Initially keep the RPS voltage knob in zero volt position.
2. Set the ammeter pointer at zero position.
3. Take the readings without parallax error.
4. Avoid loose connections.
5. Do not short-circuit the output terminals of the R.P.S.

TABLE:

A) To determine the self inductance of coil 1

S.No	V_1	I_1	W_1	V_2

A) To determine the self inductance of coil 2

S.No	V_1	I_1	W_1	V_2

RESULT:

Exp. No.: **Date:**

Schering Bridge & Anderson Bridge For Measurement Of Capacitance And Inductance Values

6 (A) SCHERING BRIDGE

AIM: To determine the unknown capacitance using Schering Bridge.

APPARATUS:

S.NO	ITEM NAME
1	KHz frequency oscillator Digital millimeter.
2	3 unmarked capacitors of different values
3	4 decade resistances, 2 in 100E steps & 2 in 10E steps,
4	2 decade capacitors in 0.0001 MFD step
5	1 potentiometer of 10K Ohm range

CIRCUIT DIAGRAM:

THEORY:

Schering Bridge is widely used for capacitance a dissipation factor measurement. Infect Schering Bridge is one of the most important of AC bridges. It is extensively used in the measurement of capacitance in general and in particular in the measurement of the properties of insulators, capacitor bushings insulating oil and other insulation material.

Let C1 = capacitance whose capacitance is to be measured.

R1 = a series resistance representing the loss in capacitor 'C'

C2 = a standard capacitor, this capacitor is either an air core or gas capacitor and hence is loss free.

However if necessary a connection may be made for the loss angle of capacitor.

R3 = a non – inductive resistance

C4 = a variable capacitor

R4 = a variable non-inductive resistance in parallel with variable capacitor CH.

At balance

(r1 + R4 / jw C1)(R4 / 1+jw C4R4) = (1 / jwC2) R3

(r1 + 1 / jw C1) R4 = (R3 / jwC2) (1+jw C4R4)

r1 R4 - j R4/ w C1 = j R3/ w C2 + R3 R4 C4 / C2

Equation real and imaginary terms.

PROCEDURE:

1. Using patch cards make connection as per Circuit diagram.
2. Connect fixed frequency Oscillator at point P- R and digital mulitmeter at Q & S.
3. Keep level control of oscillator at max.level.
4. Take C2 of a suitable value.
5. Keep C1 at 0.0001 MFD.
6. Adjust R1, R2, R3 till we get min reading in multimeter.
7. Record the values.

TABLE:

RESULT:

6(B) ANDERSON BRIDGE

AIM: To determine the self inductance by using Anderson's Bridge.

APPARATUS:

S.NO	ITEM NAME
1	Frequency oscillator – 1000 cps
2	10V variable supply
3	Head phones
4	Anderson's bridge
5	P– Non-inductive resistance Q- Non-inductive resistance R- Non-inductive resistance S- Non-inductive resistance

CIRCUIT DIAGRAM:

\

THEORY:

In this self inductance is measured in terms of a standard capacitor. This method is applicable for precise measurement of self inductance over a very wide range of values.The circuit shown in the next page shows the connections and phase diagram of bridge for balance conditions.

Let L_1 = self inductance to be measured

R_1 = resistance connected in series with self inductance.

R_1, R_2, R_3, R_4 = known non-inductive resistances

C = fixed standard capacitor

- At balance, $I_1 = I_3$ & $I_2 = I_c + I_4$

$I_1 R_3 = I_c (1/ jwc)$

- Therefore, $I_C = I_1 jwc R_3$

$I_1 (r_1 + R_1 + jw L_1) = I_2 R_2 + I_c r$

$I_c (r + 1/jwc) = (I_2 - I_c) R_4$

- Sub the value of Ic

$I_1 (r_1 + R_1 + jw L_1) = I_2 R_2 + I_1 jwc R_3 r$

$I_1 (r_1 + R_1 + jw L_1 - jwc R_3 r) = I_2 R_2$

$jwc R_3 I_1 (r_1 + 1/jwc) = [(I_2 - I_1) jwc c]R_4$

- Equating real and imaginary parts,

$R_1 = R_2 R_3 / R_4 - r_1$

$L_1 = C R_3 / R_4 [r (R_4 + R_2) + R_2 R_4]$

This bridge may be used for accurate determination of capacitance in terms of inductance.

PROCEDURE:

1. Connect oscillator and head phones to proper terminals.

2. Vary S & M alternatively change C to suitable value of R.

3. Adjust until the pointer is at null position.

4. Record the values, L = C (PQ + (R + S) M)

TABLE:

PRECAUTIONS:

1. Value of C should be small so as to allow sufficient variation of M.
2. In all calculations, value of S should include resistance of self inductance.
3. Only minimum sound should be heard.
4. The AC balance should be obtained by varying S and M alternatively.

RESULT:

Viva questions:

SCHERING BRIDGE:

1. What is a stray capacitance? Is it possible to eliminate it?

2. What is the effect of stray capacitance on the accuracy of measurement?

3. Why Schering Bridge is more convenient for measuring capacitance and loss factor when compared and loss factor when compared to the other methods?

4. What is Wagner's earthling device and its purpose?

5. Compute Tan when the loss condenser is represented in parallel combination instead

Of Series?

6. Why loss resistance in parallel with condenser is more accurate than the other method?

ANDERSON BRIDGE:

1. What problems have you come across during balance?

2. What is the accuracy of the bridge when compared to other methods?

3. What is the order of 'Q' factor of the unknown inductance that is suitable for measurement?

4. Compare its performance with Maxwell's bridge?

Exp. No.: **Date:**

Measurement Of 3- Phase Reactive Power With Single Phase Wattmeter

AIM: To measure the total reactive power of a three phase balanced load using a single phase wattmeter.

APPARATUS:

S.NO	ITEM NAME	SOECIFICATIONS	QUANTITY
1	Wattmeter	(0- 10 A/ 600V)	2Nos
2	Ammeter	(0- 5A AC)	1 No
3	Voltmeter	(0 – 600 V AC)	1 No
4	Wattmeter	(0-10A/600V, LPF)	-
5	Connecting Wires	---	---

CIRCUIT DIAGRAM:

PROCEDURE:

1. Connections are made as per circuit diagram.

2. The Autotransformer is in minimum output position.

3. The inductive load should be kept in fully closed position (Maximum reactance position).

4. Switch on the supply, by slowly varying the autotransformer, rated value is applied to motor.

5. Observe the meter readings if wattmeter reads negative change the CC connections.

6. Vary the reactance of the load by moving the knob in open direction,.

7. Ammeter, Voltmeter, Wattmeter readings are noted in each step by varying the load.

8. Close the load and switch of the supply.

PHASOR DIAGRAM:

TABLE:

RESULT:

Exp. No.: **Date:**

Measurement of Parameters of a Choke Coil Using 3 Voltmeter and 3 Ammeter Methods

8(A).MEASUREMENT OF PARAMETERS OF A CHOKE COIL USING 3-VOLTMETER METHODS

AIM: Measurement of Power consumed Power factor and Inductance of a Choke by 3-voltmeter.

APPARATUS:

S.NO	ITEM NAME	SPECIFICATION	QUANTITY
1	Auto transformer	230/0-270 V - 10amps	1No
2	Voltmeter	0-300 V AC	3No
3	Ammeter	0-2 A AC	3No
4	Load chokes	-	1No

CIRCUIT DIAGRAM:

THEORY:

Power consumed in any circuit can be measured without a voltmeter by using either with 3 voltmeter.

- Three voltmeter method:In this method 3 voltmeters and a known non inductive resistance is used. This resistance is connected in series with the load. As shown in the circuit one voltmeter is used in the experiment to measure the supply V1, voltage v2 across the resistance and voltage V3 across the load (choke).

As per the phase diagram,

V12 = V22 + V32 + 2 V2 V3 cos Φ

PL = V I3 cos Φ = I32 RL

Where R = resistance of the choke

ZL = V/ I3 where XL = √ ZL2 - RL2

Therefore L = XL / 2π

As per the phase diagram,

I12 = I22 + I32 + 2 I2 I3 cos Φ

Power factor, cosΦ = I1 2 – I2 2 - I3 2 / 2 I2 I3

Power consumed in the load PL = V I3 cos Φ, where V = I2 R

PL = I2 R I3 (I12 – I22 - I32) / 2 I2 I3

Power consumed in the load, PL = ((I12 – I22 - I3 2) R/2,

Cos Φ = V12 - V22 - V32 / 2 V2 V3

PL = V3 I cos Φ, I = V2 / R (V2 = I R),

PL = V2 V3 / R (V12 - V22 - V32 / 2 V2 V3)

Therefore PL = V12 - V22 - V32 / 2 R

PROCEDURE:

Three Voltmeter method:

1. Connect the circuit as shown in the circuit diagram.

2. Set the auto transformer at the zero position and switch ON the supply.

3. Increase input supply and note down V1, V2 and V3.

4. Tabulate the values as given in the table.

5. Switch OFF the supply.

Calculations for Three Voltmeter method

V12 = V22 + V32 + 2 V2 V3 cos Φ

Cos Φ = V12 - V22- V32 / 2 V2 V3

TABLE:

RESULT:

8(B) MEASUREMENT OF PARAMETERS OF A CHOKE COIL USING 3-AMMETER METHODS

AIM:

Measurement of Power consumed Power factor and Inductance of a Choke by 3-Ammeter method.

APPARATUS:

S.NO	ITEM NAME	SPECIFICATION	QUANTITY
1	Auto transformer	0-270 V - 2amps	1No
2	Voltmeter	0-300 V AC	3No
3	Ammeter	0-2 A AC	3No
4	Load chokes	-	1No

CIRCUIT DIAGRAM:

THEORY:

Power consumed in any circuit can be measured without a voltmeter by using either with 3 ammeters.

Three Ammeter method: In this method three ammeters are used, known resistance is connected in parallel to load. Where as in this experiment 1 ammeter and 3 no's of ON/OFF toggles switches are used to measure:

1. Current drawn from the supply I1

2. Current through the resistance I2

3. Current through the load I3

PROCEDURE:

Three Ammeter method:

1. Connect the circuit as shown in the circuit diagram.
2. Set the auto transformer at the zero position and switch ON the supply.
3. Increase input supply and note down I1, I2 and I3.
4. Tabulate the values as given in the table.
5. Switch OFF the supply.

Calculations for Three Ammeter method

TABLE:

RESULT:

Viva questions.

Measurement of Parameters of Choke Coil Using 3 –Ammeters:-

1) What are the various sources of errors in this method?

2) What are the advantages and disadvantages of this method?

3) Why this method is not generally preferred in the laboratory for measuring power in single Phase circuit?

Exp. No.: **Date:**

LVDT and Capacitance Pickup – Characteristics and Calibration

AIM: To measure displacement using linear variable differential Transformer.

APPARATUS:

S.NO	ITEM NAME
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 resp.

TABLE:

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:

Exp. No.: **Date:**

Resistance Strain Gauge – Strain Measurement and Calibration

AIM: Measurement of strain in cantilever beam using strain measurement trainer.

APPARATUS:

S.NO	ITEM NAME
1	Cantilever beam
2	PAN
3	Dead weights
4	A pin connector

CIRCUIT DIAGRAM:

THEORY:

What Is Strain-

Strain is the amount of deformation of a body due to an applied force. More specifically, strain (e) is defined as the fractional change in length, as shown in Figure 1 below.

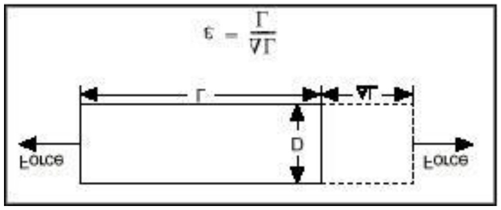


Figure 1. Strain

Strain can be positive (tensile) or negative (compressive). Although dimensionless, strain is sometimes expressed in units such as in./in. or mm/mm. In practice, the magnitude of measured strain is very small. Therefore, strain is often expressed as micro strain (me),which is ex10-6. When a bar is strained with a uniaxial force, as in Figure 1, a phenomenon known as Poisson Strain causes the girth of the bar, D, to contract in the transverse, or perpendicular, direction. The magnitude of this transverse contraction is a material property indicated by its Poisson's Ratio. The Poisson's Ratio n of a material is defined as the negative ratio of the strain in the transverse direction (perpendicular to the force) to the strain in the axial direction (parallel to the force), or n = eT/e. Poisson's Ratio for steel, for example, range from 0.2-0 .While there are several methods of measuring strain, the most common is with a strain gauge, a device whose electrical resistance varies in proportion to the amount of strain in the device. The most widely used gauge is the bonded metallic strain gauge.

The metallic strain gauge consists of a very fine wire or, more commonly, metallic foil arranged in a grid pattern. The grid pattern maximizes the amount of metallic wire or foil subject to strain in the parallel direction (Figure 2). The cross-sectional area of the grid is minimized to reduce the effect of shear strain and Poisson Strain. The grid is bonded to a thin backing, called the carrier, which is attached directly to the test specimen. Therefore, the strain experienced by the test specimen is transferred directly to the strain gauge, which responds with a linear change in electrical resistance. Strain gauges are available commercially with nominal resistance values from 30 to 3000 W, with 120, 350, and 1000 W being the most common values.

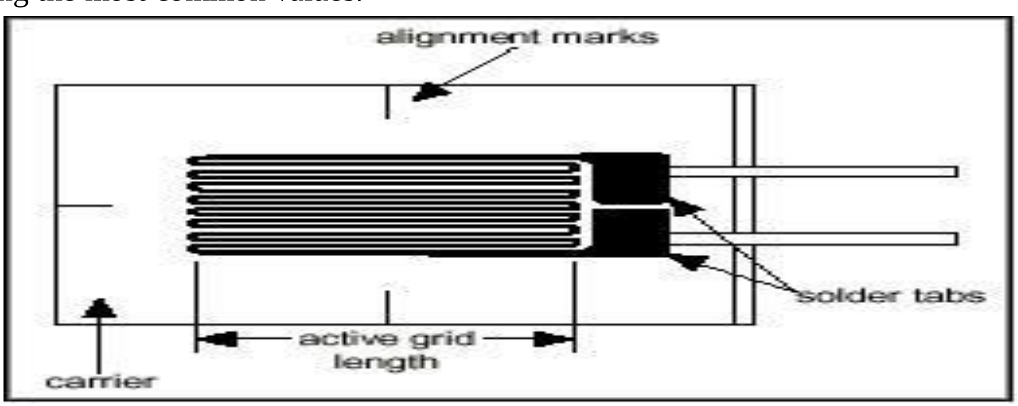


Figure 2. Bonded Metallic Strain Gauge

` It is very important that the strain gauge be properly mounted onto the test specimen so that the strain is accurately transferred from the test specimen, though the adhesive and strain gauge backing, to the foil itself. A fundamental parameter of the strain gauge is its sensitivity to strain, expressed quantitatively as the gauge factor (GF). Gauge factor is defined as the ratio of fractional change in electrical resistance to the fractional change in length (strain):

$$GF = \frac{\Delta R/R}{\Delta L/L} = \frac{\Delta R/R}{\varepsilon}$$

CONNECTION DETAILS:

1. Connect the 3 pin power supplied to 230V supply and to the instrument at the main panel.

2. Connect the strain gauge to the terminals at the measurement panel as follows.

For full bridge configuration:

Shirt Red and Blue wires and connect them to Red terminal on the panel. Match the other wire colors' with terminals.

For half bridge configuration:

Disconnect Blue and Green wires from the terminals

PROCEDURE:

1. Check the connections made and switch on the instrument by toggle switch at the back of the box. This display glows to indicate the instrument is ON.

2. Allow the instrument in the ON position for 10min for initial warm-up.

3. Select the full or half bridge configuration from the selector switch on the panel.

4. Adjust the zero potentiometer on the panel till the display reads '000'.

5. Apply 1Kg load on the cantilever beam and adjust the cal potentiometer till the display should come to '0' in case of any variation adjust the zero potential again and repeat the procedure again. Now, the instrument is calibrated to read micro-strain.

6. Apply load on the sensor using the loading arrangement provided in steps of 100grams up to 1Kg.

7. The instrument displays exact micro strain strained by the cantilever beam (for full bridge configuration and for half bridge configuration).

8. Note down the readings in the tabular column percentage error in the reading hysteresis and accuracy of the instrument can be calculated by comparing with the theoretical values.

TABLE:

CALCULATIONS:

GRAPH:

Graph plotted actual reading (x-axis) vs. indicator reading (y-axis)

RESULT:

Exp. No.: 11 **Date:**

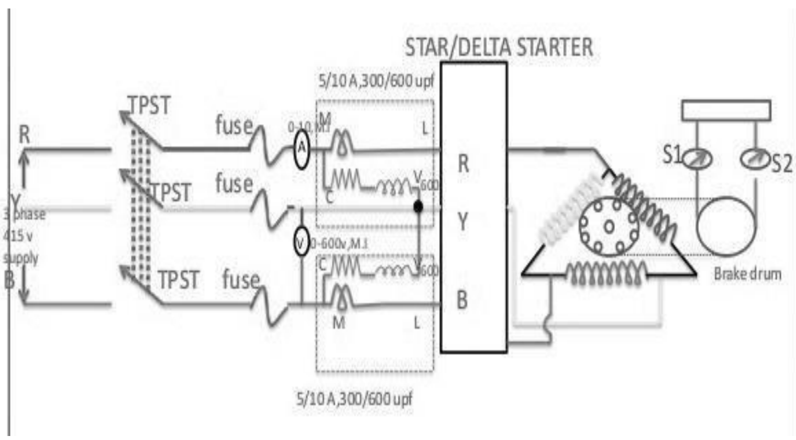
Measurement of 3-Φ Power using Two-wattmeter method

Aim: To measure 3-Φ reactive power by Two Wattmeter Method

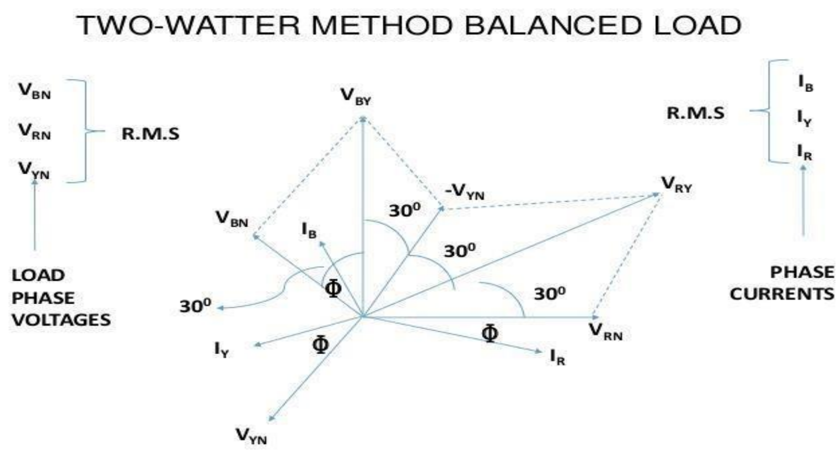
Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	3-Φ Variac	415V/(0-470)V	---	1
2	Voltmeter	(0-600)V	MI	1
3	Ammeter	(0-10)A	MI	1
4	Wattmeter	600V/10A UPF	Dynamometer	2
5	Inductive Load	3-Φ, 440V, 10A	---	1
6	Connecting Wires	---	---	Required Some

Circuit Diagram:



Phasor Diagram:



Precautions:

1. 3-Φ Variac should be in minimum position.
2. Load is kept in OFF position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions switch ON 3-Φ A.C supply and by using the 3-Φ variac apply the rated voltageof the energy meter.
3. Note down the readings of all the meters at no-load and then by gradually increasing the load in steps tillthe rated current of the inductive load, note down all the meter readings at each step.
4. Observing the precautions switch OFF the supply.

Tabular Column:

S.No.	Voltmeter Reading (V)	Ammeter Reading (A)	W_1 (W)	W_2 (W)	W (W)	Total Reactive Power	
						Two Wattmeter (VAR)	One Wattmeter (VAR)

Formulae:

3-Φ Reactive Power by Two Wattmeter = $\sqrt{3}\ (W_2 - W_1)$(VAR)

3-Φ Reactive Power by One Wattmeter = $\sqrt{3}$ W(VAR)

Result:

Viva Questions:

1. Define blendel's theorem?
2. How many watt meters are required for measurement of 3 Phase active power?
3. How many watt meters are required for measurement of 3 Phase reactive power?
4. What are the methods for measurement of 3 Phase balanced power?
5. What are the methods for measurement of 3 Phase unbalanced power?
6. How many watt meters are required for measurement of 3 Phase, 3 wire balanced system?
7. How many watt meters are required for measurement of 3 Phase, 4 wire balanced system?
8. What are the methods for measurement of 3 Phase, 3 wire unbalanced system?
9. How many watt meters are required for measurement of 3 Phase, 3 wire unbalanced system?
10. Draw the phasor diagram used for tow watt meter method.

Exp. No.: 12 **Date:**

CALIBRATION OF LPF WATTMETER BY PHANTOM TESTING

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

APPARATUS:

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

CIRCUIT DIAGRAM:

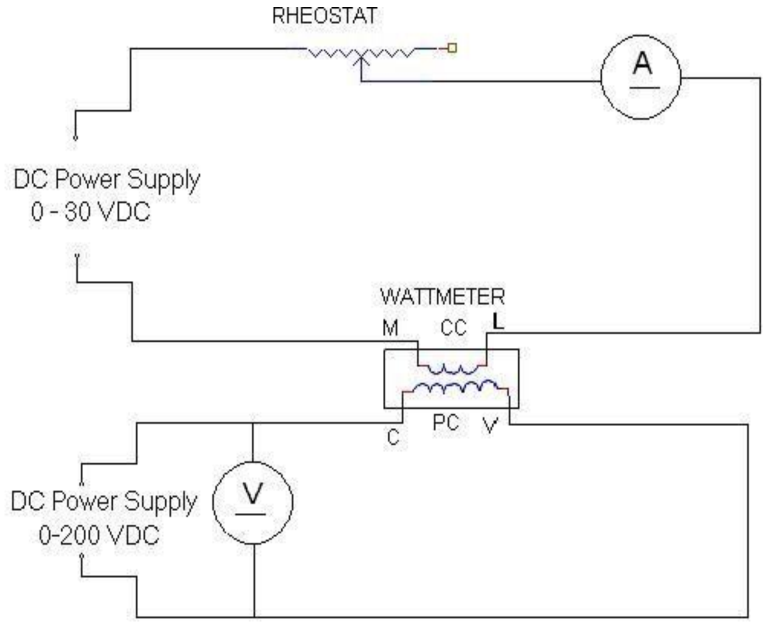


Fig – Calibration of LPF Wattmeter by Phantom Testing

PROCEDURE:

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

TABULAR COLUMN:

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

MODEL CALCULATIONS:

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

Where $W_C = VI$

RESULT:

PRE LAB VIVA QUESTIONS:

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

POST LAB VIVA QUESTIONS:

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