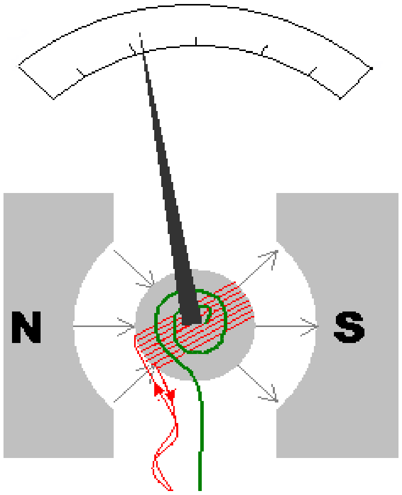
ELECTRICAL MEASUREMENTS LABORATORY



M A N U A L

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DEPARTMENT OF ELECRICAL & ELECTRONICS ENGINEERING

BALAJI INSTITUTE OF TECHNOLOGY AND SCIENCE
NARSAMPET, WARANGAL.

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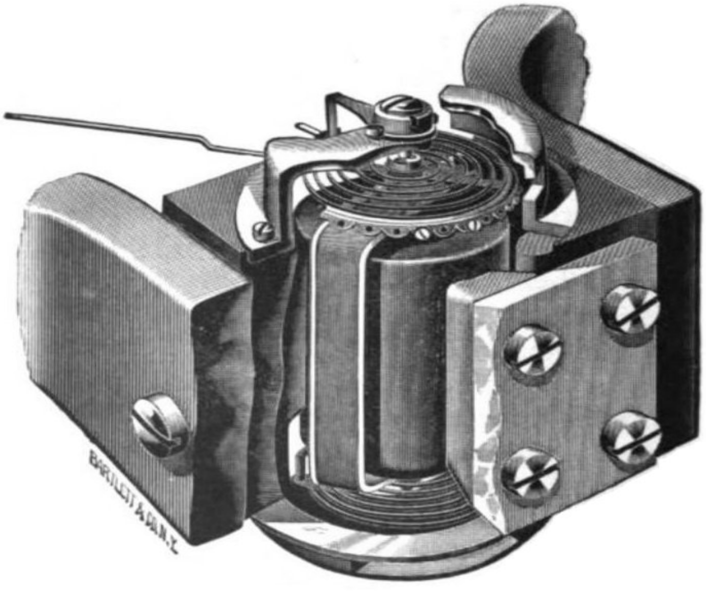

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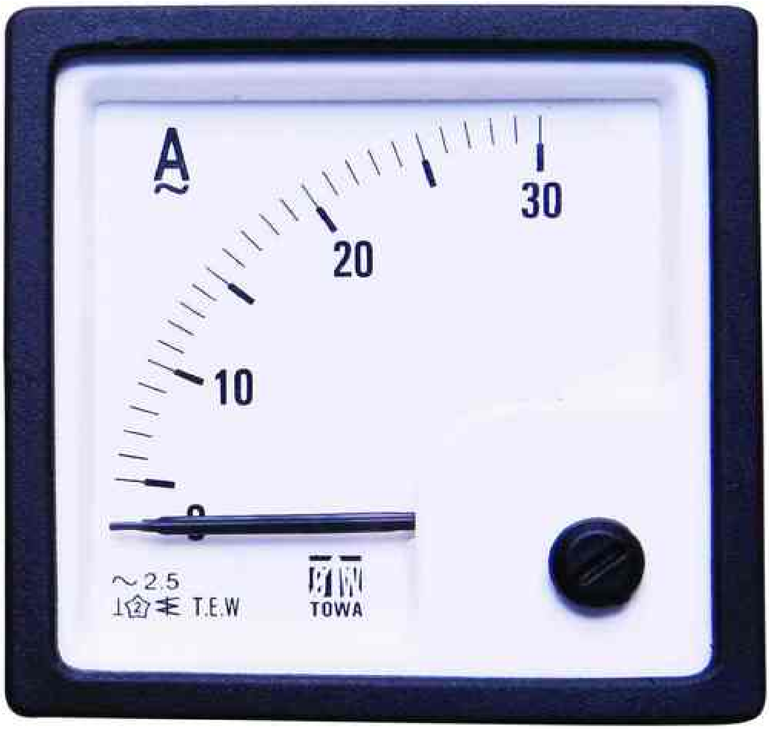


Name of the Laboratory: ELECTRICAL MEASUREMENTS

Year/Semester : III B.Tech I Sem.

Branch : Electrical & Electronics Engineering

HOD/EEE *Principal*

Vision and Mission of EEE Department

Vision:

To nurture excellence in the field of Electrical & Electronics Engineering by imparting core values to the learners and to mould the institution into a centre of academic excellence and advanced research.

Mission:

M1: To impart students with high technical knowledge to make globally adept to the new Technologies

M2: To create, disseminate and integrate knowledge of engineering, science and technology that expands the electrical engineering knowledge base towards research

M3: To provide the students with a platform for developing new products and systems that can help industry and society as a whole.

Program Outcomes

PO1	**Engineering knowledge:** Apply the knowledge of basic sciences and fundamental engineering concepts in solving engineering problems.
PO 2	**Problem analysis:** Identify and define engineering problems, conduct experiments and investigate to analyze and interpret data to arrive at substantial conclusions.
PO 3	**Design/development of solutions:** Propose an appropriate solution for engineering problems complying with functional constraints such as economic, environmental, societal, ethical, safety and sustainability.
PO 4	**Conduct investigations of complex problems:** Perform investigations, design and conduct experiments, analyze and interpret the results to provide valid conclusions.
PO 5	**Modern tool usage:** Select/ develop and apply appropriate techniques and IT tools for the design and analysis of the systems.
PO 6	**The engineer and society:** Give reasoning and assess societal, health, legal and cultural issues with competency in professional engineering practice.
PO 7	**Environment and sustainability:** Demonstrate professional skills and contextual reasoning to assess environmental/ societal issues for sustainable development.
PO 8	**Ethics:** An ability to 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 multi-disciplinary situations.
PO 10	**Communication:** An ability to communicate effectively.
PO 11	**Project management and finance:** Demonstrate apply engineering and management principles in their own / team projects in multi-disciplinary environment.
PO 12	**Life-long learning:** An ability to do the needs of current technological trends at electrical industry by bridging the gap between academic and industry.

Program Specific Outcomes

PSO1	Apply fundamental knowledge to identify, analyze diverse problems associated with electrical and electronic circuits, power electronics drives and power systems.
PSO2	Understand the current technological developments in Electrical & Electronics Engineering and develop the innovative products/software to cater to the needs of society & Industry.

Program Educational Objectives

PEO1	To prepare students with solid foundation in Mathematics, Sciences and Basic Engineering to cover multi-disciplinary subjects enabling them to comprehend, analyze Electrical & Electronics Engineering problems and develop solutions.
PEO2	To design and develop an electrical system component or process to meet the needs of society and industry with in realistic constraints.
PEO3	To prepare students with technical competence to use advance techniques, skills and modern engineering tools that allow them to work effectively as electrical and electronics engineer.

ATTAINMENT OF PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES

Exp .No	Name of the Experiment	Program Outcomes Attained	Program Specific Outcomes Attained
1	Calibration and Testing of single phase energy Meter.	PO1, PO9	PSO1
2	Calibration of dynamometer power factor meter.	PO1, PO9	PSO1
3	Crompton D.C. Potentiometer – Calibration of PMMC ammeter and PMMC voltmeter.	PO1, PO9	PSO1
4	Kelvin's double Bridge – Measurement of resistance – Determination of Tolerance.	PO1, PO9	PSO1
5	Dielectric oil testing using H.T. testing Kit.	PO1, PO9	PSO1
6	Schering bridge & Anderson bridge.	PO1, PO9	PSO1
7	Measurement of 3 - Phase reactive power with single-phase wattmeter.	PO1, PO9	PSO1
8	Measurement of displacement with the help of LVDT.	PO1, PO9	PSO1
		PO1, PO9	PSO1
9	Calibration LPF wattmeter – by Phantom testing.	PO1, PO9	PSO1
10	Measurement of 3-phase power with single watt meter and two CTs.	PO1, PO9	PSO1
11	C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given CT by Null method.	PO1, PO9	PSO1
12	PT testing by comparison – V. G. as Null detector – Measurement of % ratio error and phase angle of the given PT	PO1, PO9	PSO1
13	Resistance strain gauge – strain measurements and Calibration.	PO1, PO9	PSO1
14	Transformer turns ratio measurement using AC bridges.	PO1, PO9	PSO1
15	Measurement of % ratio error and phase angle of given CT by comparison.	PO1, PO9	PSO1

PREFACE

This Laboratory book in Electrical Measurements has been revised in order to be up to date with Curriculum changes, laboratory equipment upgrading and the latest circuit simulation.

Every effort has been made to correct all the known errors, but nobody is perfect, if you find any additional errors or anything else you think is an error, please contact the HOD/EEE at mallik95_eee@yahoo.com

The Authors thanked all the staff members from the department for their valuable Suggestion and contribution.

The author would welcome the advice and suggestions leading to the improvement of the book.

The Authors,
Department of EEE.


Danger
High voltage

LABORATORY PRACTICE

SAFETY RULES

1. SAFETY is of paramount importance in the Electrical Engineering Laboratories.

2. Electricity NEVER EXECUSES careless persons. So, exercise enough care and attention in handling electrical equipment and follow safety practices in the laboratory. (Electricity is a good servant but a bad master).

3. Avoid direct contact with any voltage source and power line voltages. (Otherwise, any such contact may subject you to electrical shock)

4. Wear rubber-soled shoes. (To insulate you from earth so that even if you accidentally contact a live point, current will not flow through your body to earth and hence you will be protected from electrical shock)

5. Wear laboratory-coat and avoid loose clothing. (Loose clothing may get caught on an equipment/instrument and this may lead to an accident particularly if the equipment happens to be a rotating machine)

6. Girl students should have their hair tucked under their coat or have it in a knot.

7. Do not wear any metallic rings, bangles, bracelets, wristwatches and neck chains. (When you move your hand/body, such conducting items may create a short circuit or may touch a live point and thereby subject you to Electrical shock)

8. Be certain that your hands are dry and that you are not standing on wet floor. (Wet parts of the body reduce the contact resistance thereby increasing the severity of the shock)

9. Ensure that the power is OFF before you start connecting up the circuit. (Otherwise you will be touching the live parts in the circuit).

10. Get your circuit diagram approved by the staff member and connect up the circuit strictly as per the approved circuit diagram.

11. Check power chords for any sign of damage and be certain that the chords use safety plugs and do not defeat the safety feature of these plugs by using ungrounded plugs.

12. When using connection leads, check for any insulation damage in the leads and avoid such defective leads.

13. Do not defeat any safety devices such as fuse or circuit breaker by shorting across it. Safety devices protect YOU and your equipment.

14. Switch on the power to your circuit and equipment only after getting them checked up and approved by the staff member.

15. Take the measurement with one hand in your pocket. (To avoid shock in case you accidentally touch two points at different potentials with your two hands)

16. Do not make any change in the connection without the approval of the staff member.

17. In case you notice any abnormal condition in your circuit (like insulation heating up, resistor heating up etc), switch off the power to your circuit immediately and inform the staff member.

18. Keep hot soldering iron in the holder when not in use.

19. After completing the experiment show your readings to the staff member and switch off the power to your circuit after getting approval from the staff member.

20. Determine the correct rating of the fuse/s to be connected in the circuit after understanding correctly the type of the experiment to be performed: no-load test or full-load test, the maximum current expected in the circuit and accordingly use that fuse-rating.(While an over-rated fuse will damage the equipment and other instruments like ammeters and watt-meters in case of over load, an under-rated fuse may not allow one even to start the experiment)

21. Moving iron ammeters and current coils of wattmeters are not so delicate and hence these can stand short time overload due to high starting current. Moving iron meters are cheaper and more rugged compared to moving coil meters. Moving iron meters can be used for both a.c. and d.c. measurement. Moving coil instruments are however more sensitive and more accurate as compared to their moving iron counterparts and these can be used for d.c. measurements only. Good features of moving coil instruments are not of much consequence for you as other sources of errors in the experiments are many times more than those caused by these meters.

22. Some students have been found to damage meters by mishandling in the following ways:

i. Keeping unnecessary material like books, labrecords, unused meters etc. causing meters to fall down the table.
ii. Putting pressure on the meter (especially glass) while making connections or while talking or listening somebody.

STUDENTS ARE STRICTLY WARNED THAT FULL COST OF THE METER WILL BE RECOVERED FROM THE INDIVIDUAL WHO HAS DAMAGED IT IN SUCH A MANNER.

Copy these rules in your Lab Record. Observe these yourself and help your friends to observe.

I have read and understand these rules and procedures. I agree to abide by these rules and procedures at all times while using these facilities. I understand that failure to follow these rules and procedures will result in my immediate dismissal from the laboratory and additional disciplinary action may be taken.

Signature Date Lab

GUIDELINES FOR LABORATORY NOTEBOOK

The laboratory notebook is a record of all work pertaining to the experiment. This record should be sufficiently complete so that you or anyone else of similar technical background can duplicate the experiment and data by simply following your laboratory notebook. Record everything directly into the notebook during the experiment. Do not use scratch paper for recording data. Do not trust your memory to fill in the details at a later time.

Organization in your notebook is important. Descriptive headings should be used to separate and identify the various parts of the experiment. Record data in chronological order. A neat, organized and complete record of an experiment is just as important as the experimental work.

1. Heading:

The experiment identification (number) should be at the top of each page.Your name and date should be at the top of the first page of each day's experimental work.

2. Object:

A brief but complete statement of what you intend to find out or verify in the experiment should be at the beginning of each experiment

3. Diagram:

A circuit diagram should be drawn and labeled so that the actual experiment circuitry could be easily duplicated at any time in the future. Be especially careful to record all circuit changes made during the experiment.

4. Equipment List:

List those items of equipment which have a direct effect on the accuracy of the data. It may be necessary later to locate specific items of equipment for rechecks if discrepancies develop in the results.

5. Procedure:

In general, lengthy explanations of procedures are unnecessary. Be brief. Short commentaries alongside the corresponding data may be used. Keep in mind the fact that the experiment must be reproducible from the information given in your notebook.

6. Data:

Think carefully about what data is required and prepare suitable data tables. Record instrument readings directly. Do not use calculated results in place of direct data; however, calculated results may be recorded in the same table with the direct data. Data tables should be clearly identified and each data column labeled and headed by the proper units of measure.

7. Calculations:

Not always necessary but equations and sample calculations are often given to illustrate the treatment of the experimental data in obtaining the results.

8. Graphs:

Graphs are used to present large amounts of data in a concise visual form. Data to be presented in graphical form should be plotted in the laboratory so that any questionable data points can be checked while the experiment is still set up. The grid lines in the notebook can be used for most graphs. If special graph paper is required, affix the graph permanently into the notebook. Give all graphs a short descriptive title. Label and scale the axes. Use units of measure. Label each curve if more than one on a graph.

9. Results:

The results should be presented in a form which makes the interpretation easy. Large amounts of numerical results are generally presented in graphical form. Tables are generally used for small amounts of results. Theoretical and experimental results should be on the same graph or arrange in the same table in a way for easy correlation of these results.

10. Conclusion:

This is your interpretation of the results of the experiment as an engineer. Be brief and specific. Give reasons for important discrepancies.

TROUBLE SHOOTING HINTS

1. Be Sure that the power is turned ON
2. Be sure the ground connections are common
3. Be sure the circuit you build is identical to your circuit diagram (Do a node by node check)
4. Be sure that the supply voltages are correct
5. Be sure that the equipment is set up correctly and you are measuring the correct parameters
6. If steps 1 through 5 are correct then you probably have used a component with the wrong value or one that doesn't work. It is also possible that the equipment does not work (although this is not probable) or the protoboard you are using may have some unwanted paths between nodes. To find your problem you must trace through the voltages in your circuit node by node and compare the signal you expect to have. Then if they are different use your engineering judgment to decide what is causing the different or ask your lab assistant.

ELECTRICAL MEASUREMENTS LABORATORY

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 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.

CALIBRATION AND TESTING OF SINGLE PHASE ENERGY METER

Aim: Calibration and testing of single phase energy meter by direct loading.

Apparatus required:

Sl.no	Name of the component	Type	Range	Quantity
1.	Single phase energy meter			1No.
2.	wattmeter			1No.
3.	Voltmeter		(0-150/300)V	1No.
4.	Ammeter		(0-5/10)A	1No.
5.	Resistive load			1No.
6.	Stop watch			1No.

Energy meter specifications:

Meter constant: ______________________
Rated voltage:________________________ current:_______________________
Frequency:___________________________ type:___DISK________________________

Theory:

Procedure:

1. Connections are made as per the circuit diagram.
2. Before closing the DPST switch ensure that Load switch is open and variac is in minimum or zero output voltage position.
3. Gradually vary the variac and apply the rated voltage of energy meter (i.e.,230V).
4. Now close the load switch and apply the load.
5. Note down the readings of the meters and time taken for 10 revolutions of energy meter disk.
6. Increase the load in steps and in each step note down the readings of the instruments and also the time taken for 10 revolution of energy meter aluminum disk and tabulated the readings.
7. Gradually reduce the load in steps and open the load switch.
8. Vary the variac gradually to minimum or zero output voltage position and open the supply DPST switch.

Observation table:

Sl.no	Supply voltage (volts)	Load current (amps)	Watt meter reading (watts)	Time taken 10 rev.	Calculated Energy (kw) $e_{act} = (w/1000*t/3600)$	Indicating energy by energy meter $e_{true} = n/m.r$	% error $\frac{e_{act} - e_{true}}{e_{act}}$

Calculations:

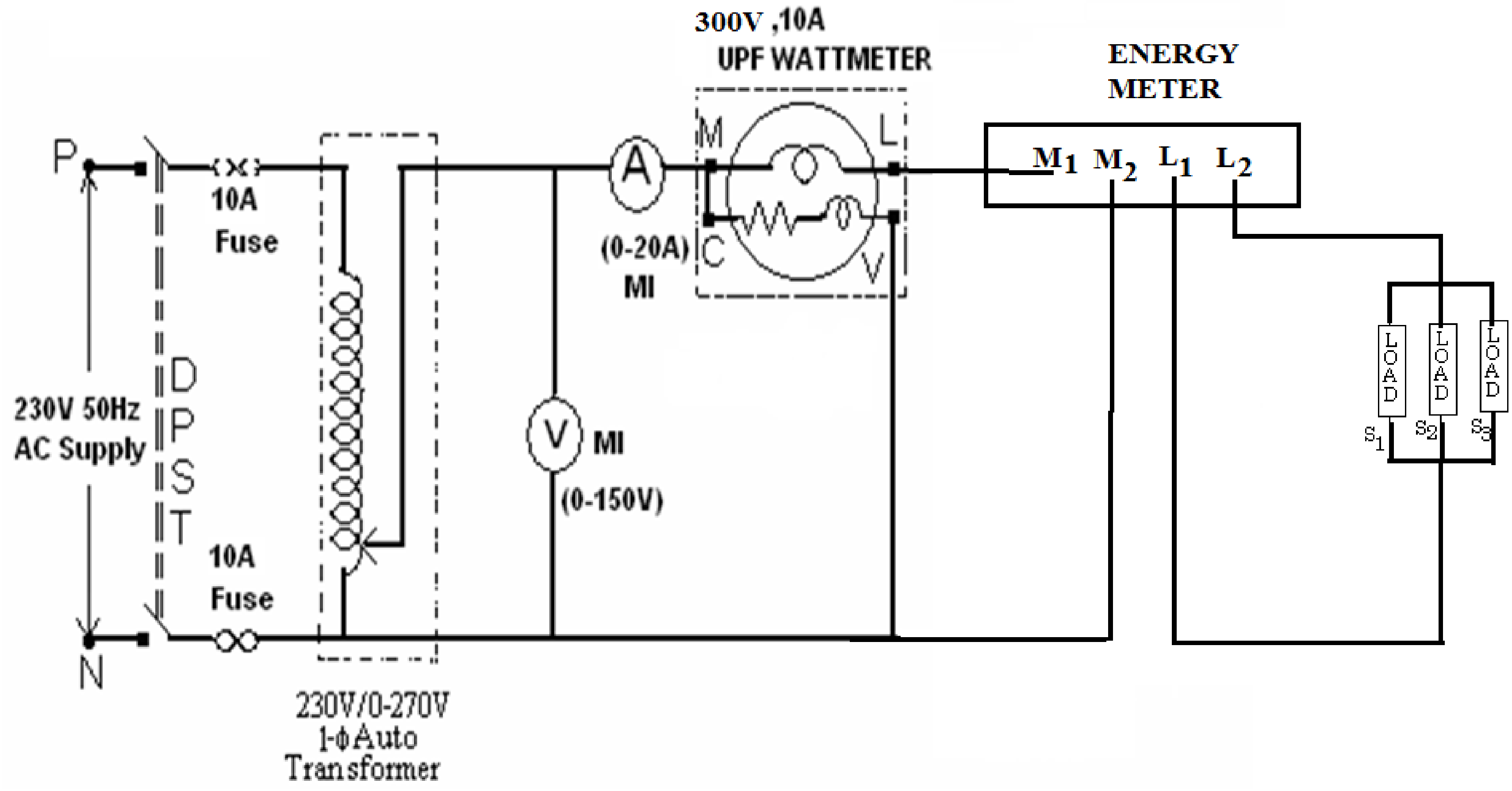
Energy meter rating =______________________(Meter constant)

$$\% \text{ Error} = \frac{E_{actual} - E_{true}}{E_{actual}} \times 100$$

Graph: Load current (vs.) % Error

Result:

TITLE: CALIBRATION OF SINGLE PHASE ENERGY METER
CIRCUIT DIAGRAM



MEASUREMENT PARAMETERS OFA CHOKE COIL USING THREE AMMETERMETHOD

Aim: Measurement parameters of a choke coil using three ammeter method.

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	Ammeter	MI		3 no.
2.	Voltmeter	MI		1 no
3.	1-ϕ variac			1 no
4.	Choke coil			1 no
5.	Rheostat			1 no

Theory:

Procedure:

1. Connections are made as per the circuit diagram.
2. Initially variac kept at minimum position or zero output voltage position
3. Vary the variac to apply the rated voltage of 230volts, note down the readings of 3 Ammeters and Voltmeter.
4. Adjust the inductive load to particular load current (1A or 2A).
5. Note down the Readings of 3 Ammeters and Voltmeter
6. Reduce the supply voltage in steps by varying the variac.
7. At each step note down the readings of 3 Ammeter and Voltmeter then tabulate the Readings in tabular Colum
8. Reduce the supply voltage to zero by bringing the variac to zero output Volta and open the DPST main switch.

Tabularcolum:

Sl.no.	V (volt)	I_1 (Amp)	I_2 (Amp)	I_3 (Amp)	$P = \frac{(I_1 - I_2 - I_3)}{2r}$	Cos ǿ	r (ohms)	L (mh)

Calculations:

From the phasor diagram resultant current = $I_1 = I_2 + I_3 + (2 I_2 * I_3 \text{ Cos } \phi)$

Power factor of the coil = $\text{Cos } \phi = \dfrac{I_1 - I_2 - I_3}{2 I_2 I_3}$

Power in the choke coil (P) = $V I_3 \text{ Cos } \phi$

Power loss in the choke coil = I3r

I_3VCOSǾ = I3r

Choke coil resistance = r = $V/I_3(\text{Cos } \phi)$

Impedance of the coil = Z = V/I_3

But Z = $r + x_L$

Coil reactance $X_L = Z - r$

Coil inductance = L = $X_L/2f$(H)

Hence by using the formula we can calculate the inductance of a choke coil.

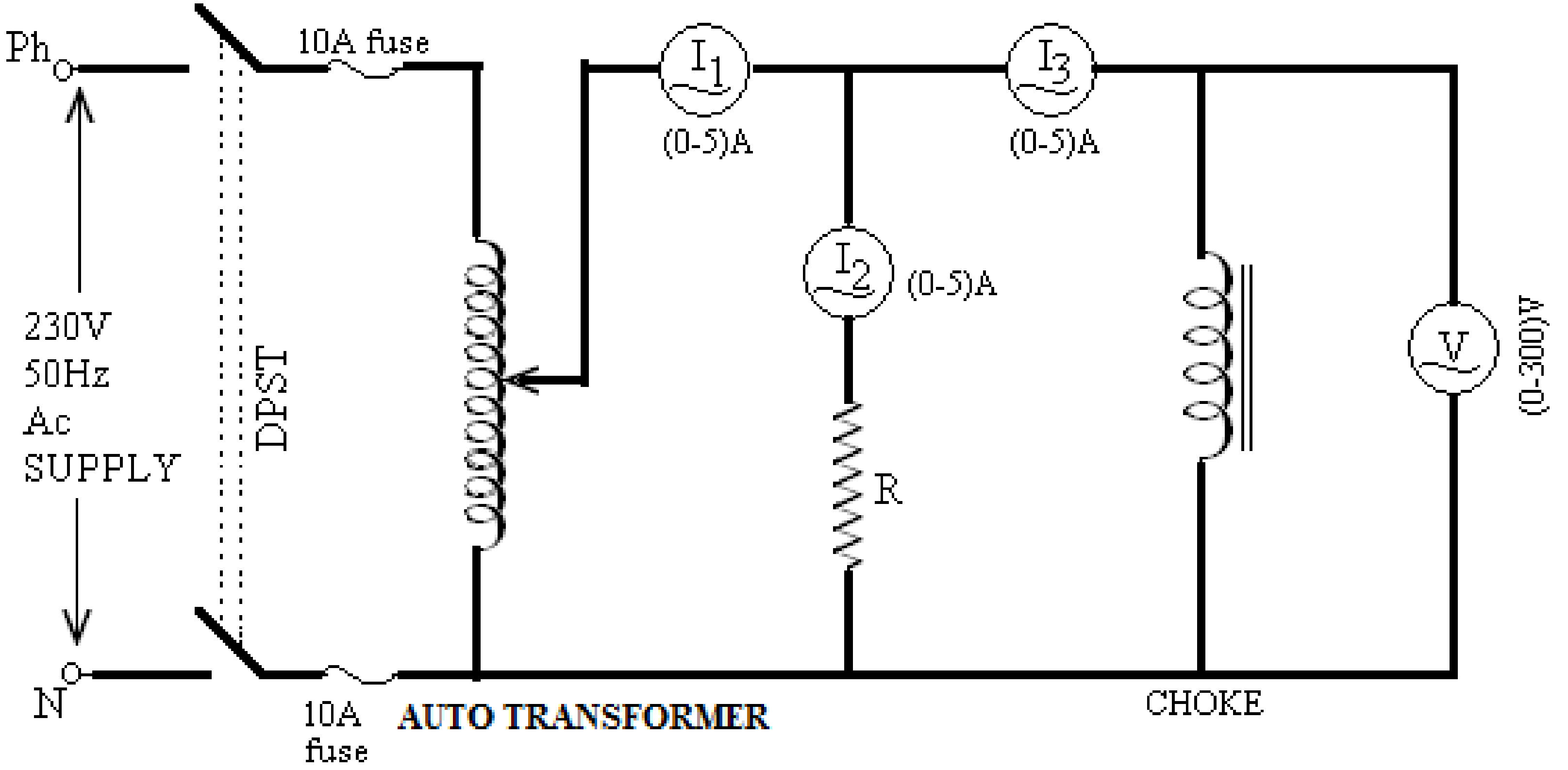
Precations:

1. Initially variac kept at minimum position.
2. Vary the variac such that the current and voltage are within the rated values.

Result:

TITLE: MEASUREMENT PARAMETERS OFA CHOWKE COIL USING THREE AMMETER METHOD

CIRCUIT DIAGRAM



MEASUREMENT OF PARAMETERS OF A CHOKE COIL USING THREE VOLTMETER METHOD

Aim: measurement parameters of a chowke coil using three voltmeter method

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	Ammeter	MI		3 no.
2.	Voltmeter	MI		1 no
3.	1-ϕ variac			1 no
4.	Choke coil			1 no
5.	Rheostat			1 no

Theory:

Procedure:

1. Connections are made as per the circuit diagram.
2. Initially variac is kept at minimum position or zero output voltage position and Close the DPST switch.
3. Vary the variac to apply the rated voltage of 230 volts, note down the readings of ammeter and 3 Voltmeters.
4. Adjust the inductive load to particular load current (1A or 2A).
5. Note down the Readings of Ammeter and 3 Voltmeter.
6. Reduce the supply voltage in steps by varying the variac.
7. At each step note down the readings of ammeter and 3voltmeterS then tabulate the Readings in tabular column
8. Reduce the supply voltage to zero by bringing the variac to zero output voltage Position and Open the DPST main switch.

TABULARCOLUM:

Sl.no.	I (Amp)	V_1 (Volt)	V_2 (Volt)	V_3 (Volt)	$P = \frac{(V_1-V_2-V_3)}{2r}$	Cos ϕ	r (ohms)	L (mh)

Calculations:

$V_1=v_2+v_3-2v_2v_3 \cos \phi$

From the phasor diagram

$\cos \phi = \frac{v_1-v_2-v_3}{2v_2v_3}$

Power in the coil=P=V_3I Cos ϕ

Power loss in the choke coil = I r

V_3ICOSØ = I r

Choke coil resistance = r = V_3/I (Cos ϕ)

Impedance of the coil = Z = V_3/I

But z = r+XL

Coil reactance X_L = Z-r

Coil inductance = L = X_L/2f (H

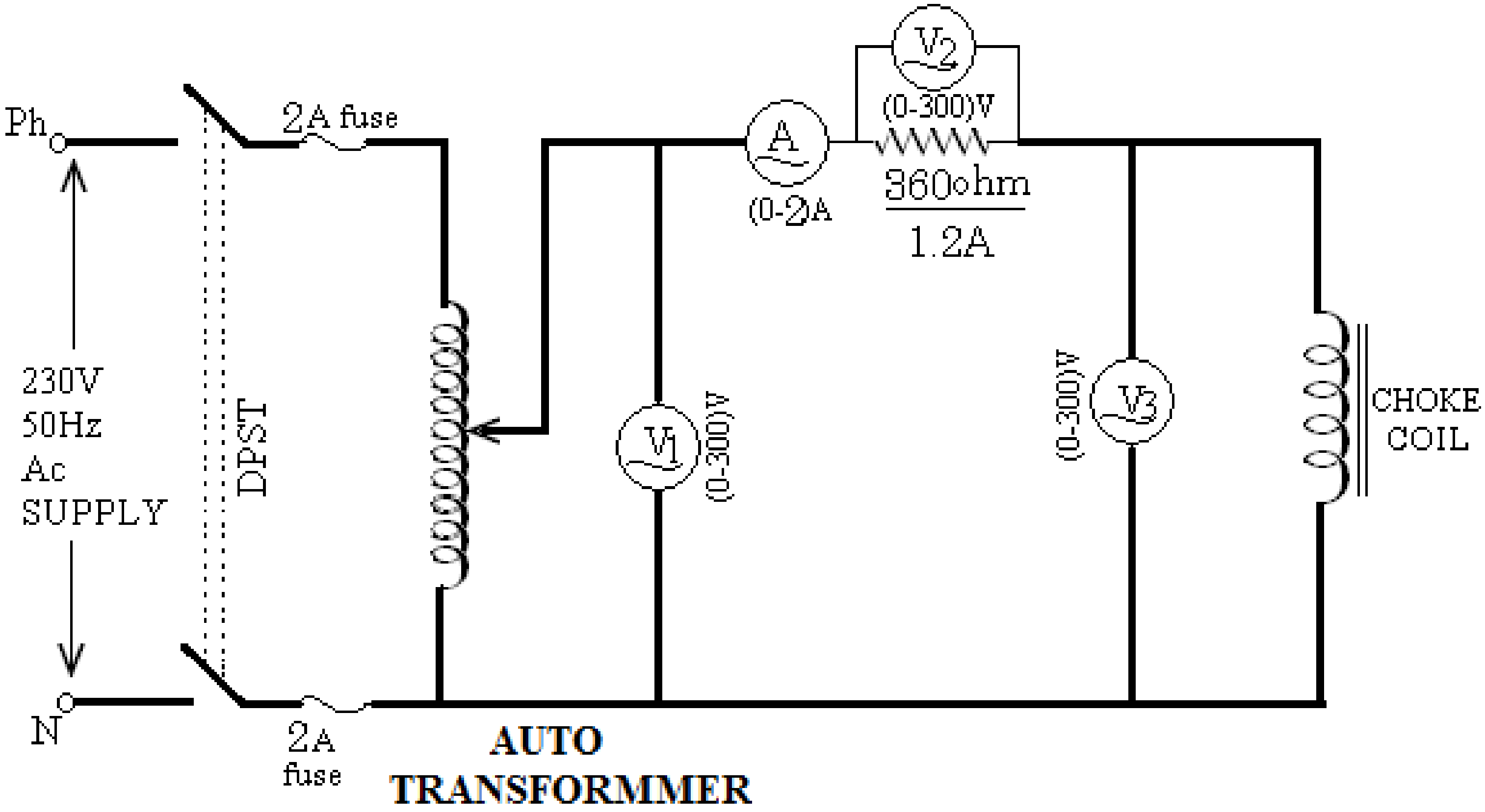
Precations:

1. Initaially set the variac to minimum position
2. Vary the variac such that the current and voltage are within the rated values.

Result:

TITLE: MEASUREMENT OF PARAMETERS OF A CHOKE COIL USING THREE VOLTMETER METHOD

CIRCUIT DIAGRAM



CALIBRATION OF SINGLE PHASE DYNAMO TYPE POWER FACTOR METER

Aim: To calibrate the given single phase dynamo type power factor meter

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	Voltmeter	M.I		1 no
2.	Ammeter	M.I		1 no
3.	Wattmeter	Dynamometer LPF		1 no
4.	Power factor meter			1 no
5.	1- ϕ variac			1 no
6.	3- ϕ phase shifting TF			1 no
7.	Rheostat			1 no

Theory:

Procedure:

1. Connections are made as per the circuit diagram.
2. Initially variac is kept at minimum position or zero out put voltage position.
3. Vary the variac gradually to obtain suitable load current (2A or 3A).
4. Close the TPST switch and adjust the pointer of phase shifting Transformer until the standard wattmeter reads zero.
5. Change the position of phase shifting transformer in steps and note down the readings of all instruments in each step.
6. Open the TPST switch and bring back the variac to minimum position and open the DPST switch.

Observation table:

Sl.no	V_{ph} (Volt)	I_l (Amp)	W_s (Watt)	Indicating power factor = Cos ϕ	Actual power factor = (W_s / V_{ph}* Il)	% error= $\frac{(I_{pf} - A_{pf})}{I_{pf}}$

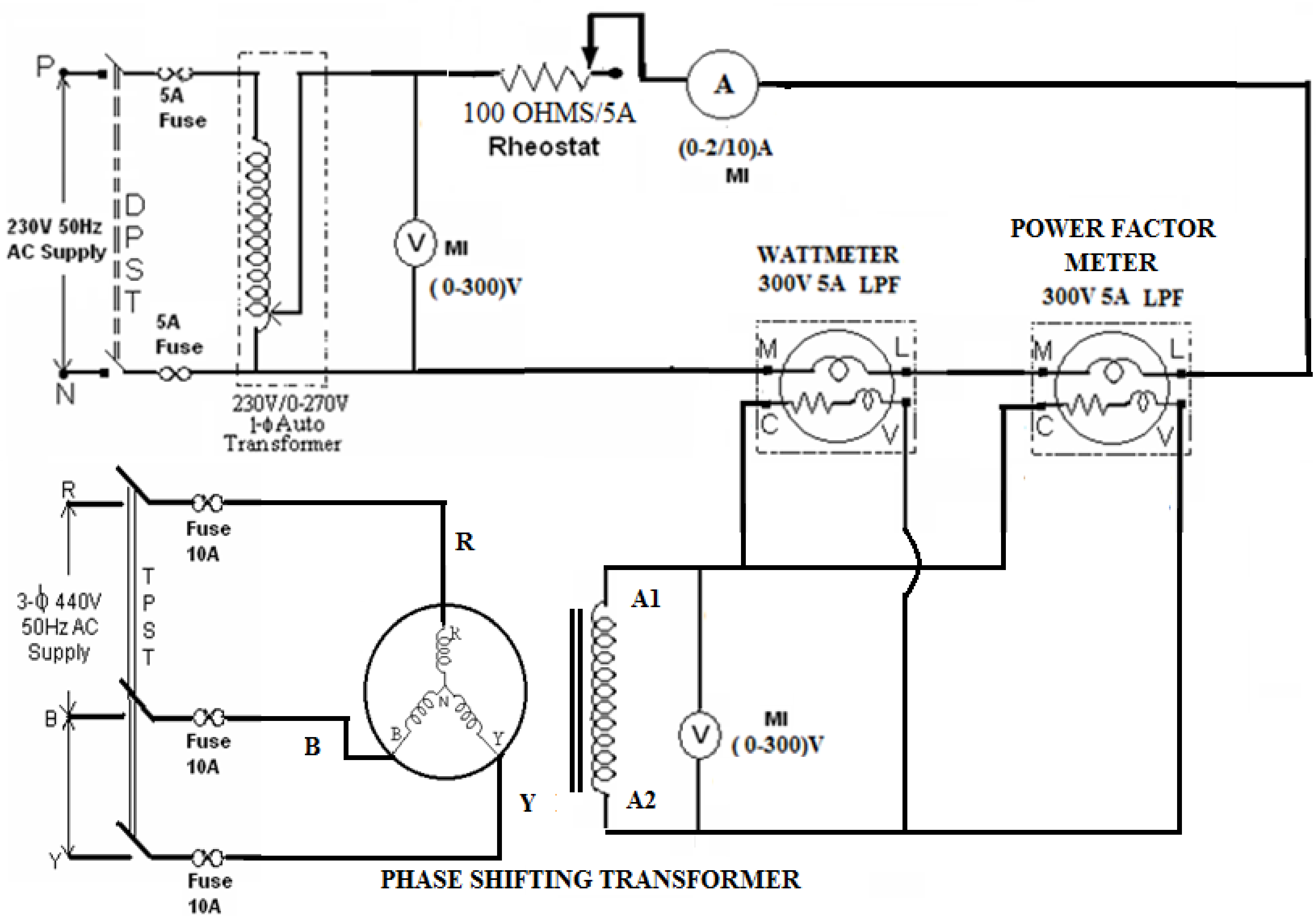
Graph: % Error (vs) Power factor

Precations:

1. There should not be any loose connections.
2. Meter readings should not exceed their ratings.

Result:

TITLE: CALIBRATION OF SINGLE PHASE DYNAMO TYPE POWER FACTOR METER
CIRCUIT DIAGRAM



MEASUREMENT OF THREE PHASE REACTIVE POWER

Aim: Measurement of three phase reactive power

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	Voltmeter	M.I.		1 no
2.	Ammeter	M.I.		1 no
3.	UPF wattmeter			2 no
4.	LPF wattmeter			1 no
5.	3- ϕ Variac			1 no
6.	3 - Inductive load			1 no

Theory:

Procedure:

1. Connections are made as per the circuit diagram.
2. Set 3- ϕ variac to zero output voltage position and inductive load is at No-load position.
3. Close the TPST switch and gradually vary the variac until the rated voltage of 415V is applied.
4. Note down all the meter readings on no-load position.
5. Apply the load in steps by varying the three phase inductive load up to the rated current. In each step, note down the readings of all instruments and tabulate the readings.
6. Reduce the supply voltage gradually to zero by bringing the 3- ϕ Variac to zero output voltage position. Open the TPST switch.

Observation table:

Sl.no.	I (Amp)	V (Volt)	W_r (Watt)	W_1 (Watt)	W_2 (Watt)	Calculated W_r (Watt)	Cos ϕ	% error $\frac{W_r - W_a}{W_r}$

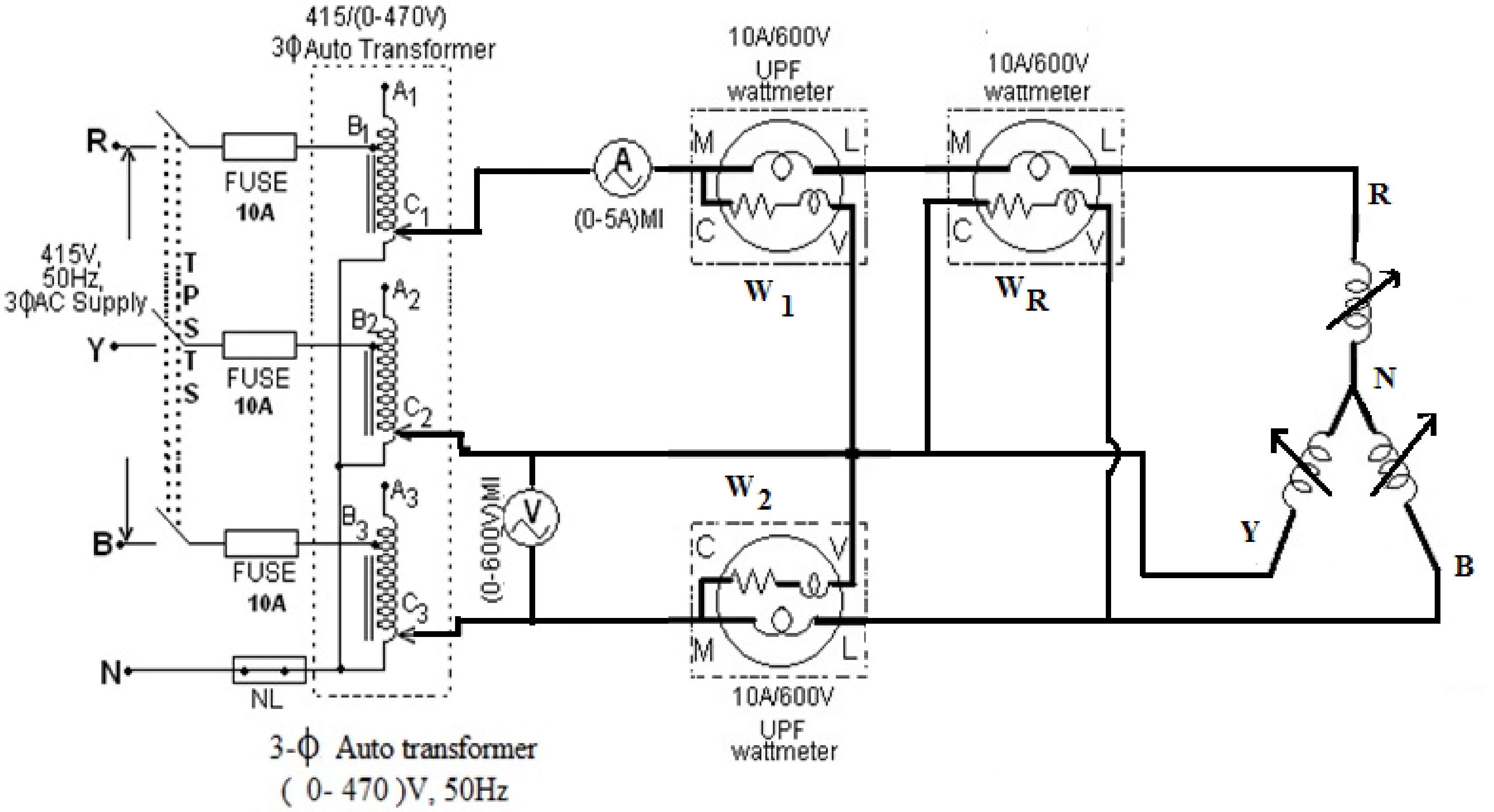
Graph: Load current (vs) %Error

Precations:

1. Initially keep the three phase variac in zero out put voltage position.
2. Don’t touch the line conductors of watt meters, voltmeters and ammeters terminals when working on it.

Result:

TILTE: MEASUREMENT OF THREE PHASE REACTIVE POWER
CIRCUIT DIAGRAM



CALIBRATION OF LPF WATTMETER BY PHANTOM LOADING

Aim: Calibration of LPF wattmeter by phantom loading method.

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	Voltmeter	M.I		1 no
2.	Ammeter	M.I		1 no
3.	Wattmeter			1 no
4.	1- ϕ variac			1 no
5.	Rheostat			1 no

Theory:

Procedure:

1. Connections are made as per the circuit diagram.
2. Initially both variac's 1 & 2 are set in minimum position and rheostat in maximum position. Close the DPST switch-2.
3. Vary the variac-2 gradually to apply the rated voltage (230V).
4. Vary the variac-1 to apply the suitable current of 1A or 2A as indicated by Ammeter.
5. Note down the readings of all the instruments.
6. Vary the rheostat gradually in steps for different values of currents (up to 4 Amp) as indicated by ammeter.
7. Bring the rheostat to maximum position; variac-1 and variac-2 to minimum position. Open the DPST switches.

Observation table:

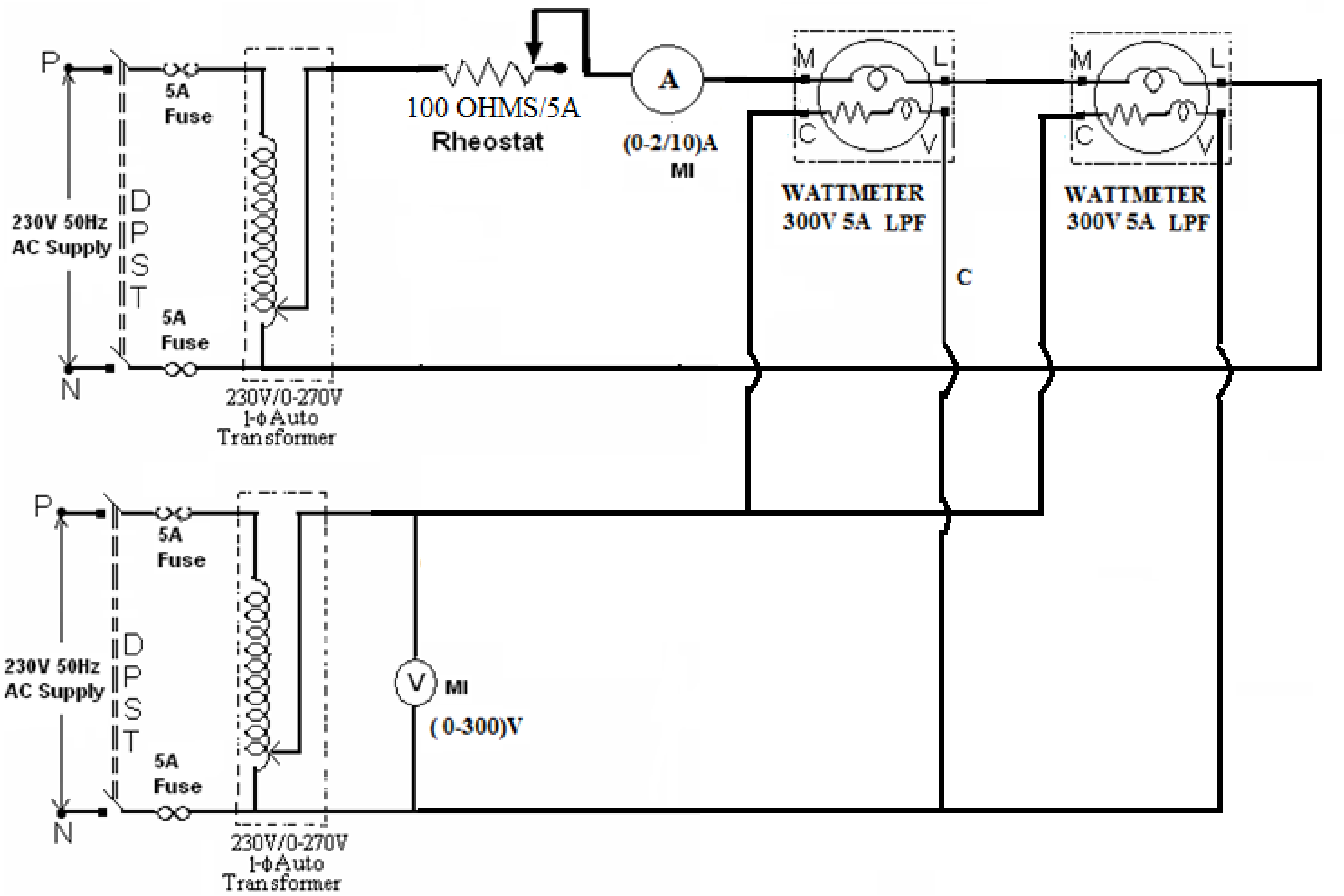
Sl.no.	Voltmeter reading (volts)	Ammeter reading (amps)	W_s (watts)	W_x (watts)	% Error = $\frac{(W_s-W_x)*100}{W_s}$

Graph: Load current (vs) % Error

Result:

TITLE: CALIBRATION OF LPF WATTMEETER BY PHANTOM LOADING

CIRCUIT DIAGRAM



MEASUREMENT OF THREE-PHASE POWER BY USING 2CT'S METHOD

Aim: To measure the three phase power by using aWatt meter and 2 **CT'S.**

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	Watt meter	LPF		1 no
2.	CT's			2 no
3.	Voltmeter	M.I		1 no
4.	Ammeter	M.I.		1 no
5.	3- ϕ Variac			1 no
6.	3- ϕ variable inductive load			1 no

Theory:

Procedure:

1. Make the connections as per the circuit diagram.
2. Keep the 3- ϕ variac in minimum position and close the TPST Switch.
3. Vary the 3- ϕ variac gradually and apply the rated voltage (415V).
4. Note down all the meter readings at no-load position and tabulate them.
5. Vary the inductive load in steps up to the rated CT'S current and tabulate the meter readings in each step.
6. Reduce the load to zero position; reduce the voltage to zero gradually by varying the 3- ϕ variac and open the TPST switch.

Observation table:

Sl.no.	I_l (Amp)	V_l (Volt)	V_l / I_l (Ohm)	Wattmeter reading	Power loss in the load (Watt)	% Error

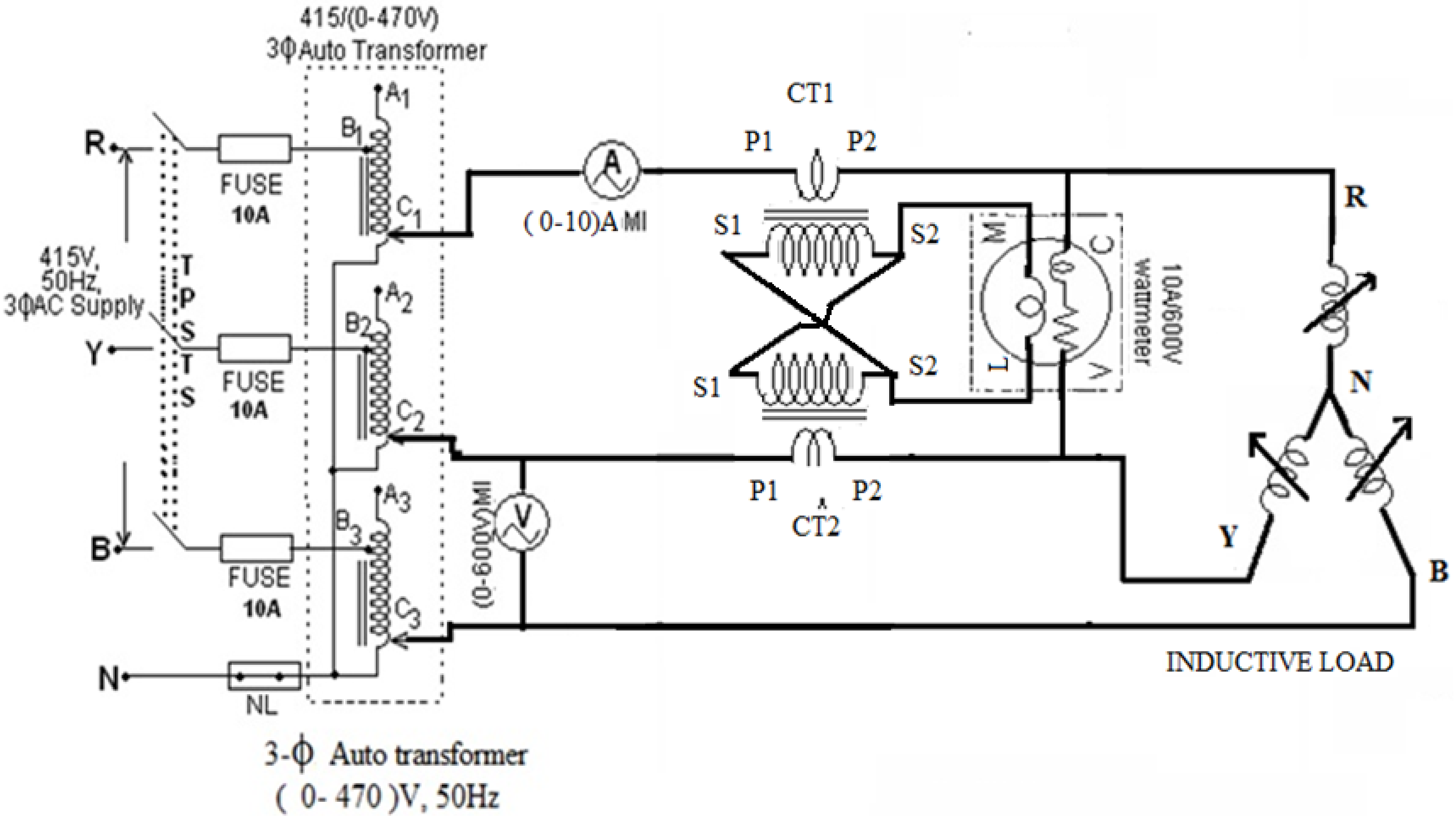
Precations:

1. Avoid loose connections so that the readings will be absolute.
2. The secondary of CT's should not be open.

Result:

TITLE: MEASUREMENT OF THREE PHASE POWER BY USING 2 CT'S METHOD

CIRCUIT DIAGRAM



SILSBEE'S METHOD OF TESTING CURRENT TRANSFORMERS

Aim: Testing of given CT using Silsbee's method.

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	Precision CT			1 no
2.	Commercial CT			1 no
3.	LPF wattmeter			1 no
4.	UPF wattmeter			2 no
5.	Voltmeter			1 no
6.	Ammeter			3 no
7.	Ammeter			1 no
8.	Phase-shifting transformer			1 no
9.	Rheostat			1 no
10.	Loading rheostat			1 no

THEORY:

Procedure:

1. Make the connections as per the circuit diagram.
2. Keep the single phase variac in minimum position and close the DPST Switch.
3. Apply the load up to 10A at the primary side of CT'S**.**
4. Vary the Burden Rheostat in the secondary circuit of test CT **a**nd adjust the reading of Ammeter (I_{sx}) to 0.5Amps.
5. Close the TPST Switch and adjust the phase shifting transformer till the W_s reading is zero.
6. Note down the readings of all the instruments.
7. Now adjust the phase shifting transformer till W_s reads maximum.
8. Note down the readings of all the instruments.
9. Repeat the above procedure in steps 4 to 8 for different values of burden.
10. Switch OFF the three-phase supply. Remove the load in the primary circuit of CT's in steps and open DPST.

Observation table:

Sl.no.	V_{ph} (Volt)	I_{ph} (Amp)	I_{ss} (Amp)	I_{sx} (Amp)	I_d (Amp)	W_s (Watt)	Wd_1 (Watt)	Wd_2 (Watt)	% error	phase angle error

Formula used:

Nominal ratio of standard CT = 2
Ratio error of standard CT = 0.2%
Phase angle error of standard CT = 5

Actual ratio of standard CT = $\frac{5}{1+0002}$ = 4.99002.

Actual ratio of CT under test Rx= $\frac{W01}{Rs\quad 1+VIss}$

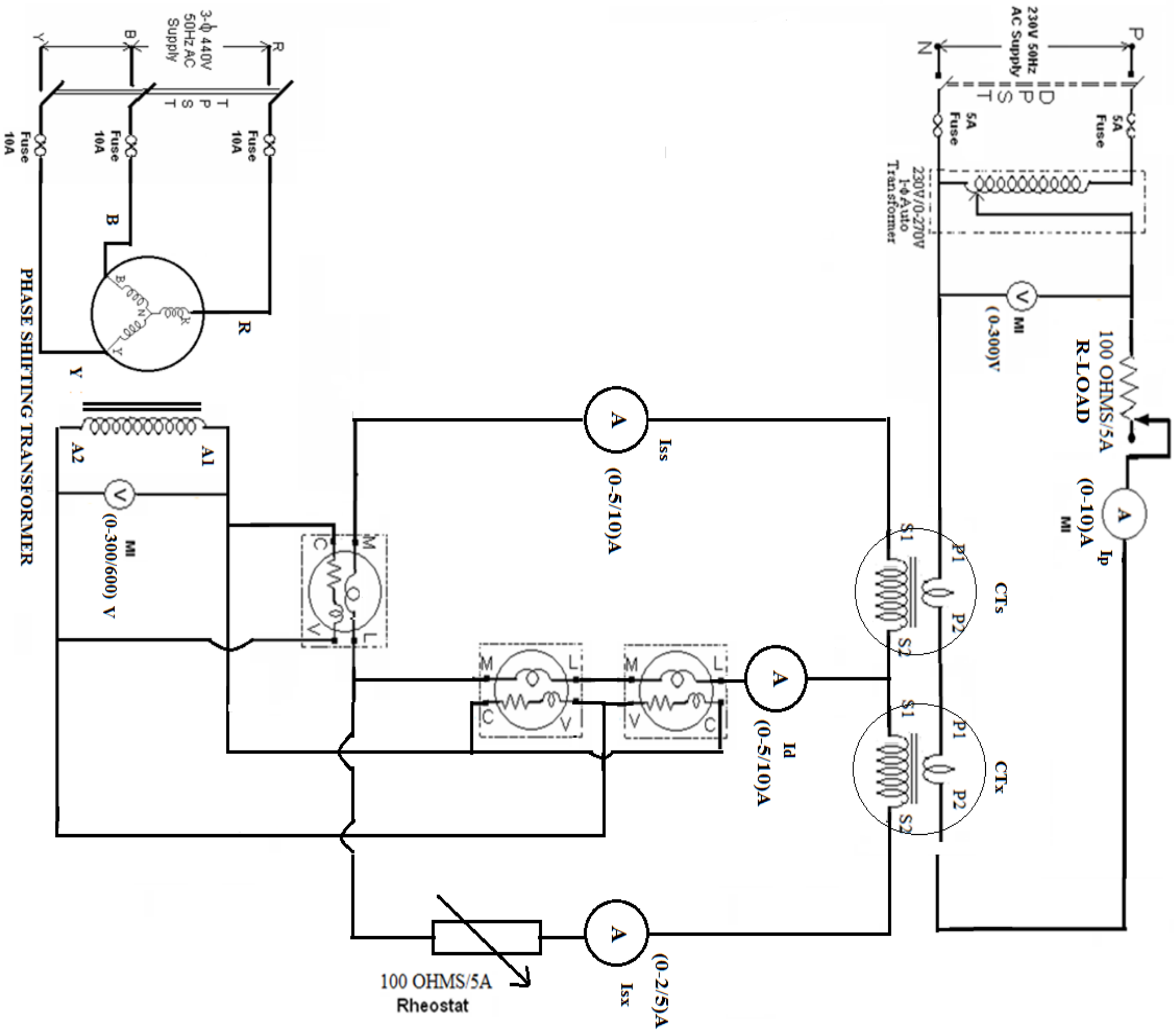
% ratio error = $\frac{Rs-R}{Rx}$

Phase angle error for CT under test =

Result:

TITLE: SILSBEE’S METHOD OF TESTING CURRENT TRANSFORMERS

CIRCUIT DIAGRAM



CALIBRATION OF PMMC AMMETER & VOLTMETER USING CROMPTON D.C. POTENTIOMETER

Aim : To calibrate PMMC Ammeter and voltmeter using Crompton DC potentiometer.

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	DC potentiometer			1no.
2.	Standard cell			1no.
3.	Volt ratio box			1no.
4.	Sensitive galvanometer			1no.
5.	Regulated power supply			1no.
6.	Ammeter	M.C		1no.
7.	Voltmeter	M.C		1no.
8.	Rheostat			1no.

Theory:

Procedure:

1. Connections are made as per the circuit diagram.
2. Keep the function knob of potentiometer to **STD** position. Switch **ON** the **RPS (1)** and adjust to 2volt.
3. Adjust the slide contact and slide wire of the potentiometer to read Standard cell voltage **(1.08v).**
4. Press the galvano key on potentiometer and adjust the coarse and fine of rheostat until the spot reflecting galvanometer gives null deflection. This completes standardization of the potentiometer.
5. Change the function knob to E1 position. Switch **ON RPS (2)** and adjust a suitable voltage.
6. Press the galvano key on the potentiometer and adjust the slide contact and slide wire until the spot reflecting galvanometer gives null deflection.
7. Note down the readings of voltmeter, and potentiometer slide contact and Slide wire readings.
8. Repeat the steps 6 to 7 times for different voltages from **RPS (2).**

Observation table:

Sl.no.	V_{act} (Volt)	Coarse voltage (Volt)	Fine voltage (Volt)	V_{true} (Volt)	% error= $\frac{(V_{act} - V_{true})}{V_{act}}$

Precautions:

1. RPS (1) must be at 2volts only.
2. Smoothly vary the knobs on the potentiometer.
3. Keep the spot reflecting galvanometer switch to AC mains position and rotating key to free position during the conduction of experiment.
4. At the end of the experiment, remove the supply to the galvanometer and move the rotating key to lock position and short the galvanometer output terminals.

Calculation :

Calibration of voltmeter:

V_{act} = Voltmeter reading.

V_{true} = Reading obtained from potentiometer.

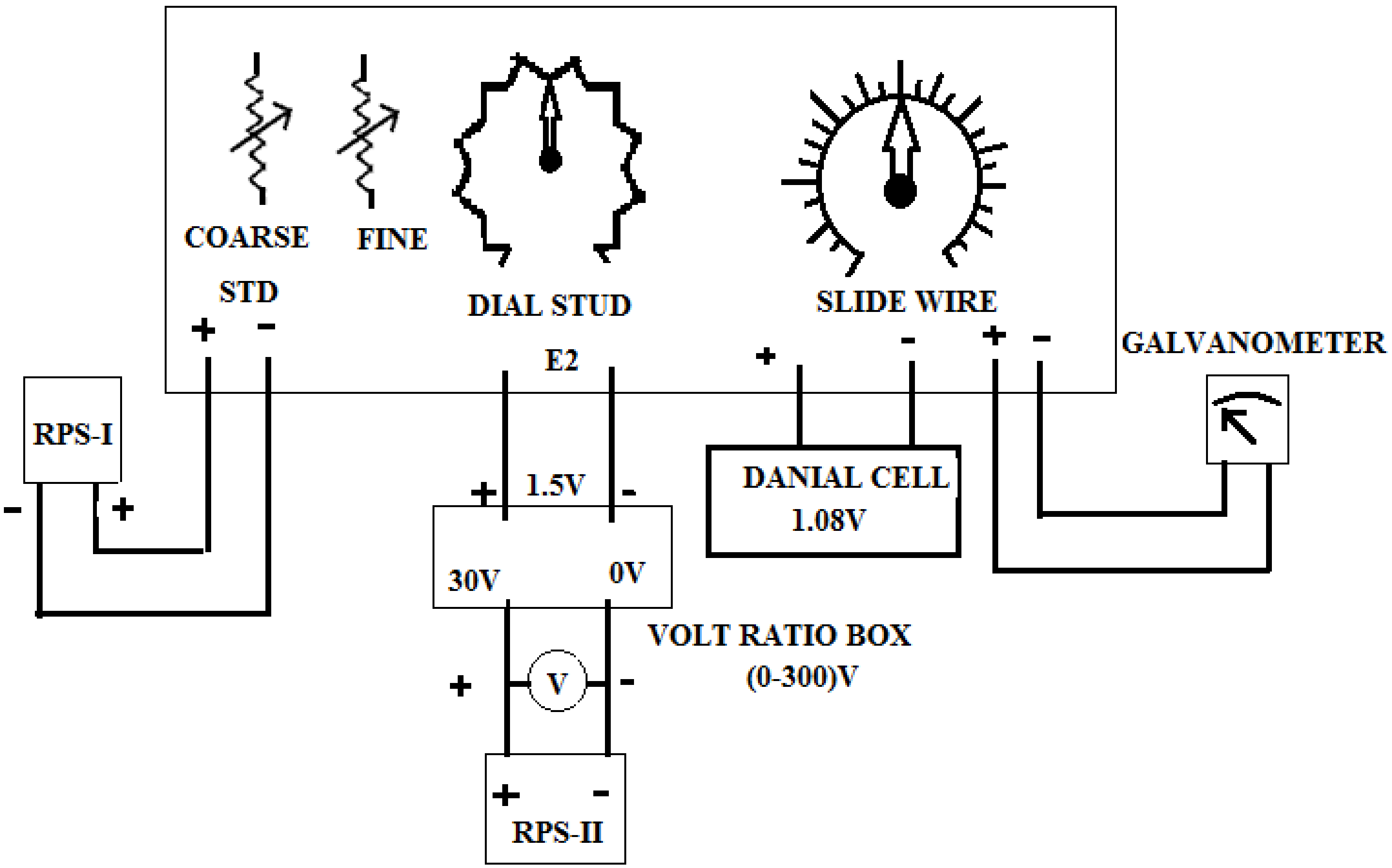
= (Coarse voltage + Fine voltage)* V – R Box

$$\% \text{ Error} = \frac{V_{act} - V_{true}}{V_{true}} * 100$$

Result:

TITLE: CALIBRATION OF PMMC AMMETER & VOLTMETER USING CROMPTON D.C. POTENTIOMETER

CIRCUIT DIAGRAM



CALIBRATION OF PMMC AMMETER & VOLTMETER USING CROMPTON D.C. POTENTIOMETER

Aim: To calibrate **PMMC** Ammeter and voltmeter using **DC** Potentiometer.

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	DC potentiometer			1 no.
2.	Standard cell			1 no.
3.	Volt ratio box			1 no.
4.	Sensitive galvanometer			1 no.
5.	Regulated power supply			1 no.
6.	Ammeter	M.C		1 no.
7.	Voltmeter	M.C		1 no.
8.	Rheostat			1 no.

Theory:

Procedure:

1. Connections are made as per the circuit diagram.
2. Keep the function knob of potentiometer to STD position. Switch ON the RPS (1) and adjust to **2** volt.
3. Adjust the slide contact and slide wire of the potentiometer to read standard cell voltage (1.08v).
4. Press the galvano key on potentiometer and adjust the coarse and fine rheostat until the spot reflecting galvanometer gives null deflection. This completes standardization of the potentiometer.
5. Change the function knob to E1 position. Switch ON RPS (2**)** and adjust to 30 volts.
6. Press the galvano key on the potentiometer and adjust the slide contact and slide wire until the spot reflecting galvanometer gives null deflection.
7. Note down the readings of voltmeter, and potentiometer slide contact and slide wire readings.
8. By varying the rheostat change the current range and do the above procedure, than note down the readings.
9. Repeat the steps 6 to 7 times for different voltages from RPS (2)

Observation table:

Sl.no.	I_{act} (Amp)	Coarse voltage (Volt)	Fine voltage (Volt)	I_{true} (Amp)	% error= $\frac{(I_{act} - I_{true})}{I_{act}}$

Precautions:

1. RPS (1) must be at 2volts only.
2. Smoothly vary the knobs on the potentiometer.
3. Keep the spot reflecting galvanometer switch to AC mains position and rotating key to free position during the conduction of experiment.
4. At the end of the experiment, remove the supply to the galvanometer and move the rotating key to lock position and short the galvanometer output terminals.

Calculations:

Calibration of voltmeter:

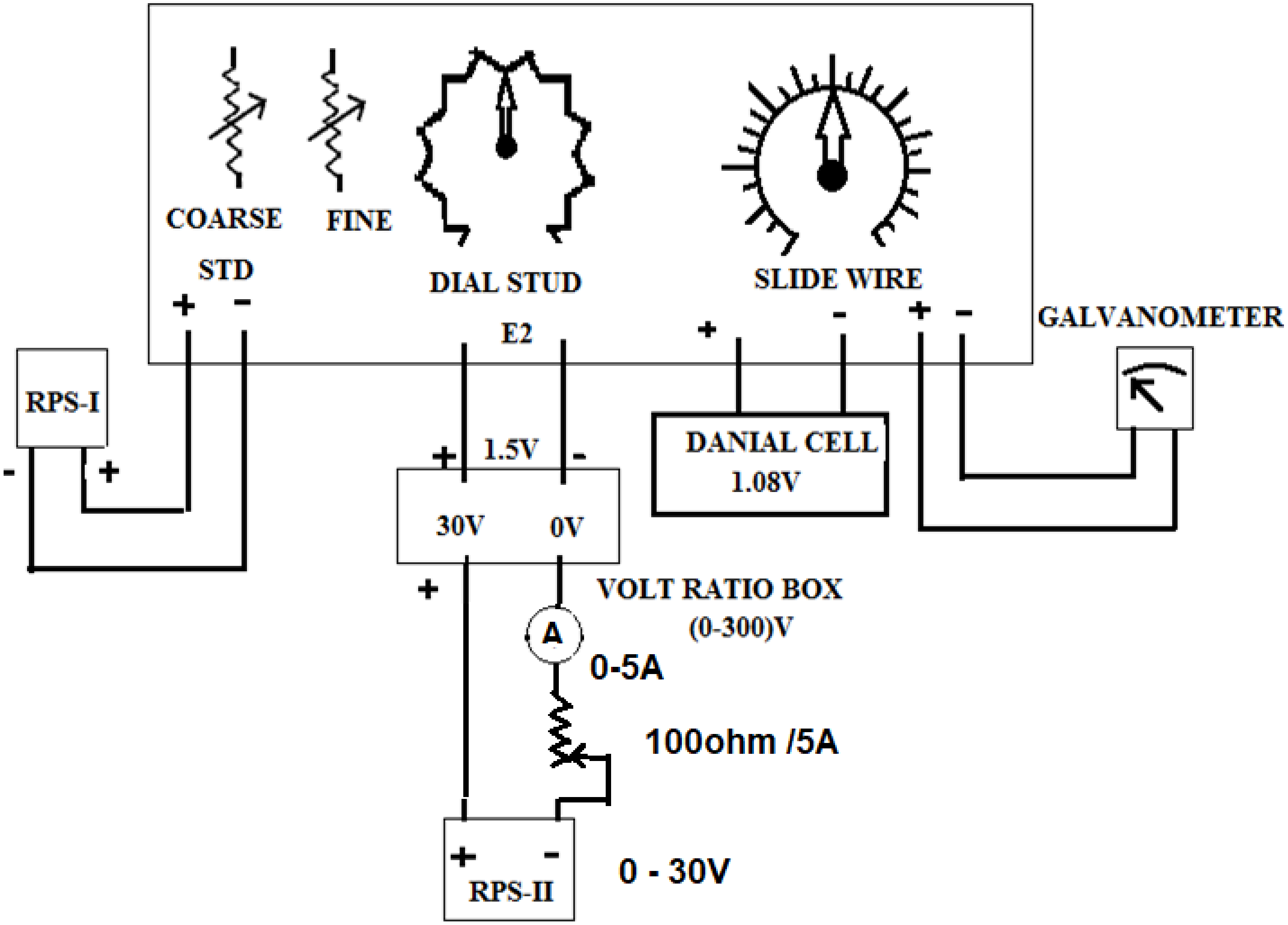
I_{act} = Ammeter reading.
I_{true} = Reading obtained from potentiometer.

$$\frac{(\text{Coarse voltage} + \text{Fine voltage}) * \text{V} - \text{R Box}}{\text{Standard resistance}}$$

Result:

TITLE: CALIBRATION OF PMMC AMMETER & VOLTMETER USING CROMPTON D.C. POTENTIOMETER

CIRCUIT DIAGRAM



MEASUREMENT OF STRAIN USING STRAIN GAUGE

Aim: Resistance strain gauge-strain measurements and calibration.

Apparatus required:

S.no.	Name of the component	Type	Range	Quantity
1.	Strain measuring setup			1no.
2.	Cantilever beam			1no.
3.	Weight – 100gm			10nos.
4.	Digital multimeter			1no.

Theory:

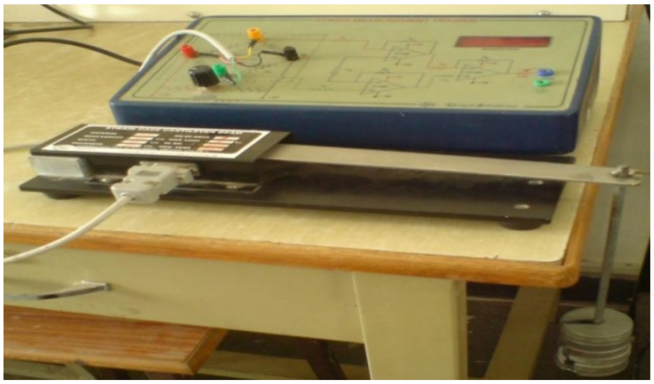
Specifications:

DISPLAY RANGE : 31/2 digit RED LED display of 200 mV FSD to read upto +/- 1999 microstrain .
GAUGE FACTOR SETTING : 2.1
BALANCE : Potentiometer to set zero on the panel.
BRIDGE EXCITATION : 10V DC
BRIDGE CONFIGURATIONS: Full bridge.
MAX. LOAD : 1Kg.
POWER : 230 V +/- 10% at 50Hz. with perfect grounding.
All specifications nominal or typical at 230 C unless noted.

Cantilever beam specification:

MATERIAL : Stainless Steel
BEAM THICKNESS (t) : 0.25 Cm.
BEAM WIDTH (b) : 2.8 Cms.
BEAM LENGTH (Actual) : 22 Cms.
YOUNGS MODULUS (e) : 2 X 106 Kg / cm2.
STRAIN GAUGE : Foil type gauge
GAUGE LENGTH (l) : 5 mm
GAUGE RESISTANCE (R) : 300 Ohms.
GAUGE FACTOR (g) : 2.01

Trainer KIT



Procedure:

1. Connections are made as per the circuit diagram.
2. Switch **ON** the supply with no-load on Cantilever.
3. Keep the calibrate knob to maximum position and adjust the **zero** balance Knob, until the display is **zero micro strain.**
4. Load the cantilever beam with 0.1 kg and adjust the calibration knob to display **38** micro strains. Remove the load and check for **zero** display. This completes strain gauge calibration.
5. Gradually apply the load in steps of 0.1 kg and tabulate the readings of micro strain displayed on the strain measurement kit and the voltmeter readings.
6. Gradually remove the loads and switch **OFF** the supply.
7. Note down the dimensions of cantilever beam and calculate the micro strain for each load.

observation table:

Sl.no.	Load (kg)	Calculated value	Indicator reading	Voltage (mv)	% Error =

Specimen calculation for cantilever beam

$$\boxed{S = (6PL)/BT^2E}$$

P = Load applied in Kg. (1 Kg)
L = Effective length of the beam in Cms. (22 Cms)
B = Width of the beam (2.8 Cms)
T = Thickness of the beam (0.25Cm)
E = Youngs modulus (2×10^6)
S = Microstrain

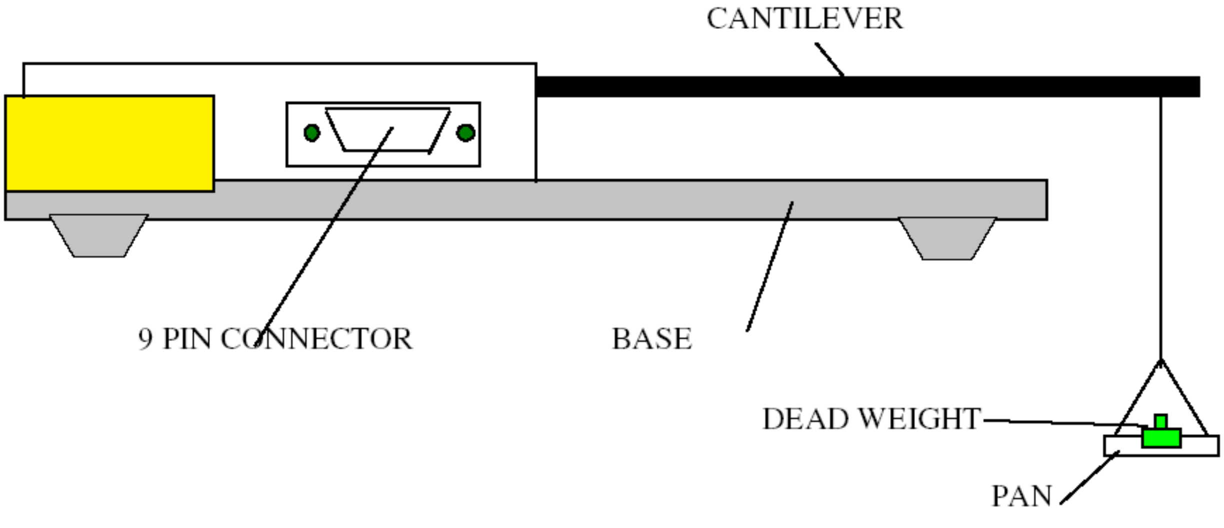
Then the microstrain for the above can be calculated as fallows

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

$$S = 3.77 \times 10^{-4}$$

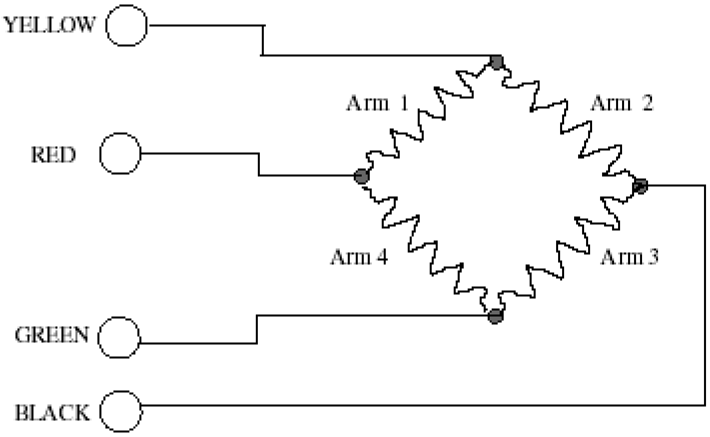
S = 377 microstrain.

CANTILEVER BEAM SETUP



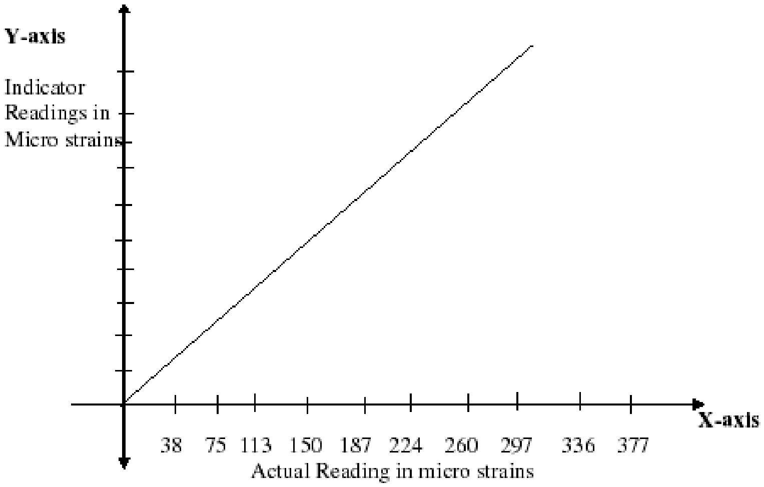
Physical dimensions:

Over all BEAM Length (X) : 300 mm
Actual Length (L) : 220.0 mm (Middle of the Strain Gauge Grid to loading point)
Width of the Beam (b) : 28.0 mm
Thickness of the Beam (t) : 2.5 mm

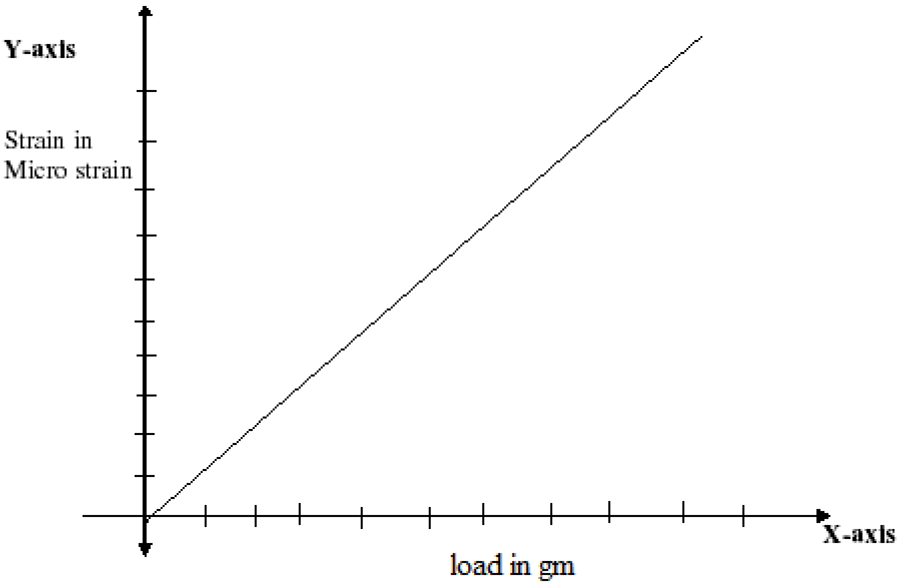


Graph: Load (Vs) Display micro strain.

Graph : Graph Plotted Actual Readings (X-axis) Vs Indicator Readings (Y-axis)



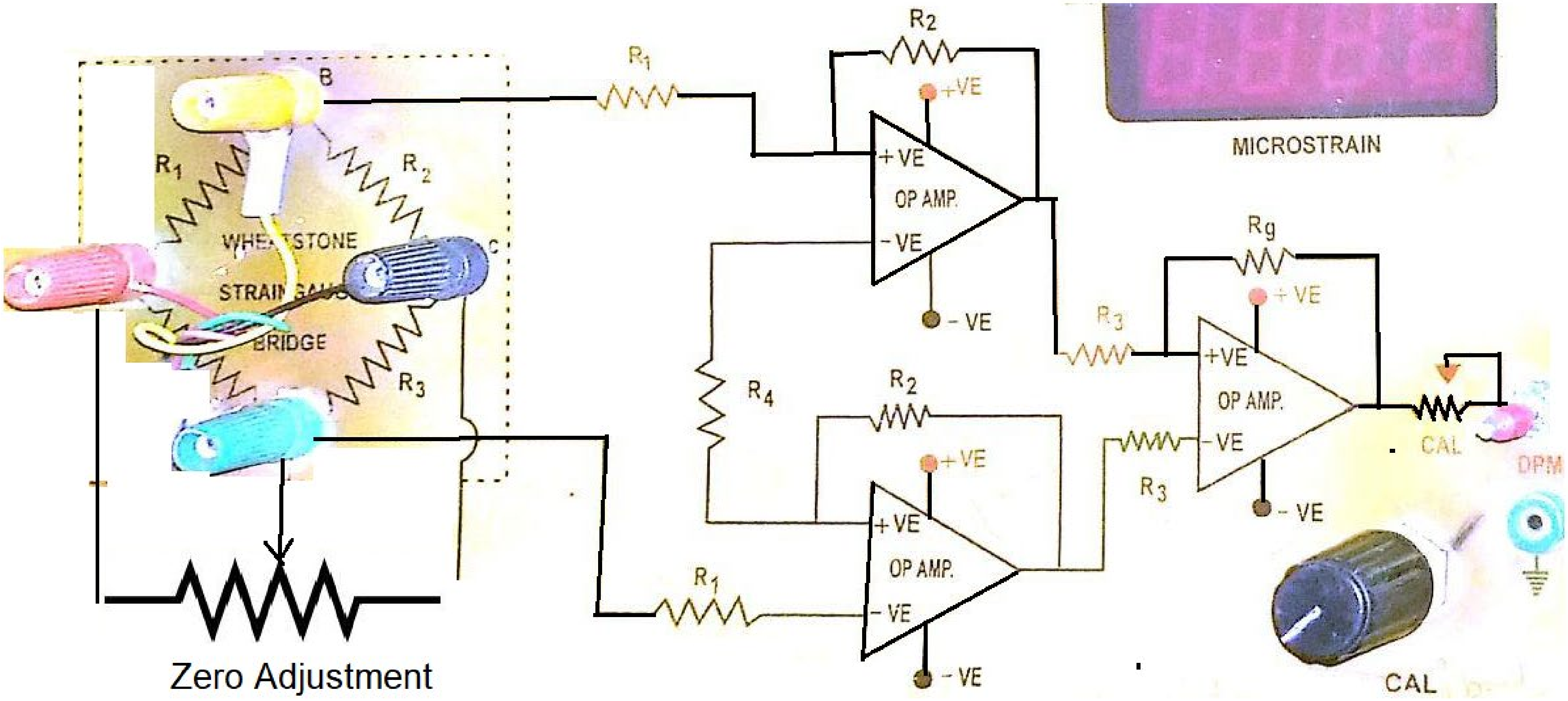
Load Vs Strain



Result:

TITLE: MEASUREMENT OF STRAIN USING STRAIN GAUGE

CIRCUIT DIAGRAM:



DISPLACEMENT MEASUREMENT USING LINEAR VARIABLE DIFFERENTIAL TRANSFORMER

Aim: Measurement of displacement using linear variable Differential transformer.

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	LVDT trainer kit			1no.
2.	LVDT			1no.
3.	Digital multimeter			1no.

Theory:

Specifications:

INDICATOR

* DISPLAY : 31/2 digit seven segment red LED display of range 200mV for full scale deflection. to read +/- 1999 counts.
* EXCITATION VOLTAGE : 1000 Hz at 1V
* OPERATING TEMPERATURE : +100 C to 550 C
* ZERO ADJUSTMENT : Front panel through Potentiometer.
* SENSITIVITY : 0.1mm
* SYSTEM INACCURACY : 1%
* REPEATABILITY : 1%
* CONNECTION : Through 6 core shielded cable with Din connector.
* FUSE : 250mA fast glow type.
* POWER : 230 V +/- 10 %, 50 Hz.

SENSOR

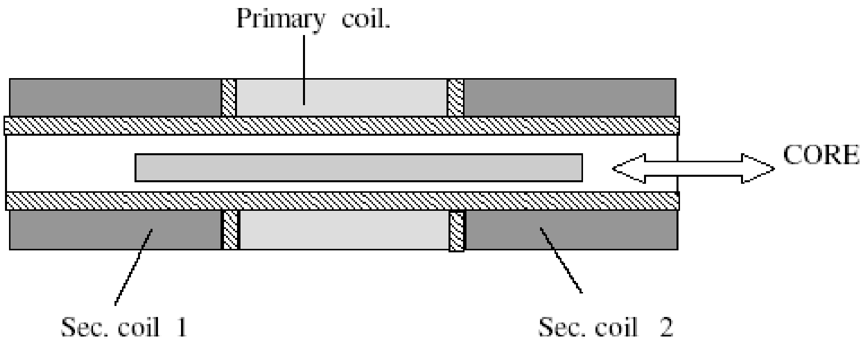
* RANGE : +/- 10.0 mm
* EXCITATION VOLTAGE : 1 to 4 kHz at 1 to 4V
* LINEARITY : 1%
* OPERATING TEMPERATURE : +100 C to 550 C
* CONNECTION : Through 6 core shielded cable provided along with the sensor of 2M length.
* CALIBRATION JIG : Micrometer of 0 to 25mm length is mounted on the base.

PANEL DETAILS

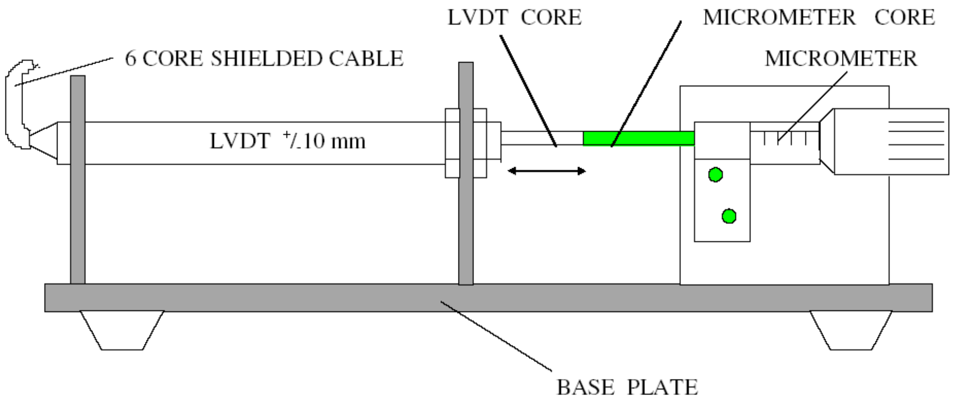
DISPLAY : 31/2 Digit LED display of 200mV FSD to read upto “+/- 1999” counts.
ZERO : Single turn potentiometer to adjust “000” when the sensor is connected.
CAL : Single turn potentiometer to adjust the calibration point.

CIRCUITRY : Block diagram of the circuit for displacement indicator. The diagram also shows LVDT block diagram also.

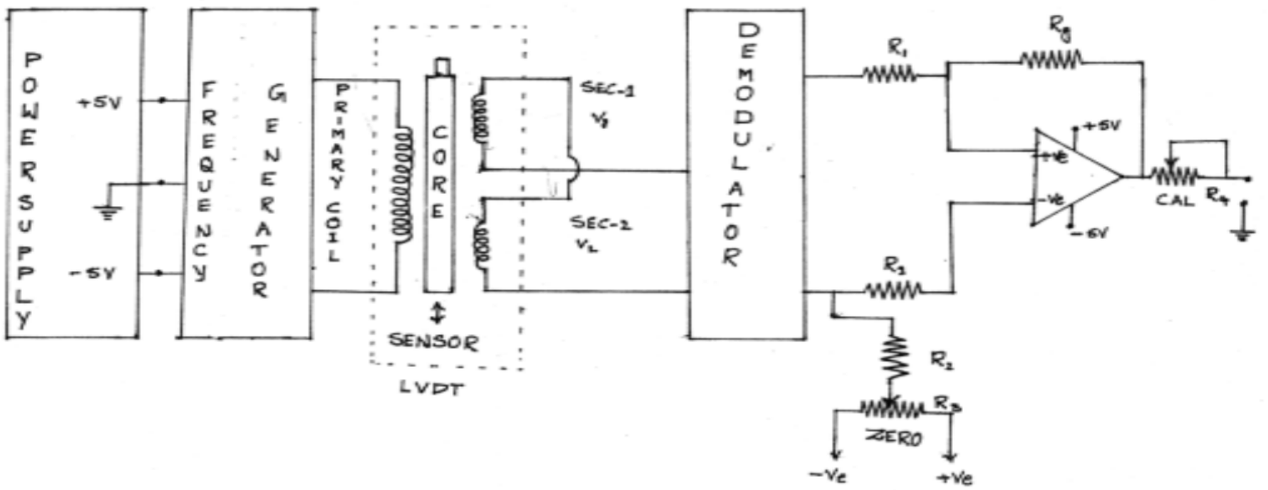
Physical set-up:



LVDT WITH CALIBRATION JIG



CIRCUIT DIAGRAM



Procedure:

1. Connect the power supply chard at rear panel to the 230v, 50HZ. Switch ON the instrument by passing down the toggle switch the display glows to indicate instrument is **ON**.
2. Allow the instrument in **ON** position for 10min. for initial warm up.
3. Rotate the micrometer till it reads **20.0**.
4. Adjust the **CAL** potentiometer at the front panel so that the display reads **10.0**.
5. Rotate the core of micro meter till the micrometer reads **10.0** and adjust the Zero potentiometer till the display read **0.0**
6. Rotate back the micrometer core up to 20.0 and adjust once again **CAL p**otentiometer till the display reads 10.0. Now the instrument is calibrated for 10mm range.
7. Rotate the core of micro meter insteps of **1mm or 2mm** and tabulate the readings of micrometer **LVDT** trainer kit display and voltmeter. The Micrometer shows the exact displacement given to **LVDT** core. The **LVDT** trainer kit display will read the displacement sensed by **LVDT**.
8. Tabulate the readings and plot the graph of actual (vs) indicated reading.

Observation table:

Sl.no.	Meter reading (m.m)	Indicator displacement using in m.m	Volts (mv)

Graph:

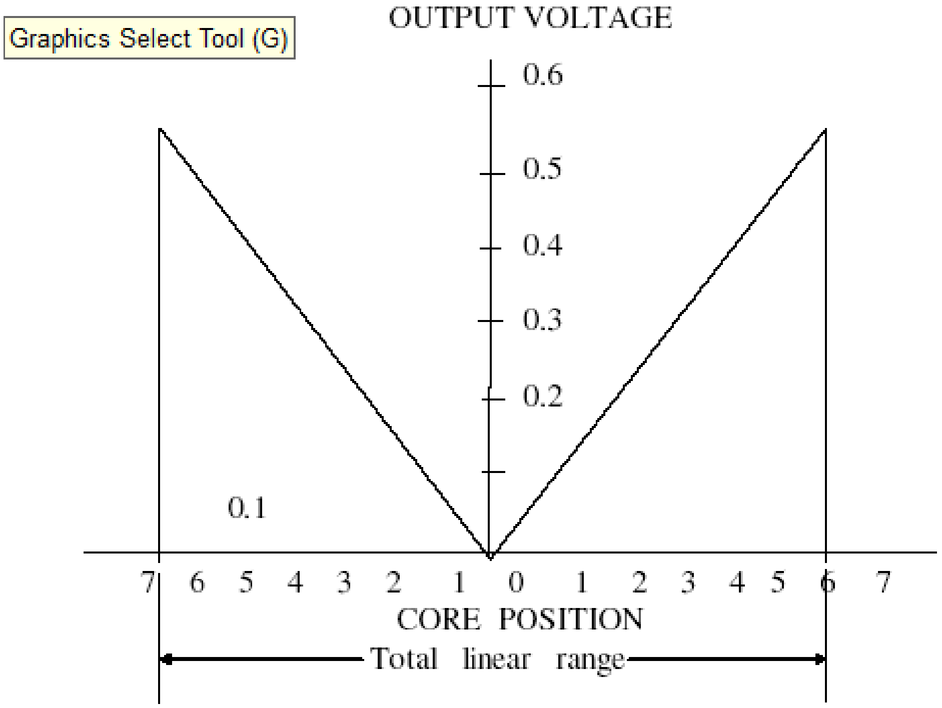
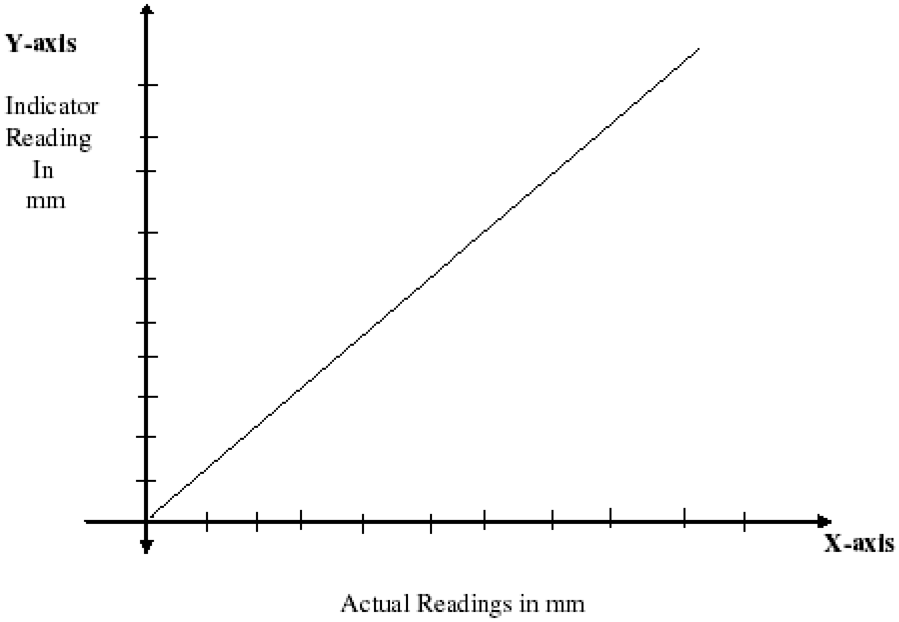


FIG. 1 Magnitude of the output Voltage as a function of LVDT core Position.

Graph:

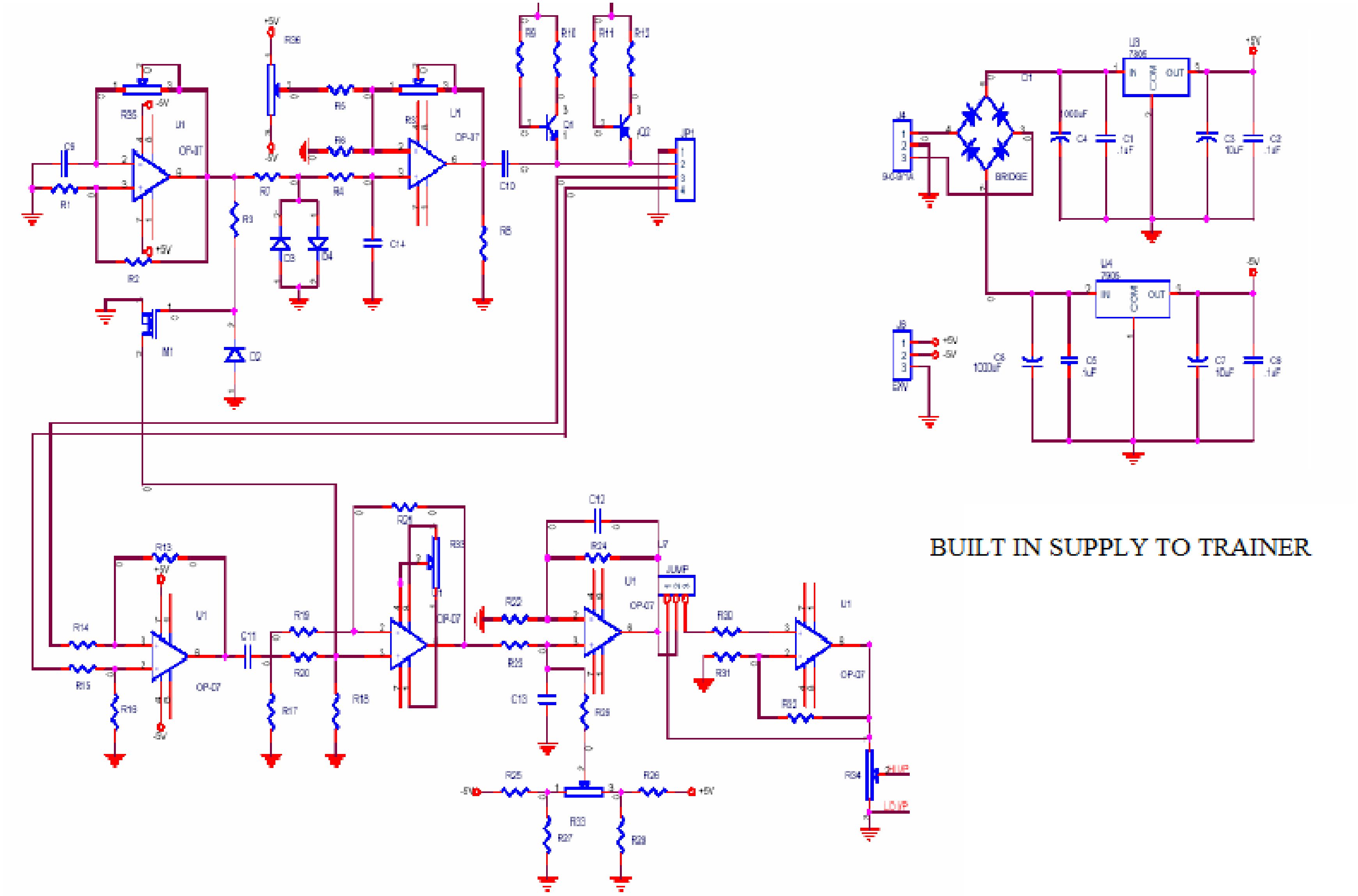
Graph Plotted Actual Micrometer Readings (X-axis) Vs Indicator Readings (Y-axis)



Result:

TITLE: DISPLACEMENT MEASUREMENT USING LINEAR VARIABLE DIFFERENTIAL TRANSFORMER

CIRCUIT DIAGRAM:



BUILT IN SUPPLY TO TRAINER

MEASUREMENT OF INDUCTANCE BY ANDERSONS BRIDGE

Aim: To find the unknown inductance of a coil (or) inductor using Anderson's Bridge.

Apparatus required:

Sl.no.	Name of the component	Type	Range	Quantity
1.	Andersons Bridge			1no.
2.	Head phone			1no.
3.	Decade inductance box			1no.

Theory:

Procedure:

1. Connections are made as per the circuit diagram with an audio oscillator.
2. Connect the unknown inductor L as shown in the circuit diagram.
3. Switch **ON** the supply and select a certain value of **C** say **0.001mF**.
4. Adjust **S** and **M** alternately till the head phones give minimum (or) no sound.
5. Note down the values of **S, M** and **C** at this balanced condition.
6. Repeat steps (4) and (5) for the same inductance by selecting different values of **C.**
7. Repeat the above step for different values of unknown inductance.

Observation table:

Sl.no.	R (Ohm)	M (Ohm)	C (mF)	S (Ohm)	L (mH)

Note:

1. The value of C is so chosen that there is sufficient adjustment available in the value of M.
2. When C is small, M will be large.
3. The bridge is useful for measuring small values of inductor such as 50, 100, 150 and 200.

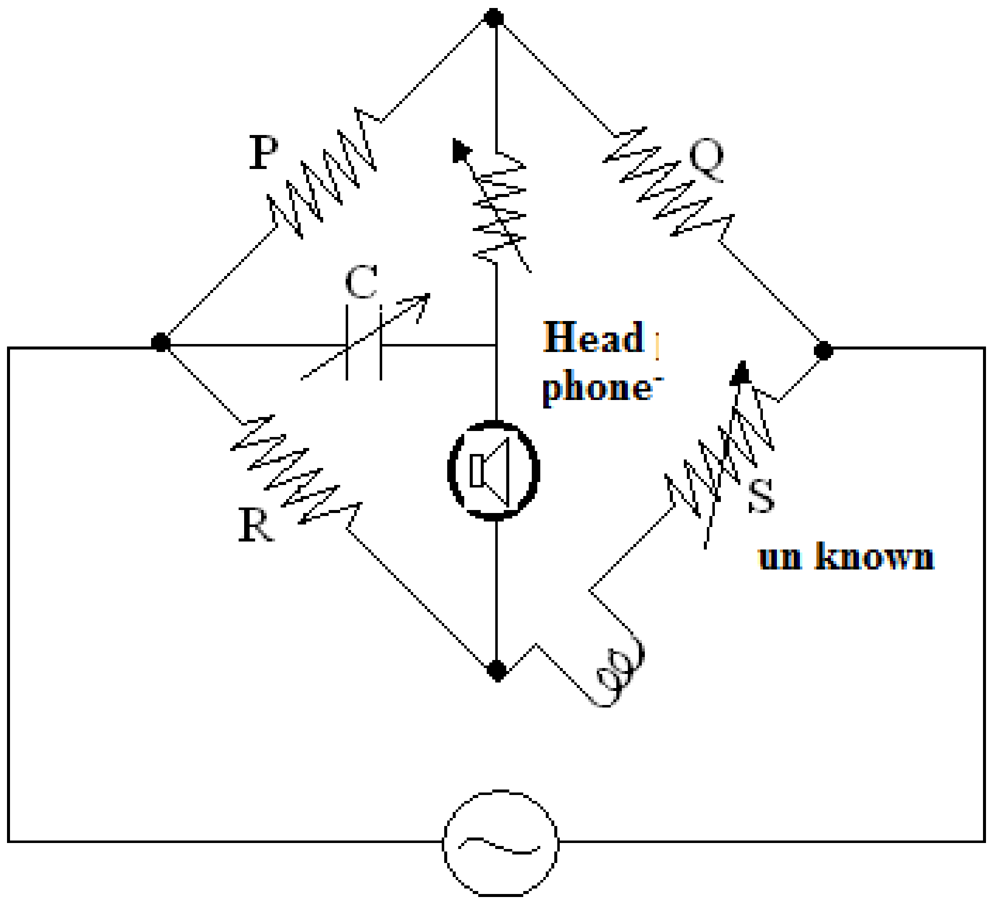
Calculations:

L Value is calculated by the given formula.

$$L = C[\, RQ + (R+S)M]$$

Result:

TITLE: MEASUREMENT OF INDUCTANCE BY USING ANDERSON'S BRIDGE
CIRCUIT DIAGRAM



Frequency Oscillator, 1KHZ

MEASUREMENT OF CAPACITANCE BY SCHERING BRIDGE

Aim: To study the Schering bridge & calculate the unknown Capacitance value.

Apparatus required:

S.no.	Name of the component	Type	Range	Quantity
1.	Schering bridge trainer kit			1no.
2.	Oscilloscope			1no.
3.	Patch wires			1no.
4.	Multimeter			1no.
5.	Unknown capacitance			1no.

Theory:

Procedure:

1. Connections are made as per the circuit diagram with **1KHZ** Oscillator.
2. Connect the unknown capacitance Cx between **A & D**.
3. Connect the input of imbalance amplifier across **C & D**.
4. Connect the output of imbalance amplifier to the input of loud speaker.
5. Switch **ON** the supply **&** vary the resistance knob **(R_1)** until the sound from loud speaker is minimum.
6. Switch **OFF** the supply and measure the Resistance **(R_1)** between **C & B** by using **DMM.**
7. Repeat the above steps for different values of **(C) &** tabulate the readings.

Observation table:

s.no.	R_1 (Ohm)	R_2 (Ohm)	C_3 (mf)	$Cx = C_2 \frac{R_4}{R_3}$	%error = $\frac{(C_3 - C_x)}{C_3}$

Formula used:

$$Cx = C_2 \frac{R_4}{R_3}$$

There Cx = Unknown Capacitor.
C_2 = Standard Capacitor of 0.1, µF.
C_4 = Variable Capacitor of 0.001 to 0.01, µF.
R_3 = 1, K ohm (Fixed)
R_4 = 1, K ohm variable resistance used for balance.

Precations:

1. Avoid loose connections.
2. Resistance should be varied very smoothly.

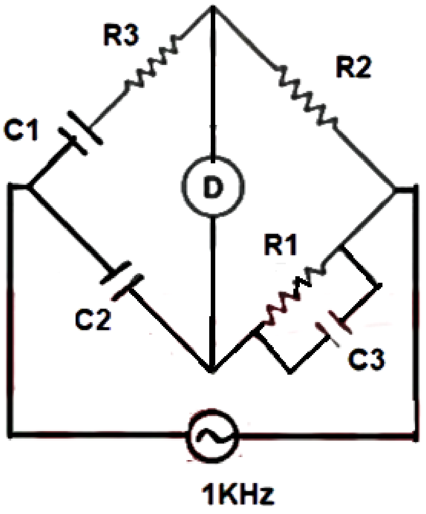
Graph:

1. Capacitance (C mF) (vs) % Error

Result:

TILTE: MEASUREMENT OF CAPACITANCE BY SCHERING BRIDGE

CIRCUIT DIAGRAM:



Experiment

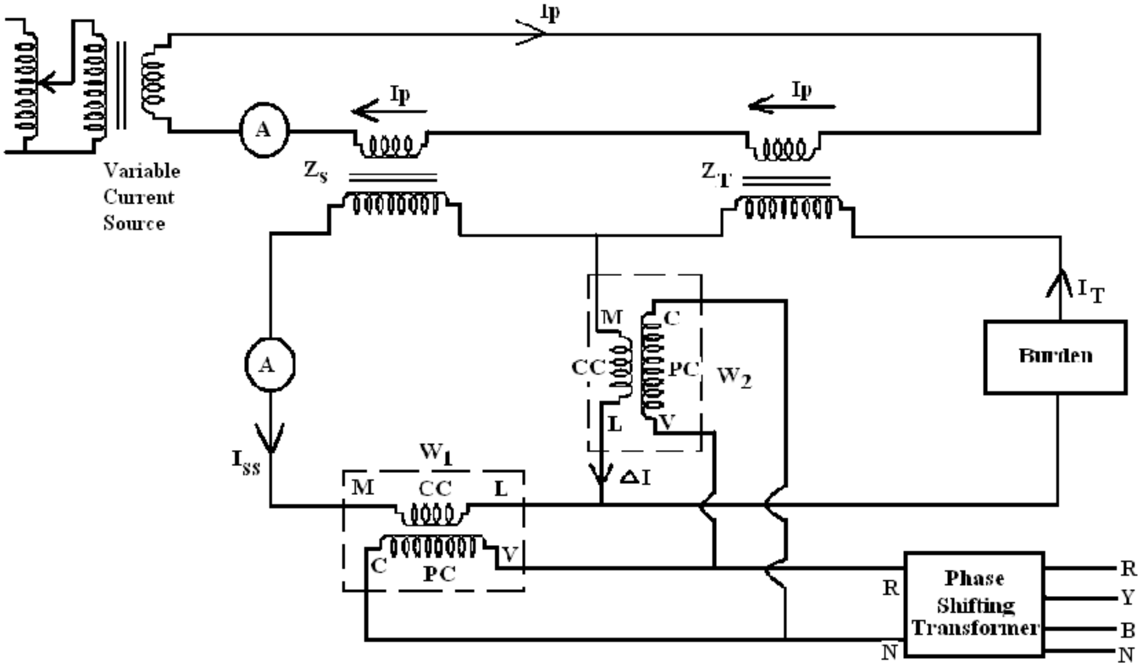
Measurement of % ratio error and phase angle of given current transformer by comparison

Aim: To obtain the ratio and phase angle errors of the given current transformer.(C.T).

Method: Silsbee's deflectional method.

Apparatus: Watt meters (2 Nos.), Standard current transformer having the same nominal ratio as the C.T. under test, Ammeter, Adjustable load (burden for the C.T. under test), Phase Shifting transformer connected to a single phase supply.

Circuit Diagram: Fig 5.1



Theory:

Silsbee's method is a comparison method. There are two types of Silsbee's methods: deflection and null. Only deflection method is described here. Here the ratio and phase angle of the test transformer X are determined, in terms of that of a standard transformer S having the same nominal ratio. The two transformers are connected with their primaries in series. An adjustable burden is put in the secondary circuit of the transformer under test.

An ammeter is included in the secondary circuit of the standard transformer so that the current may be sent to the desired value.W1 is a wattmeter whose current coil is connected to carry the secondary current of the standard transformer. The current coil of wattmeter W2 carries current ΔI which is the difference between the secondary currents of the standard and test transformer s. The voltage circuits of the wattmeter's (i.e; their pressure coils) are supplied in parallel from a phase shifting transformer at a constant voltage V.

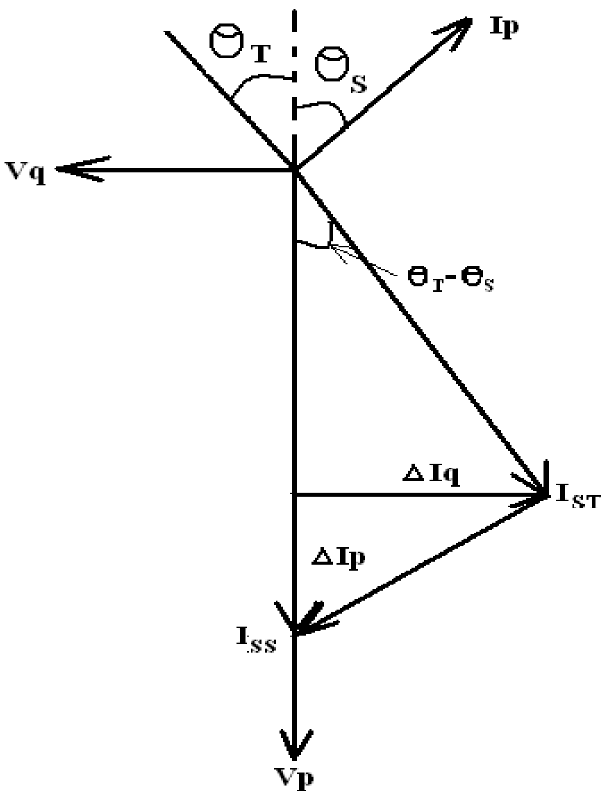
Procedure:

a) Connect the C.T. under test (T) as given in the circuit diagram (Fig 5.1) to the standard C.T and the other equipment given under 'apparatus' mentioned above.

b) Adjust the phase of the voltage(V) given to the wattmeters by varying the phase shifting transformer. The phase of this voltage is to be adjusted such that wattmeter W1 reads zero.

Voltage V is in quadrature with current Iss as given in the phasor diagram (Fig 5.2).

Fig 5.2 – Phase Diagram



c) Note the reading of the wattmeter W2. Let this be W_{2q}.

d) The phase of the voltage V is shifted through 90^0 so that V is phase with Iss.

Note the readings of both Wattmeters W1 and W2.

Let the reading of Wattmeter W1 be W_{1p} and le the reading of wattmeter w2 be W_{2p}.

e) The ratio of the standard (C.T) transformer be R_S and that of the C.T. under test be R_T.

There $R_T = R_S\ (1+\frac{W2p}{W1p})$

The Phase angle of the transformer under test is $\theta_T = \frac{W2q}{W1p} + \theta_S$ rad.

Where θ_S is the phase angle of the Standard C.T. in radian.

Calculations:

Nominal ratio of standard C.T = 4

Ratio error of standard C.T = 0.5%
Phase angle error of standard C.T = 8
Actual ratio of standard C.T =4(1+0.005) =Na’
Phase angle error for the C.T Under test = $\theta_T = \frac{W2q}{W1p} + \theta_S$ rad.
%Error = NR-AR/AR(R_T)

Tabular Column:

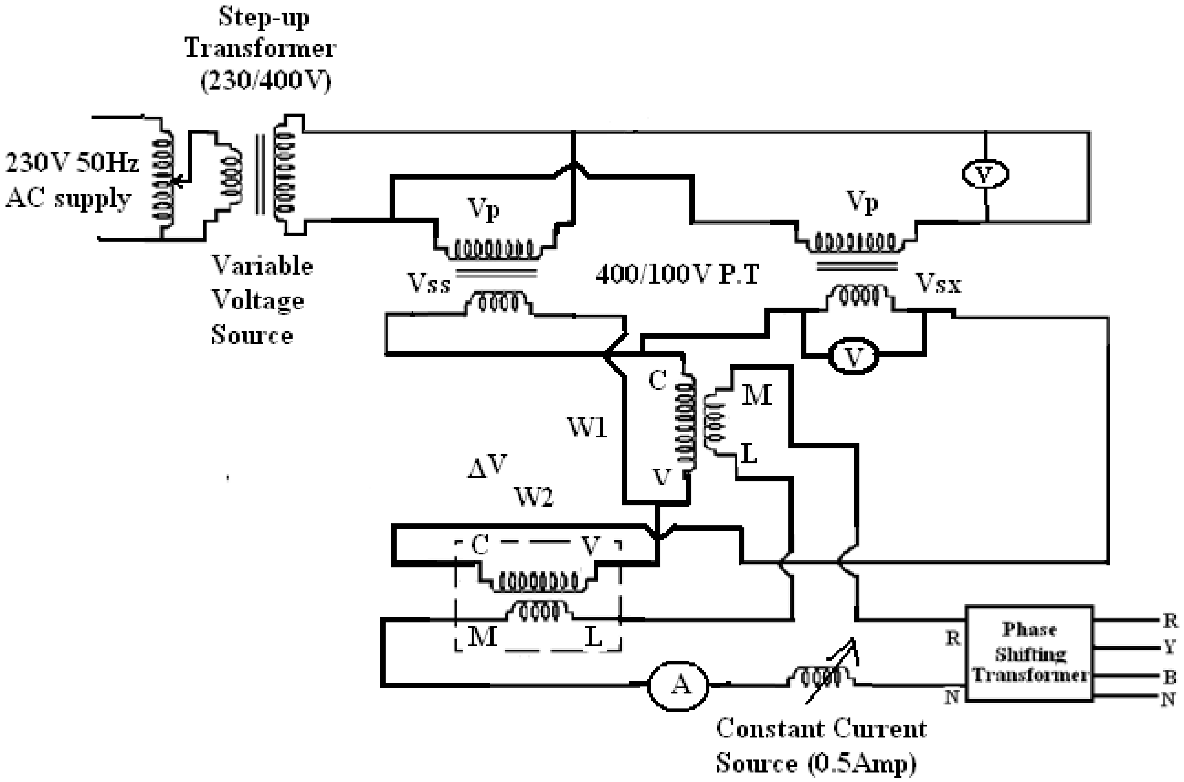
S.NO	I_P(A)	Iss(A)	I_D(A)	W_{2q}(A)	W_{1p}(W)	W_{2p}(W)	Ratio Error	Phase angle error

Result:

Measurement of % ratio error and phase angle of given Potential transformer by comparison Method

Aim: To obtain the ratio and phase angle errors of the given Potential transformer.(P.T).
Method: Comparison method.
Apparatus: Watt meters (2 Nos.), Standard Potential transformer having the same nominal ratio as the P.T. under test, Ammeter, (P.T. under test), Phase Shifting transformer connected to a single phase supply.

Circuit Diagram: Fig 5.1



Theory:

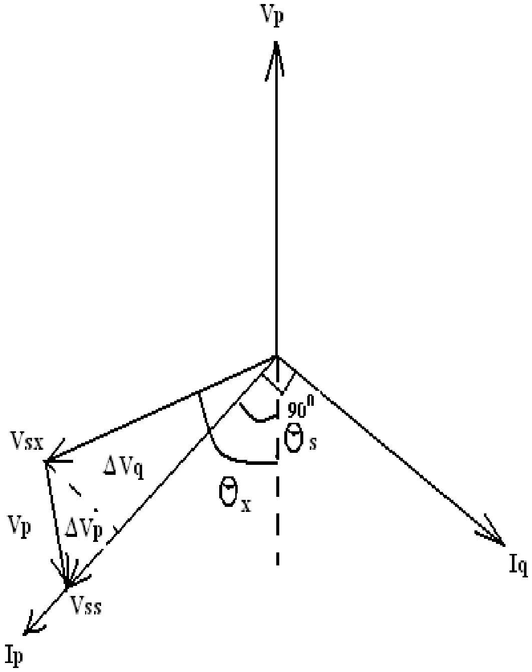
Method using Wattmeters. This method is analogous to silsbee's deflectional comparison method for potential transformers. The arrangement is shown in Fig 5.1. The ratio and phase angle errors of a test transformer are determined in terms of those of a standard transformer S having the same nominal ratio.

The two transformers are connected with their primaries in parallel. A burden is put in the secondary circuit of test transformer. W1 is a wattmeter whose potential coil 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 secondary voltages of standard and test transformers, is impressed across it. The current coils of the two watt meters are connected in series and are supplied from a phase shifting transformer. They carry a constant current I.

Procedure:

a) Connect the P.T. under test (T) as given in the circuit diagram (Fig 5.1) to the standard P.T and the other equipment given under 'apparatus' mentioned above.
b) Adjust the phase of the voltage(V) given to the watt meters by varying the phase shifting transformer. The phase of this voltage is to be adjusted such that wattmeter W1 reads zero.
c) Under these conditions current I is in Vss quadrature with voltage Vss. The position of current phasor for this case is shown in figure 5.2

Fig 5.2 – Phase Diagram



d) Note the reading of the wattmeter W2. Let this be W_{2q}.

e) The phase of the current I is shifted through 90^0 so that it occupies a position Ip is in phase with Vss.

Note the readings of both Wattmeters W1 and W2.

Let the reading of Wattmeter W_1 be W_{1p} and le the reading of wattmeter w_2 be W_{2p}.

f) The ratio of the standard (P.T) transformer be R_S and that of the P.T. under test be R_T.

$$\text{There } R_T = R_S\left(1+\frac{W2p}{W1p}\right)$$

The Phase angle of the transformer under test is $\Theta_T = \frac{W2q}{W1p} + \Theta_S$ rad.

Where Θ_S is the phase angle of the Standard P.T. in radian.

Calculations:

Nominal ratio of standard P.T = 4

Ratio error of standard P.T = 0.92%

Phase angle error of standard P.T = 3

Actual ratio of standard P.T =4(1+0.0092) =Na’

Phase angle error for the P.T Under test = $\Theta_T = \frac{W2q}{W1p} + \Theta_S$ rad.

%Error = NR-AR/AR(R_T)

Tabular Column:

S.NO	V_P(V)	Vss(V)	W_{2q}(W)	W_{1p}(W)	W_{2p}(W)	Ratio Error	Phase angle error

EXPERIMENT

Transformer turns ratio measurement using AC bridges.

AIM:- To measure transformation ratio of transformer using A.C.Bridge Model: HiQ-5108.

EQUIPMENT REQUIRED:-

- A.C Bridge Model: HiQ – 5108.
- 20MHz Dual beam CRO.
- Patch Cards.

A. INTRODUCTION:-

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

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

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 $N^2\alpha$ Type equation here.

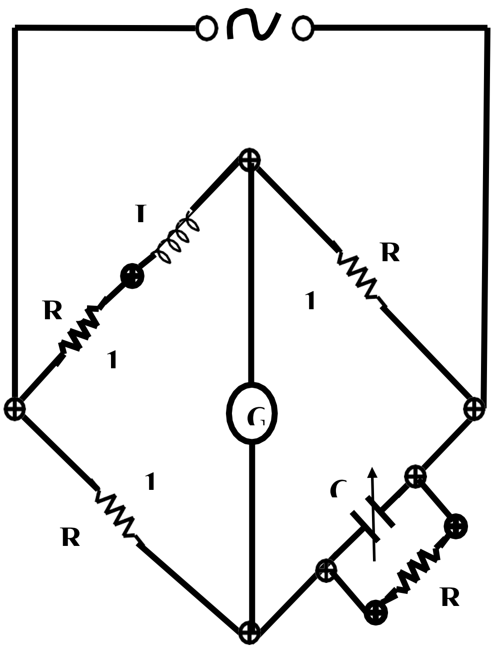
$$\text{Or } K = \frac{Vp}{Vs} = \frac{Np}{Ns} = \sqrt{\frac{LP}{LS}}$$

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.

A.C.BRIDGE:-It consists of four arms of impedance, a sinewave 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 turns ratio is decided.

Inductance – capacitance Bridge is shown below:-

A.C SIGNAL



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 P_1 & P_2.

A.C signal output from oscillator is applied at bridge as input signal.

When bridge is at balance,

$$Z_1 . Z_4 = Z_2 . Z_3 \text{ Or}$$

$$Z_1 = Z_2. \ Z_3 \ \frac{1}{Z4}$$

$$= Z_2 . Z_3 . Y_4.$$

Equating imaginary ports L =

R_2 R_3 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 P_1 and P2 pots to variable R_4 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 realpart(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 40KHz 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 = $\sqrt{\frac{Lp}{Ls}}$

Table:-

Sl.No	Transformer	Inductance of Primary winding	Inductance of secondary winding	Transformation ratio K= $\sqrt{\frac{Lp}{Ls}}$
1.				
2.				
3.				
4.				
5.				