DEPARTMENT OF ELECTRICAL ENGINEERING

INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

BASIC ELECTRICAL ENGINEERING LABORATORY

General guidelines for conducting experiments and preparing reports:

1) The laboratory classes begin in the very first day of opening the classes in each semester. However, the first day of laboratory class is scheduled for giving generally instruction and Laboratory sheets.
2) Always wear covered shoes with socks in the laboratory.
3) The students must come to the laboratory duly prepared with the knowledge of the theories and the method of the experiments to be performed.
4) The students are advised not to work alone in the laboratory.
5) They should not touch any terminal or switch without ensuring that it is dead.
6) Remember the golden rule -"CONNECT LAST, DISCONNECT FIRST" for all power hardware set-ups.
7) Use appropriate length of connecting wires, rather than joining two or three small ones. In this case you have open joints, which are dangerous.
8) Make sure that the electrical connections are right and tight.
9) Use fuse wire/MCB of proper rating only.
10) Keep safe distance away from all moving parts of rotating machines as far as possible and avoid loose garments etc.
11) Prepare Apparatus list & Table in **Report Sheet**.
12) While preparing apparatus list, note down all apparatus used even if some of them were kept fixed on the table/bed.
13) Draw final circuit diagrams, graphs, tables etc. with pen only at the time of submission of reports.
14) Follow established symbols for drawing circuits.
15) In circuit diagrams (for submission with reports) mention brief ratings of all apparatus.
16) While preparing experimental results in the data sheet take as many readings as may be required for the purpose like (1) drawing precise graphs (eg. while drawing O.C.C. of d.c. generator more points may be required in region where there are non-linearity), (2) device performance details etc.
17) If the sample calculation, graphs, any discussion or comment on the experiment are essential then those should be appended in the report.
18) Scheduled time of submission of reports is as per directed by the teacher. In case of late submission, marks will be deduced at the rate of 10% for each week or part thereof up to a maximum delay of one month.
19) Refer to available standards (IS, IEC, IEEE etc.) for engineering practice/norms.

DEPARTMENT OF ELECTRICAL ENGINEERING
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BASIC E.E. LABORATORY **First/Second Semester**

Expt. No: 1251/1(a)

Title: **FAMILIARISATION EXPERIMENT – PART 1**
(VARIAC, POTENTIAL DIVIDER, MCV, MIV, MCA, MIA)

Objective : 1) To become familiar with 'POTENTIAL DIVIDER' and 'VARIAC'
2) To become familiar with Moving Coil (MC) and Moving Iron (MI) type ammeter and voltmeter and to understand the use of these meters

Theory : 1) **POTENTIAL DIVIDER**

Potential divider is a device by which we can vary voltage from zero to maximum supply voltage. It can be used in both a.c. and d.c. circuits. Potential divider is made of two resistances $R_1 = A_1 B_1$ and $R_2 = A_2 B_2$ as shown in Fig.1.1. B_1 and B_2 is connected to give the assembly a rectangular shape and the whole assembly is placed on a wooden platform. There are two jockey J_1 and J_2 which can move over the resistance arms. By moving the jockey the resistance is varied which in turn varies output voltage across J_1, J_2. A_1 and A_2 are the input terminals.

With reference to Fig.1.1, let R_{out} = resistance across J_1 B_1 B_2 J_2. When input voltage V_{IN} is applied across A_1A_2 and output circuit is open then the input current is

$$I_{IN} = \frac{V_{IN}}{R_1 + R_2}$$

$$V_{OUT} = I_{IN}.R_{OUT} = V_{IN} \times \frac{R_{OUT}}{R_1 + R_2}$$

Procedure:

[Note the fuse rating. Do not put on supply power without the permission of the teacher/ teaching assistant assigned for the expt.]

1) Connect the given MCA and MIA in series and MCV and MIV in parallel as shown in Fig. 1.2, after checking their ranges. IN NO CASE THE READING SHOULD GO 'OUT OF SCALE'.
2) Note the positions of the moving contacts at which the output voltage is a) approximately zero and b) maximum and nearly equal to the supply voltage.
3) Keep the load resistance fixed. Vary the output voltage in 3 steps and record the ammeter and voltmeter readings in the DATA SHEET to be prepared by you as shown in Table-I of the SAMPLE DATA SHEET.
4) Record what happens when terminal connections of MCA and MIA and also MCV and MIV are reversed, in the DATA SHEET to be prepared by you as shown in Table-I of the SAMPLE DATA SHEET

Brief Theory : 2) **VARIAC**

It is a device used to obtain variable output alternating voltage. Voltage magnitude (r.m.s.) can be varied from zero to a voltage even higher than the supply voltage by inserting more number of turns in the output circuit. Variac can only be used in a.c. circuits .
Note: A potential divider can be used in both d.c. and a.c. circuits.

Procedure:

1) Make connections as shown in Fig.1.4.
2) Vary the position of the moving contact J and record ammeter and voltmeter readings in the DATA SHEET to be prepared by you as shown in Table-I of the SAMPLE DATA SHEET.
3) Note down the fuse rating also.

REPORT :

1. (a) Moving coil instruments can measure ....
   (b) Moving iron instruments can measure ....
   (Fill up with words)
2. A Moving coil ammeter is giving deflections in the wrong direction. How can you make it to read in the proper direction?
3. You are given a moving coil and a moving iron instrument. Can you recognize the meters from the appearance of their scales?
4. Can you use a potential divider for obtaining variable d.c supply from a fixed a.c supply?
5. What are the differences between a variac and potential divider? Take to previous page.
6. Check the specification of each apparatus you have used.

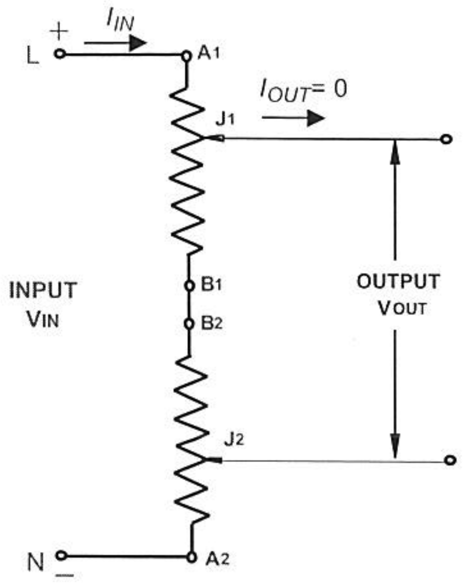

Fig : 1.1 Potential Divider Connection

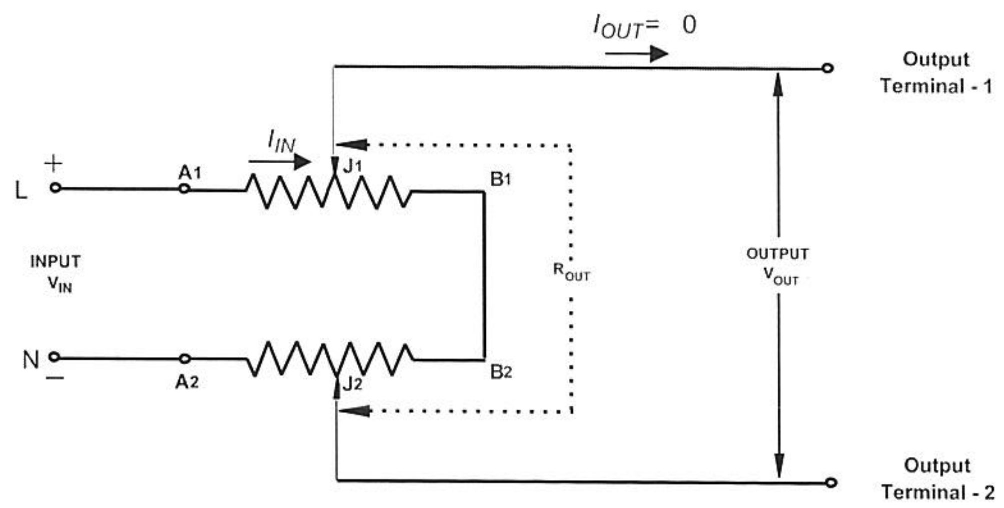

Fig : 1.2 Potential Divider

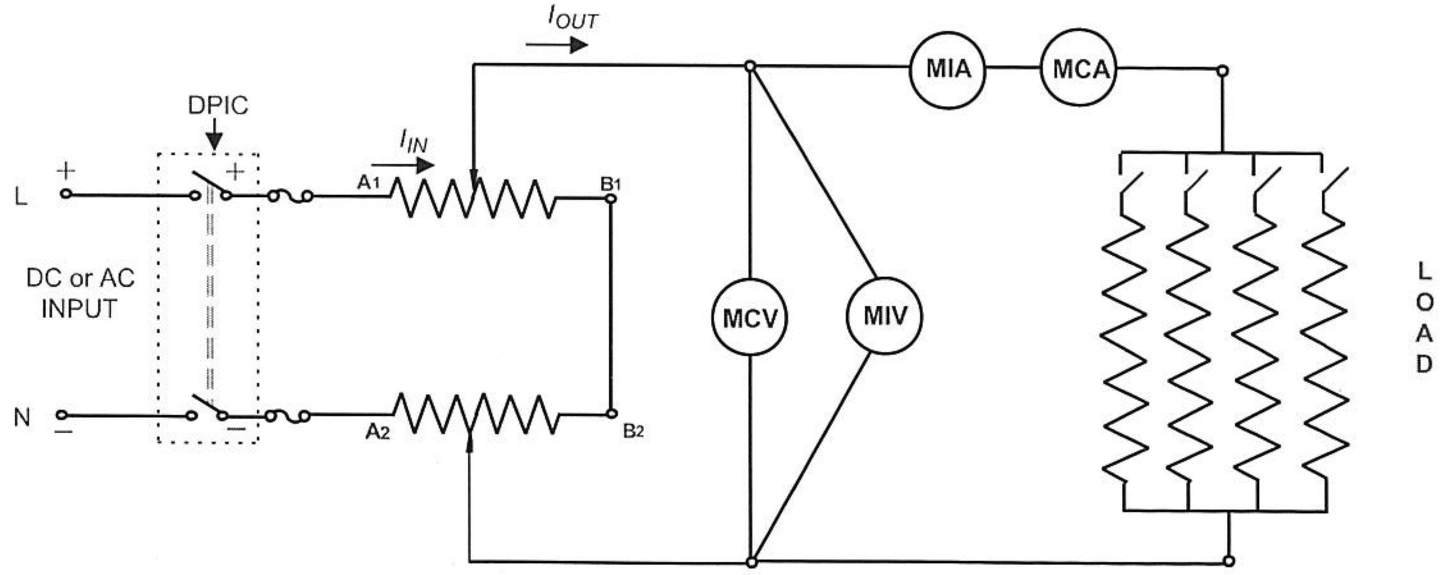

Fig : 1.3 Circuit diagram for familiarization on MIA, MCA, MCV, MIV using Potential divider

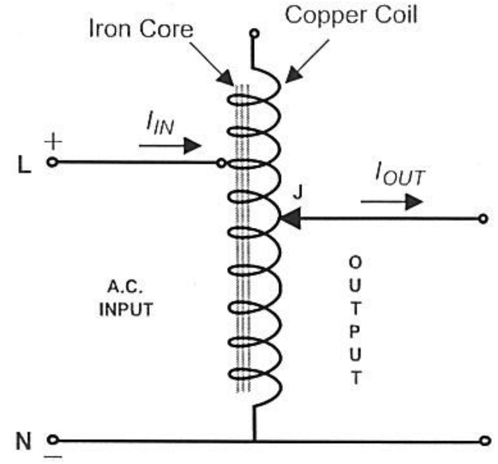

Fig : 2.1 Variac

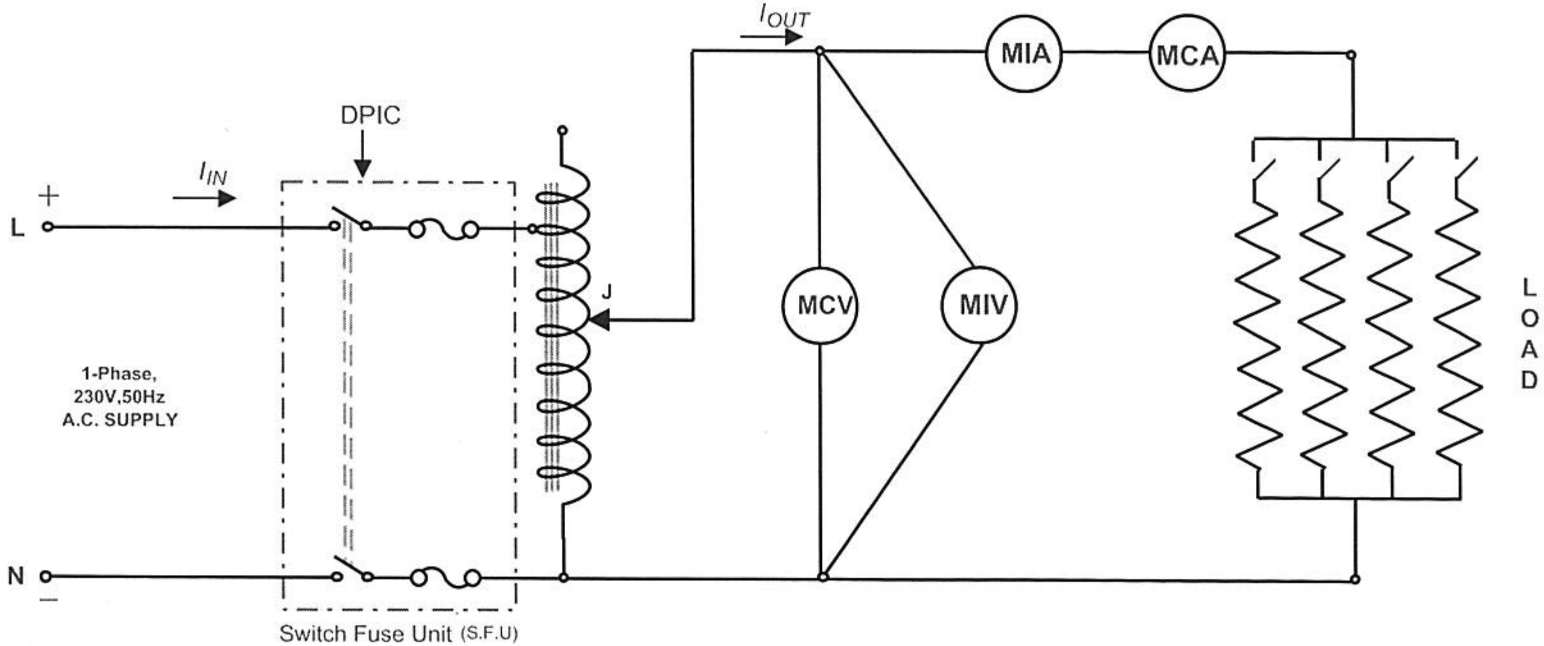

Fig : 2.2 Circuit Diagram for Familiarization Experiment on MIA, MCA, MCV, MIV Using Variac

SAMPLE DATA SHEET

TITLE OF THE EXPERIMENT :____

NAME: ____________________________ ROLL NO: __________

DATE: __________

Apparatus used:(Add additional rows if needed.)

Sl. No.	Item	Qty	Range/Rating	Lab. No.	Maker's Name

EXPERIMENTAL DATA :

TABLE-I

Sl. No.	Readings of				REMARKS
	MCA	MIA	MCV	MIV	

TABLE-II

METER	Remarks for Normal Connection	Remarks for Reversed Connection
MCA		
MIA		
MCV		
MIV		

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DEPARTMENT OF ELECTRICAL ENGINEERING
INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

BASIC E.E. LABORATORY **First/Second Semester**

Expt. No. 1251/1(b)

Title: FAMILIARIZATION EXPERIMENT –PART 2 (WATTMETER)

Objective : To become familiar with wattmeter connections at different current and voltage ratings

Theory : A wattmeter is an instrument which measures electrical power.

Mathematically, Power = voltage × current

A wattmeter has a voltage coil or 'pressure coil' (PC) which senses voltage across the element for which the power is to be measured and a current coil (CC) which senses the current through that element or part of the circuit (load). Thus, a wattmeter will show a reading when its current and pressure coils are excited simultaneously. A wattmeter has at least four terminals, two for current coil and two for pressure coil . However in a usual portable wattmeter, quite often many more terminals are provided for measuring power at different currents and voltage ranges. The symbolic representation of wattmeter is shown in Fig.1.5.

Procedure :

[Note the supply fuse rating. Do not put on the supply without the permission of the teacher/ teaching assistant assigned for the expt.]

1) Make connections as shown in the Fig.1.5 with lower current range and lower voltage range of wattmeter.
2) Adjust the variac output voltage below the voltage range used to allowing a current to flow through the load. Record then the wattmeter reading in the DATA SHEET to be prepared by you as shown in Table-I of the SAMPLE DATA SHEET.
3) Change the voltage to another range but supply voltage must be same to the previous value and record the wattmeter reading in TABLE-I.
4) Change the current to another range and record the wattmeter reading in TABLE-I.
5) Change the voltage to another range and record the wattmeter reading in TABLE-I.
6) See what happens when,
   a) the current coil is reversed
   b) the pressure coil is reversed.
   c) both current and pressure coils are reversed and complete TABLE-2.

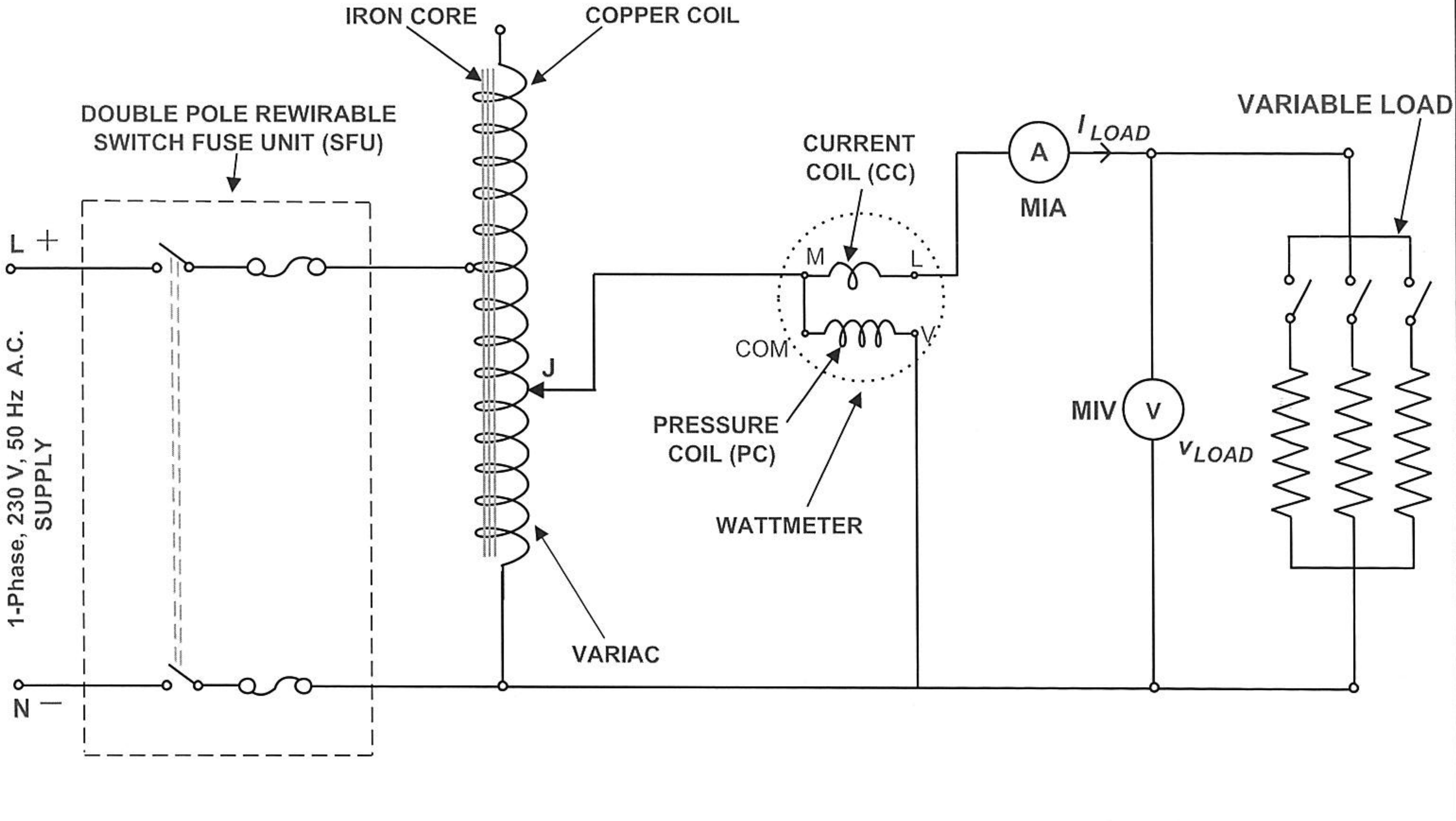

Fig : 1.5 Circuit diagram for familiarization of wattmeter

SAMPLE DATA SHEET

TITLE OF THE EXPERIMENT :______________________________________

NAME: ______________________________ ROLL NO: __________

DATE: __________

Apparatus used: **(Add additional rows if needed.)**

Sl. No.	Item	Quantity	Range/Rating	Lab. No.	Maker's Nam

Experimental Data:

TABLE-1

Sl. No.	Current range	Voltage range	Wattmeter reading	Multiplying factor(M_f)	Power

TABLE-2

Sl. No.	Type of connection	Deflection (Indicate positive or negative)
1.	Current coil terminal "**M**" connected to Pressure coil "**COM**" terminal as in Fig.1.5	
2.	Current coil reversed, pressure coil is kept as in Fig-1.	
3.	Current coil as in Fig-1 but pressure coil is reversed.	
4.	Both current and pressure coil are reversed.	

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BASIC E.E. LABORATORY **First/Second Semester**

Expt. No. 1251/2

Title: Experimental verification of circuit theorems (For DC Circuit)

a) Superposition theorem
b) Thevenin's theorem
c) Maximum power transfer theorem

Objective : 1) To verify the theorems experimentally
2) To find out the current through a given load resistance R_L (6Ω) using two different theorems

Statement of the Theorems:

Superposition Theorem:

In any linear bilateral network, the current at any point due to the simultaneous action of a number of sources of e.m.f.s distributed throughout the network, is the algebraic sum of component currents in the network. A component current in a network is that due to one e.m.f acting alone with other e.m.fs replaced by their internal resistances.

Thevenin's Theorem:

Any two-terminal active linear bilateral network can be replaced, at any pair of terminals *a-b*, by an equivalent circuit having a voltage source E_{th} in series with a resistance R_{th}, where, E_{th} is the voltage across the terminals *a-b* when they are open circuited and R_{th} is the equivalent resistance between the terminals *a-b* looking back into network when all the voltage sources are replaced by their internal resistance .

Maximum power transfer theorem:

A resistive load connected to a d.c. network receives maximum power when the load resistance is equal to the Thevenin equivalent resistance of the network as seen from load terminals.

The current (I) in a series circuit containing load resistance R_L and source resistance R_S is given by,

$$I = \frac{V}{(R_L + R_S)}$$ where, V is the applied voltage.

So, the power (P) absorbed in the resistance R_L is

$$P = \left[\frac{V}{(R_L + R_S)}\right]^2 R_L$$

The value of R_L for which P will be maximum is obtained from the relation when $R_L = R_S$. Hence, for maximum power transfer to the load, the load resistance (R_L) must be equal to the source resistance (R_S).

Procedure:

[Check fuse rating. Do not put on supply power without the permission of the teacher/ teaching assistant assigned for the expt.]

For Superposition Theorem:

1. Make connections as shown in the diagram Fig.2.1.
2. Measure the current through R_L when both sources (V_1 & V_2) are present and tabulate in the DATA SHEET to be prepared by you as shown in Table-I of the SAMPLE DATA SHEET
3. Keeping one voltage source (V_1) in the circuit and other voltage source (V_2) replaced by its internal resistance (here assume zero), note down the ammeter reading in Table-I with proper polarity.
4. Now insert the other source (V_2) in the circuit replacing the previous voltage source (V_1) by its internal resistance (here assume zero). Measure and note down the circuit current with proper polarity.

For Thevenin's Theorem:

1. Remove the resistance R_L and measure the open circuit voltage (V_{th}) across *a* & *b* (Fig.2.1) and tabulate in the DATA SHEET to be prepared by you as shown in Table-II of the SAMPLE DATA SHEET
2. Measure the resistance R_{th} of the circuit across *a* & *b* when the two sources are replaced by their respective internal resistances. The resistance R_{th} is measured across *a* & *b* by drop method (i.e, either V_1 or V_2 is connected across a & b and ammeter current I_{RL} is noted). Then $R_{th} = (V_1 \text{ or } V_2)/\, I_{RL}$
3. $I_L = \dfrac{V_{th}}{(R_{th} + R_L)}$
4. Tabulate in Table-II.

For Maximum Power Transfer Theorem:

1. Make connection as shown in Fig-2.2. Check the fuse rating.
2. Switch on 25 volt d.c. supply and do not alter R_S.
3. Increase R_L to maximum and measure supply voltage (V), voltage across the load resistance (V_{RL}), voltage across the source resistance (V_{RS}) and the current through the circuit and tabulate the data.
4. Keeping the supply voltage fixed, lower the load resistance (R_L) and tabulate the results for different values of current.

SAMPLE DATA SHEET

TITLE OF THE EXPERIMENT :____

NAME: _______________________________ ROLL NO: __________

DATE:___________

Apparatus used : (Add additional rows if needed.)

Sl. No.	Item	Quantity	Range/Rating	Lab No	Maker's Name

Experimental Data :

TABLE-I (For Superposition Theorem)

Sl. No	Particulars	Current / Voltage
1	Current through R_L with both the sources present (I)	
2	Current through R for source V_1 only (I_1)	
3	Current through R_L for source V_2 only (I_2)	
4	Algebraic sum of I_1 and I_2	

TABLE-II (ForThevenin's Theorem)

<table>
<tr><th>Sl. No</th><th colspan="2">Particulars</th><th>Current / Voltage / Resistance</th></tr>
<tr><td>1</td><td colspan="2">Voltage across a and b when R_L is removed (V_{th})</td><td></td></tr>
<tr><td rowspan="2">2</td><td>Voltmeter reading (V_1 or V_2)</td><td rowspan="2">Drop Method</td><td></td></tr>
<tr><td>Ammeter reading (I_{RL})</td><td></td></tr>
<tr><td>3</td><td colspan="2">Equivalent Resistance (R_{th})</td><td></td></tr>
<tr><td>4</td><td colspan="2">Load current (I_L)</td><td></td></tr>
</table>

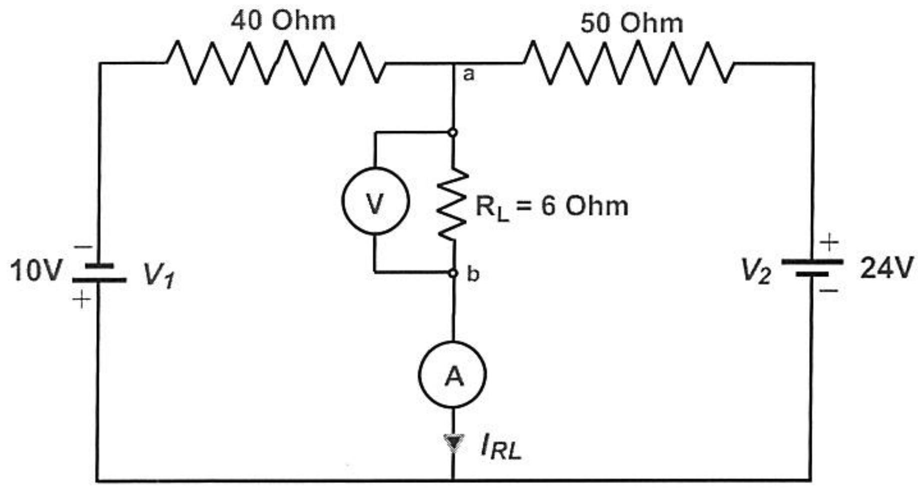

Fig : 2.1 Circuit Diagram for Conducting Experiment on (1) Superposition Theorem (2) Thevenin's Theorem

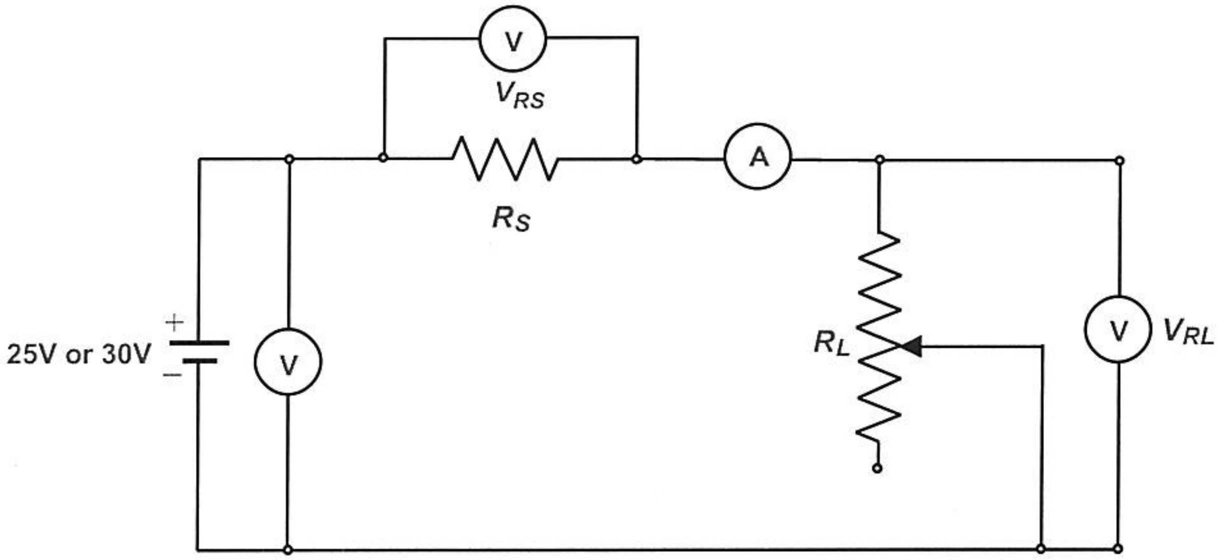

Fig : 2.2 Circuit Diagram for Conducting Experiment on Verification of Maximum Power Transfer Theorem

TABLE-III (For Maximum Power Transfer Theorem)

Sl. No.	Supply Voltage (V) volt	Voltage Across R_S (V_{RS}) volt	Voltage across R_L (V_{RL}) volt	Current (I) amp	Value of R_L ohm	Power Consumed in R_L (P) Watt

Signature of Teacher

Report:

1. (a) How do you represent ideal voltage and current sources?
   (b) What is meant by linear, bilateral network? Give example.
   (c) Are the network theorems valid for a.c. circuits?
   (d) Give a simple example (draw circuit diagram) where Network Theorem's may fail.
2. Compare the values of currents obtained theoretically from Superposition Theorem, Thevenin's Theorem, Max. Power Transfer Theorem and the actual experiments. In case of discrepancy, state possible reasons.
3. Draw the graph of V_{RS} vs. I in a graph paper and determine the values of the source resistance (R_S).
4. Plot P vs. R_L in a graph paper and determine the value of R_L for which P is maximum. Hence, compare this with R_S obtained in (2) above.

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BASIC E.E. LABORATORY **First/Second Semester**

Expt. No. 1251/3

Title: STUDY OF A.C. SERIES R-L-C CIRCUIT

Objective: To study a.c. single phase series circuits with reference to power, power factor and phasor diagram

A) Determination of Parameters of the Choke coil:

Procedure:

[Note the fuse rating. Do not put-on supply without the permission of the teacher/ teaching assistant assigned for the expt.]

1) Connect the choke coil as shown in the Fig.3.1.
   [**Note**: A choke coil is equivalent to a small resistance R_L and an inductance L in series, so that at any frequency f the impedance of the choke coil is
   $Z= (R_L^2+X_L^2)^{1/2}$, where, $X_L=2\pi fL$]
2) Measure power, current and voltage for two values of current between 0.7 and 1.1A. (Adjust by means of the rheostat R_l) to complete the DATA SHEET to be prepared by you as shown in SAMPLE DATA SHEET.

Report:

a) Complete the DATA SHEET to be prepared by you as shown in SAMPLE DATA SHEET to find R_L , L and power factor of the choke coil.
b) For one value of current, of TABLE-I of the DATA SHEET, calculate the product IR_l (V_{RL}) and IX_L (V_{XL}). Choose suitable voltage scale and draw the phasor diagram as shown in Fig to scale. Find power factor (p.f.) **"cosø"** and tabulate the value.

B) Determination of Parameters of Capacitor :

Procedure:

1) Replace the choke coil of Fig.3.1 by a capacitor in between the points. X & Y and repeat the procedure (2) above. Complete the DATA SHEET to be prepared by you as shown in SAMPLE DATA SHEET

Report:

a) Complete TABLE- II of the DATA SHEET to find R_C , C and power factor (p.f.).
b) Draw the phasor diagram on a graph paper as shown in Fig to scale. Find power factor (p.f.) **"cosø"** and tabulate the value.

C) R-L-C SERIES CIRCUIT :

Procedure:

1) Connect as shown in Figure.3.2.
2) For two values of current between 0.7 and 1.1A (adjusted by the rheostat R_I), measure Power, Current and Voltage to complete the DATA SHEET to be prepared by you as shown in SAMPLE DATA SHEET.

Report:

a) For one value of current from the observed data, calculate for value of R_L, L and C previously determined.

b) Draw the phasor diagram to scale following the procedure given below:-

i. Draw the phasor of V_{Rf} and $V_{CB} = V_{cap}$ and find p.f. angle and p.f.

ii. Draw the phasor diagram of V_{Choke} knowing $\vec{V}_{RL}$, $\vec{V}_{XL}$ and $\vec{I}$. Segregate $\vec{V}_L$:(pure inductive part) and $\vec{V}_{RL}$ (due to resistance of choke coil) from $\vec{V}_{Choke}$.

iii. Find $V = (V_{Choke} + V_{Rf} + V_{cap})$ and hence the magnitude of V and **"cosø"** and tabulate the value.

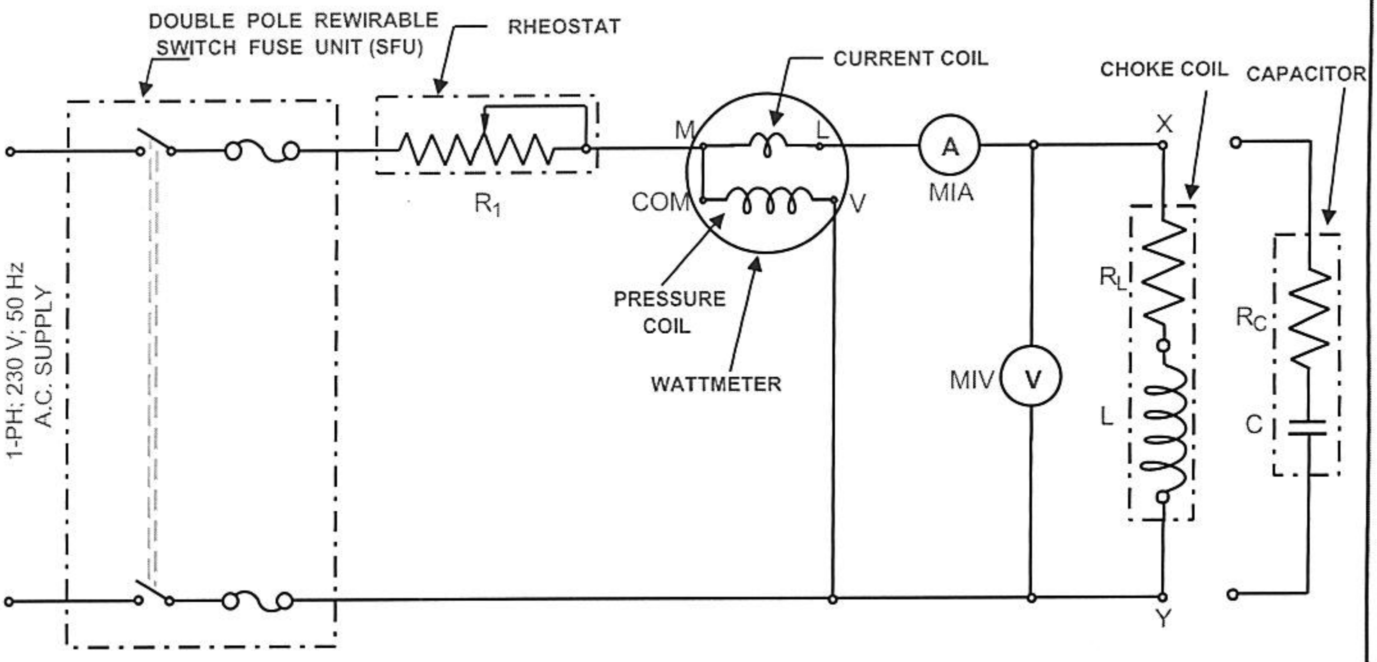

Fig:3.1 Circuit Diagram for Study of R-L Series Circuit

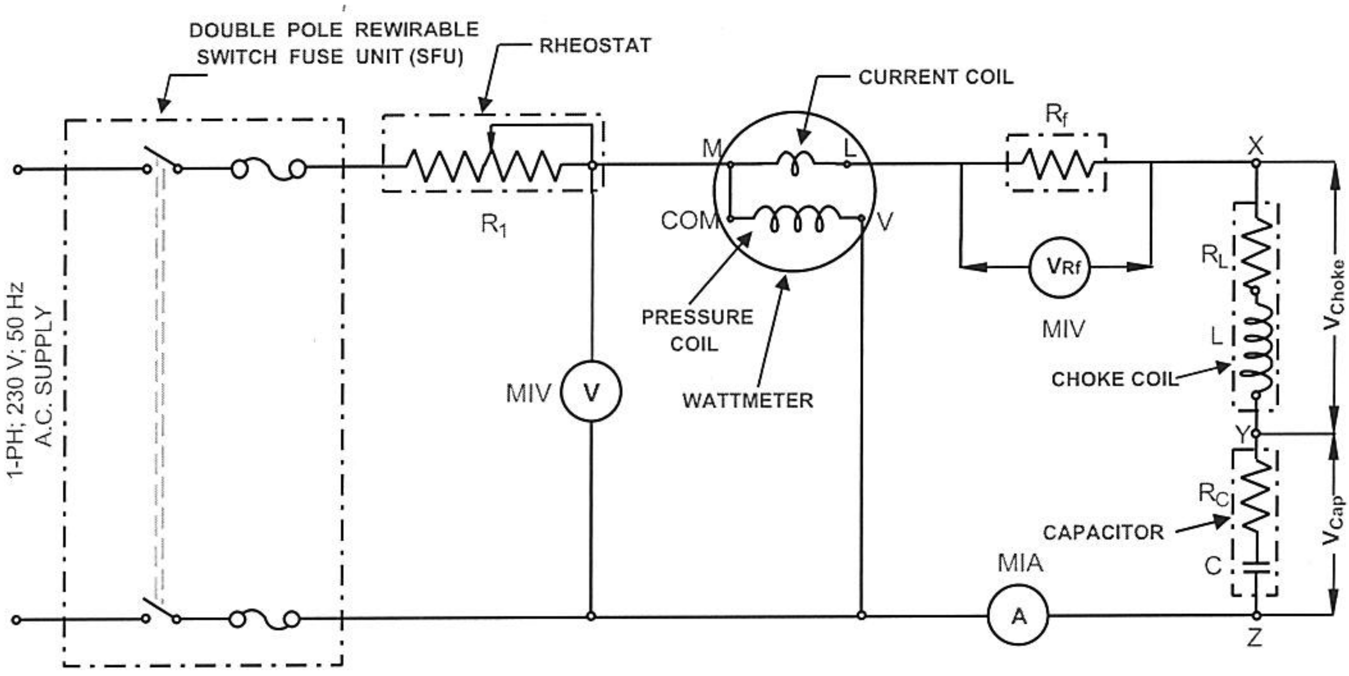

Fig:3.2 Circuit Diagram For Study of R-L-C Series Circuit

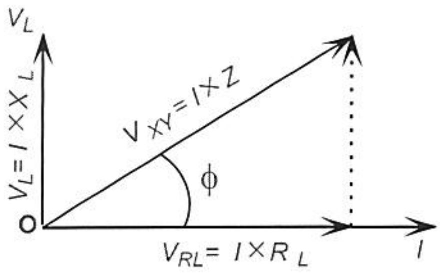

Fig: 3.3 Phasor Diagram of Choke Coil

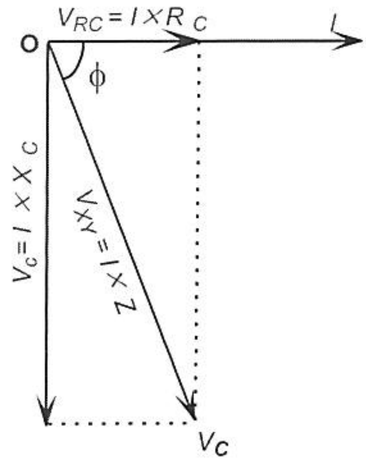

Fig: 3.4 Phasor Diagram of Capacitor

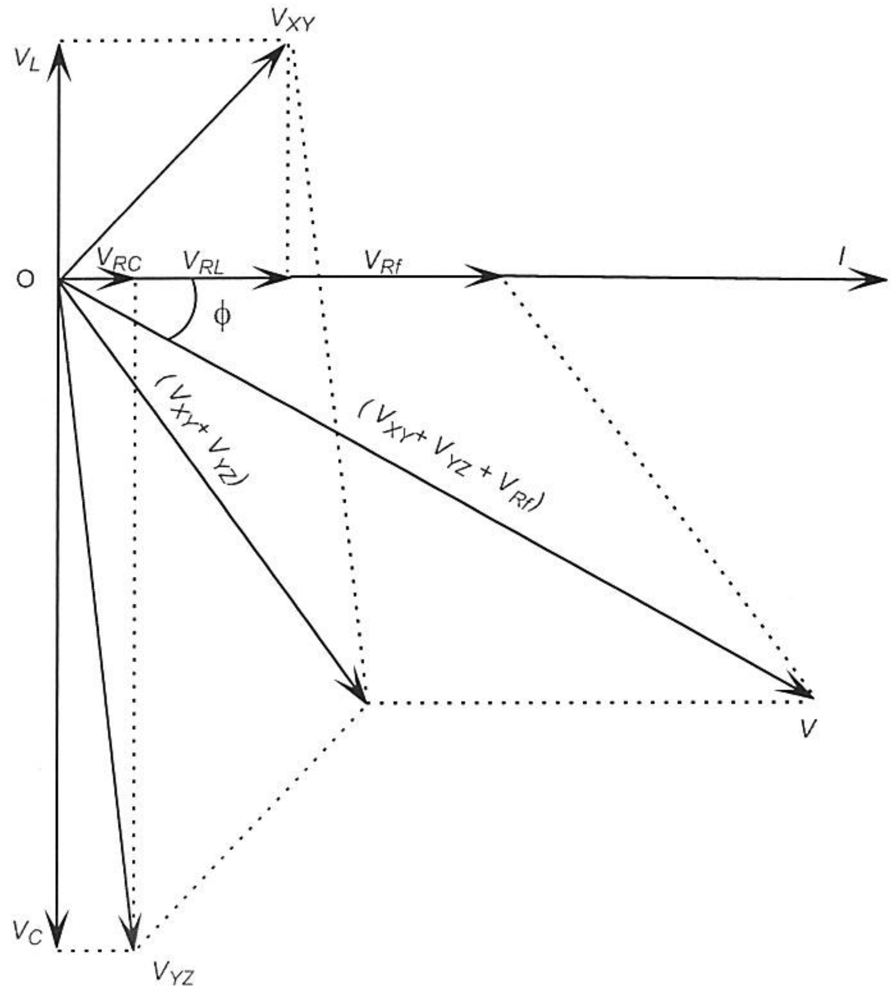

Fig : 3.5 Phasor Diagram of R-L-C Series Circuit

<u>SAMPLE DATA SHEET</u>

TITLE OF THE EXPERIMENT :____

NAME: ______________________________ ROLL NO: ____________

DATE: ____________

Apparatus used: (Add additional rows as needed.)

Sl. No	Item	Quantity	Range/Rating	Lab No.	Maker's Name

Experiment Data:

TABLE-I

No. of Obsvs.	Observed Data			Calculated data				p.f. (cosø) from phasor diagram
	V	I	W	$Z=V/I$	R_L	L	p.f. = ***cosø*** = *W/VI*	

TABLE-II

No. of Obsvs.	Observed Data			Calculated data				p.f. (*cosø*) from phasor diagram
	V	I	W	$Z=V/I$	R_C	C	p.f.= cosø = *W/VI*	

TABLE-III

No. of Obsvs.	Observed data				Calculated power factor, p.f. (cosø)		*V* from Phasor diagram
	I	V_{Rf}	V	W	p.f. (*cosø*)	From phasor diagram	

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Signature of the Teacher

DEPARTMENT OF ELECTRICAL ENGINEERING
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BASIC E.E. LABORATORY **First/Second Semester**

Expt. No. 1251/4
Title: SPEED CONTROL OF D.C. SHUNT MOTOR

Objective: To study two methods of speed control of a D.C Shunt Motor, namely,

a) Armature voltage control and
b) Field current control

Theory: The voltage V_a across the armature terminals of a D.C. Shunt Motor is related as,

$$V_a = I_a R_a + E$$

where, $E = K_b \Phi N$

where, 'Φ' is the flux per pole and is proportional to field current (I_f).
'N' is the speed of the motor in rev/min and
'K_b' is a constant for the motor (back-emf const)
Since the armature resistance is small, $\mathbf{I_a R_a}$ drop may be neglected.
If we neglect the '$I_a R_a$' drop, then

$$V_a = E = K_b \Phi N.$$

or, $N \approx V_a / K_b \Phi$

The speed therefore can be controlled

A) by controlling the armature voltage (V_a), keeping the field current (I_f) constant. Since Voltage cannot be increased above rated value, speed variation is possible from zero to rated speed.

B) by controlling the field current (I_f), keeping armature voltage(V_a) constant. In this method speed variation may be possible from rated to above rated value by decreasing field current from rated value.

Procedure : [Note the fuse rating. Do not put-on supply without the permission of the teacher/ teaching assistant assigned for the experiment.]

1) Make connections as shown in the circuit diagram. (Fig.4.1)

RUN-I

2) With minimum resistance in the field circuit (that is maximum I_f) and the potential divider slider at the minimum output voltage position (V_a=0) switch on the D.C. 220V mains.
3) Apply a small voltage to the armature circuit (by increasing the potential divider slider output voltage) keeping field current constant and at its maximum value and observe that the motor runs at a steady speed. Note down the armature voltage, speed and field current values.
4) Increase V_a to the maximum possible value in about 9 to 10 steps and complete the DATA SHEET to be prepared by you as shown in SAMPLE DATA SHEET.

RUN-II

5) Keeping the potential divider in the maximum voltage position, decrease field current (I_f). Observe that the speed increases. Note down the field current (I_f), speed (N) and armature voltage (V_a) values.
6) Decrease the field current (I_f) in about 7 to 8 steps till the motor speed is about 1800 r.p.m and complete the DATA SHEET to be prepared by you as shown in SAMPLE DATA SHEET.

Report : 1) Draw curves showing –

a) Speed (N) versus armature voltage (V_a), with field current (I_f) constant
b) Speed (N) versus field current (I_f), with armature voltage (V_a) constant

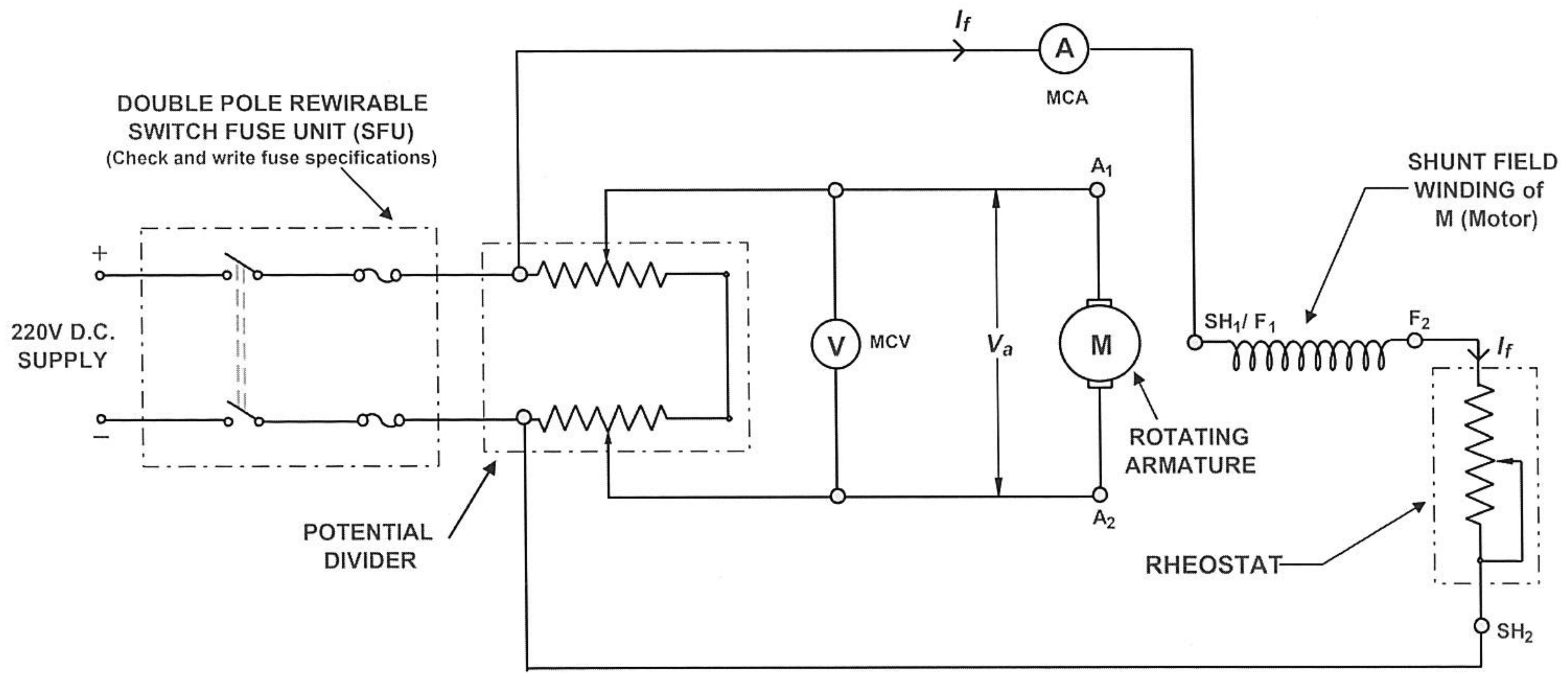

Fig : 4.1 **Circuit diagram for speed control of D.C. shunt motor**

SAMPLE DATA SHEET

TITLE OF THE EXPERIMENT :____

NAME: ______________________________ ROLL NO: ____________________

DATE: ________________

Apparatus used: (Add additional rows if needed)

Sl. No.	Item	Quantity	Range/Rating	Lab No	Maker's Name

Machine under test: D.C Shunt Motor

Voltage (V): ____________________ Power: ____________________

Current: ______________________ Speed: ____________________

Lab No/Sl. No: _________________ Maker's Name: ___________

Experimental Data:

TABLE-1

Current I_f (constant) = _________________

No. of Obsvs.	Armature Voltage(V_a) in volts	Speed (N) in r.p.m

TABLE-2

Voltage V_a (Constant) = ____________________________

No. of Obvs.	Field current (I_f) in mA	Speed (N) in r.p.m

***The student(s) should add rows if necessary.**

____

Signature of the Teacher

DEPARTMENT OF ELECTRICAL ENGINEERING

INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

BASIC E.E. LABORATORY **First/Second Semester**

Expt. No. 1251/5

Title : NO-LOAD TEST ON SINGLE PHASE TRANSFORMER

Objective: To study the variation of (i) current, (ii) power and voltage ratio with variation of applied voltage of a single-phase transformer at no-load

Theory :

On no-load, the power consumed by a transformer is used in providing its own losses which comprises: (1) Magnetic loss i.e. hysteresis and eddy current losses combined together in the transformer core. This loss is also known as "Iron Loss" and is approximately proportional to the square of the applied voltage, (2) power loss in the resistance of the coil of the primary winding due to the no-load current which is known as no-load copper loss. The no-load copper loss is usually very small in comparison to iron loss and is proportional to the square of the no-load current. As the secondary winding is open on no-load, there would be no copper loss in the secondary winding.

The voltage ratio is V_p/V_s and is approximately equal to the ratio of number of turns in the primary and secondary windings, where V_P (r.m.s) is primary voltage of the transformer and V_s (r.m.s) is the secondary voltage of the transformer.

Procedure : [Note the fuse rating. Do not put- on supply without the permission of the teacher/teaching assistant assigned for the experiment]

1) Make connections as shown in the Fig.5.1 and switch on the supply voltage.
2) By adjusting the variac, increase the voltage applied to the transformer from about 50% to 110% the rated value in about six steps, and in each step note down the readings of primary voltage, primary current, power input and secondary voltage.

   Tabulate the result in the DATA SHEET to be prepared by you as shown in SAMPL DATA SHEET.

GIVEN DATA: THE PRIMARY WINDING RESISTANCE IS **0.56** ohms (for old setup) & **2.1** ohms (for new setup)

Report:

1. Draw curves to show the variation of –
   a) No-load current, b) Voltage ratio and c) Iron loss with applied voltage.
2. Show one sample calculation. Each group member should show sample calculation for a separate set of observations.

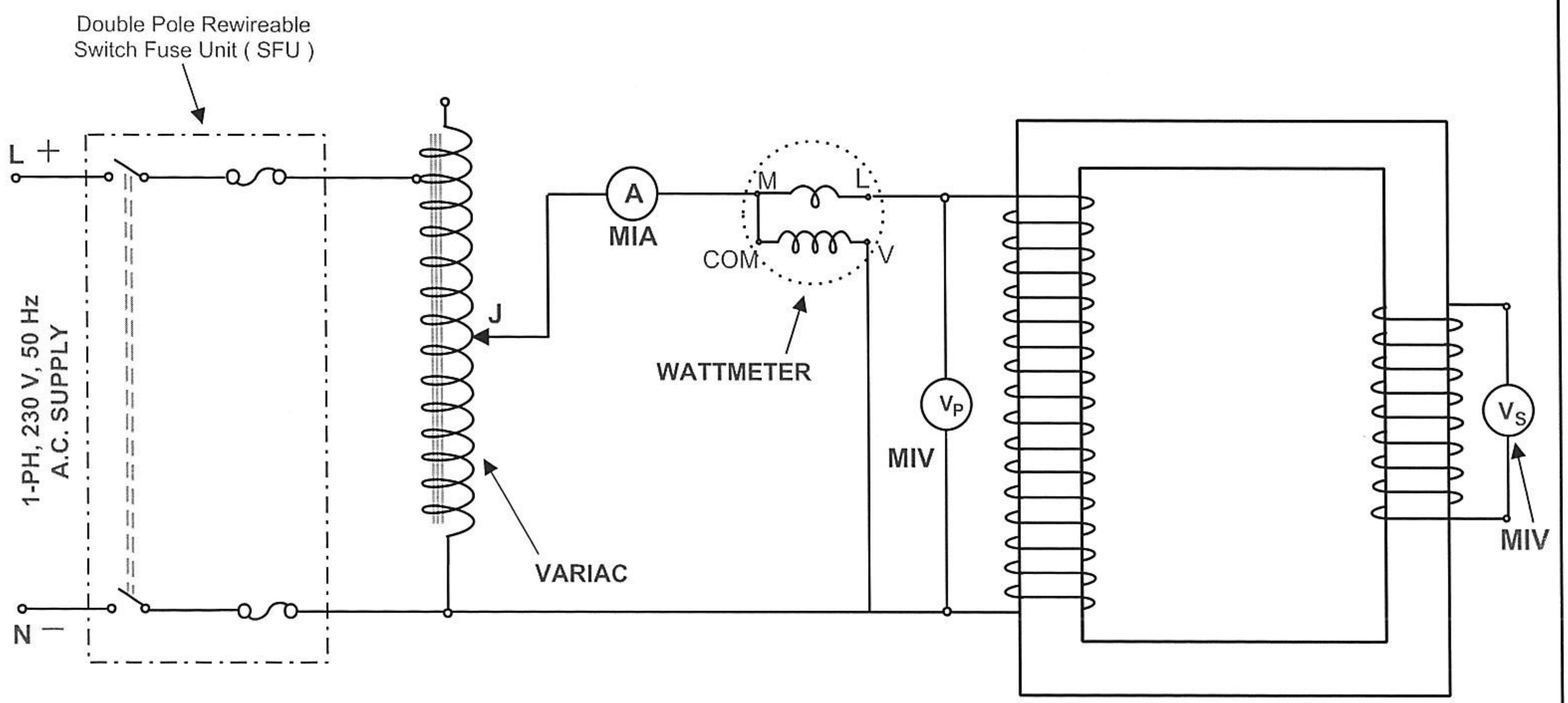

Fig : 5.1 Circuit Diagram for Connection of No Load Test of Single Phase Transformer

SAMPLE DATA SHEET

TITLE OF THE EXPERIMENT :____

NAME: ______________________________ ROLL NO: __________

DATE: ____________

Apparatus used: (Add additional rows if needed.)

Sl. No.	Item	Quantity	Range/Rating	Lab No.	Maker's Name

Transformer under test:

Primary voltage (V_p): ____________ Secondary voltage (V_s) : ______________

Volt-Ampere (VA) : ____________ Phase : __________ Frequency : 50 Hz

Maker's Name : ____________

Experimental Data:

Sl.No.	Primary Voltage (V_P) in volt	Ammeter Reading (I_0) in amp	Wattmeter Reading (W_0) in watt	Secondary voltage (V_s) in volt	Voltage ratio (V_P/V_S)	Copper loss(P_{cu}) in watt	Iron loss(P_i) in watt

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INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

BASIC E.E. LABORATORY **First/Second Semester**

Expt. No. 1251/6

Title: **Determination of Characteristics and luminosity of**
a) Carbon and Tungsten filament lamps and b) Fluorescent lamp and Compact Fluorescent lamp(CFL)

Objective: For experiment 6 (a)

To study the volt-ampere, power-voltage and resistance-voltage characteristics of carbon & tungsten filament lamps

For experiment 6 (b)

i. To study the starting method, minimum striking voltage, extinguishing voltage and effect of varying voltage on florescent lamp operating from AC supply

ii. To study the effect of different types of ballast e.g. Aluminum choke, Copper choke and electronic choke on power consumption of Fluorescent Lamp

iii. To find the relative light output of the various lamps on the working area

Procedure : [Note the fuse rating. Do not put on supply power without the permission of the teacher/teaching assistant assigned for the experiment.]

For experiment no. 6(a)

1. Connect the circuit as shown in Fig.6.1. First use the Tungsten filament lamp.
2. ENSURE ZERO VOLTAGE OUTPUT OF VARIAC BEFORE CONNECTING IT TO THE CIRCUIT.
3. Set the variac voltage to 100 volt and take down the readings of ammeter and voltmeter.
4. Increase the variac output voltage to 230V A.C (rated voltage) in steps of 20 volt.
5. Note the luxmeter reading at 230 V for Tungsten lamp over and above the ambient lighted environment.
6. Repeat the above steps for Carbon filament lamp.
7. complete the DATA SHEET to be prepared by you as shown in SAMPLE DATA SHEET.

For experiment no. 6(b)

1. Connect the Fluorescent lamp according to the circuit diagram in Fig.6.2.
2. ENSURE ZERO VOLTAGE OUTPUT OF VARIAC BEFORE CONNECTING IT TO THE CIRCUIT.
3. Increase the input voltage by variac and note the voltage at which the Fluorescent lamp strikes. This voltage is known as "Striking Voltage."
4. Note down the readings of the voltmeters, ammeter and wattmeter from striking voltage up to rated voltage 230V in steps of 20 volt.
5. Measure the luxmeter reading at 230 V for Fluorescent lamp over and above the ambient lighted environment.

6. Decrease the applied voltage gradually till the lamp just extinguishes. Note this voltage. This voltage is known as "Extinguishing Voltage."
7. Repeat each of the above steps for Aluminum choke, Copper choke and Electronic choke as shown in Fig.6.3.
8. Connect the Compact Fluorescent (CFL) as shown in Fig.6.4. and measure the power consumption and compare with readings for Fluorescent lamp.
9. Measure the Luxmeter reading at 230V for CFL over and above the ambient lighted environment.
10. Fill up TABLE -II(a),TABLE-II(b) and TABLE -III of DATA SHEET to be prepared by you as shown in SAMPLE DATA SHEET.

Report:

1) Draw curves of a) voltage vs. current, b) power vs. voltage and c) resistance vs. voltage for both tungsten and carbon lamp on the same graph paper (using 2 different colors).
2) Why the slope of volt-ampere characteristics is increasing in case of tungsten lamp and decreasing in case of carbon lamp?
3) Plot power vs. voltage curve for each type of choke for fluorescent lamp.
4) Plot power vs. voltage curve for CFL.
5) Comment on the variation of power consumption of fluorescent lamp for different types of choke.
6) Draw a complete circuit diagram showing how a Fluorescent lamp is to be operated from D.C. supply.
7) Show one set of sample calculations.

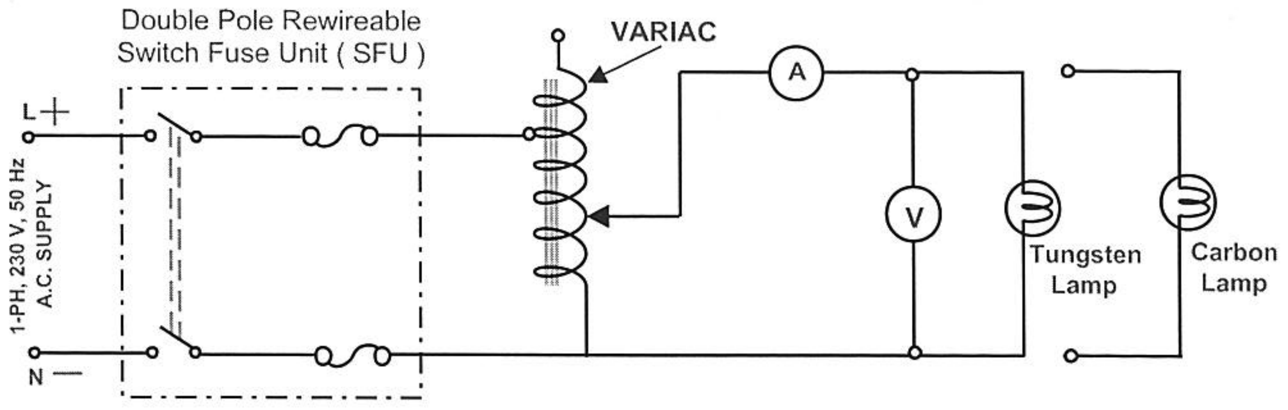

Fig : 6.1 Circuit Diagram for Determination of Lamp Characteristic (Tungsten/Carbon)

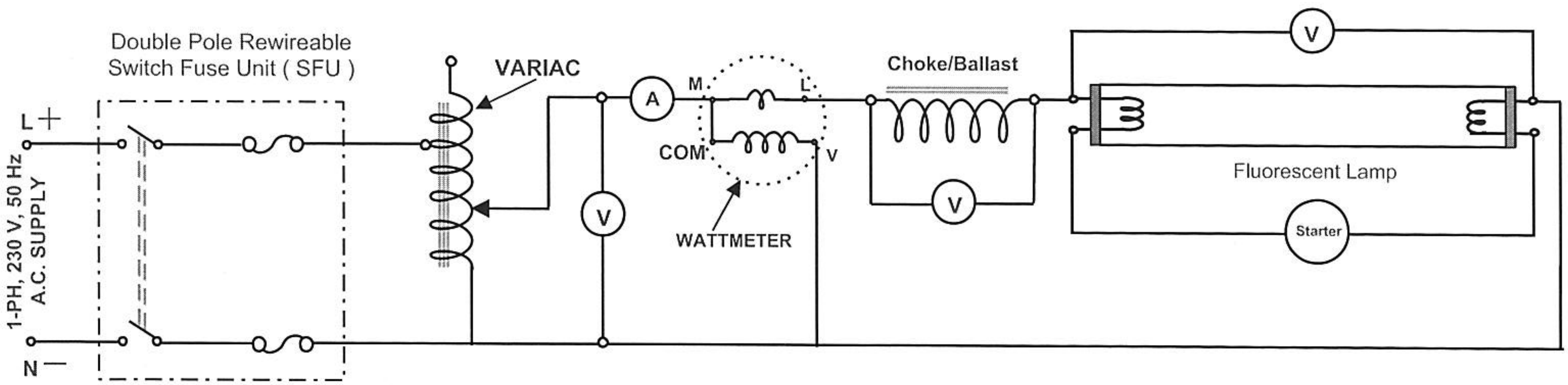

Fig : 6.2 Circuit Diagram for Determination of Lamp Characteristic (Fluorescent)

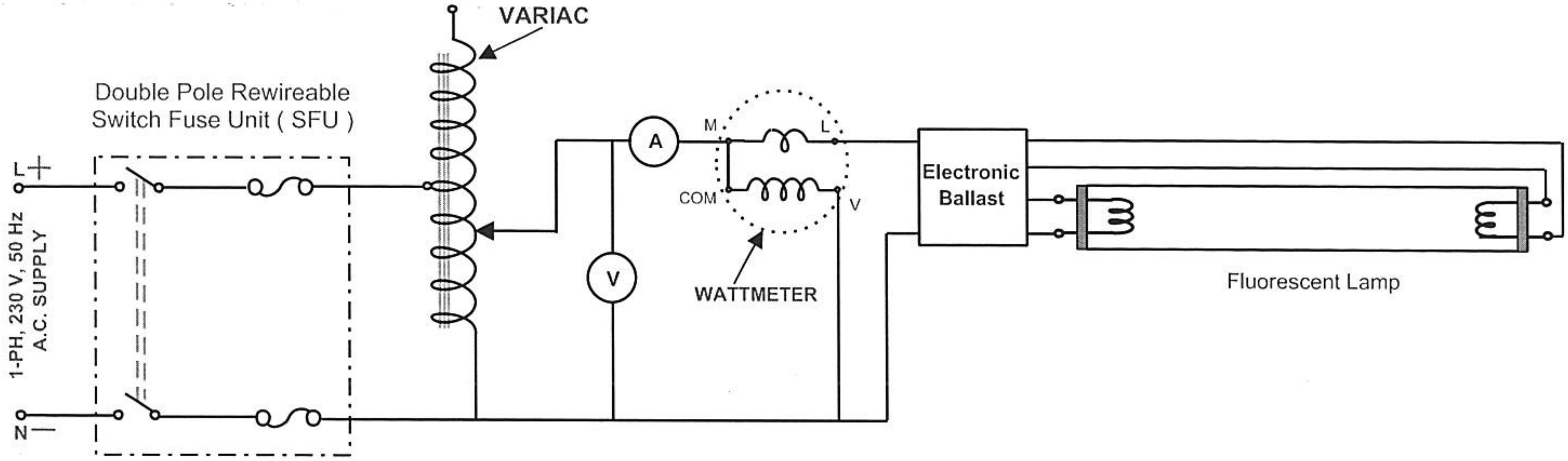

Fig: 6.3 Circuit Diagram For Determination Of Lamp Characteristic With Electronic Ballast (Fluorescent Lamp)

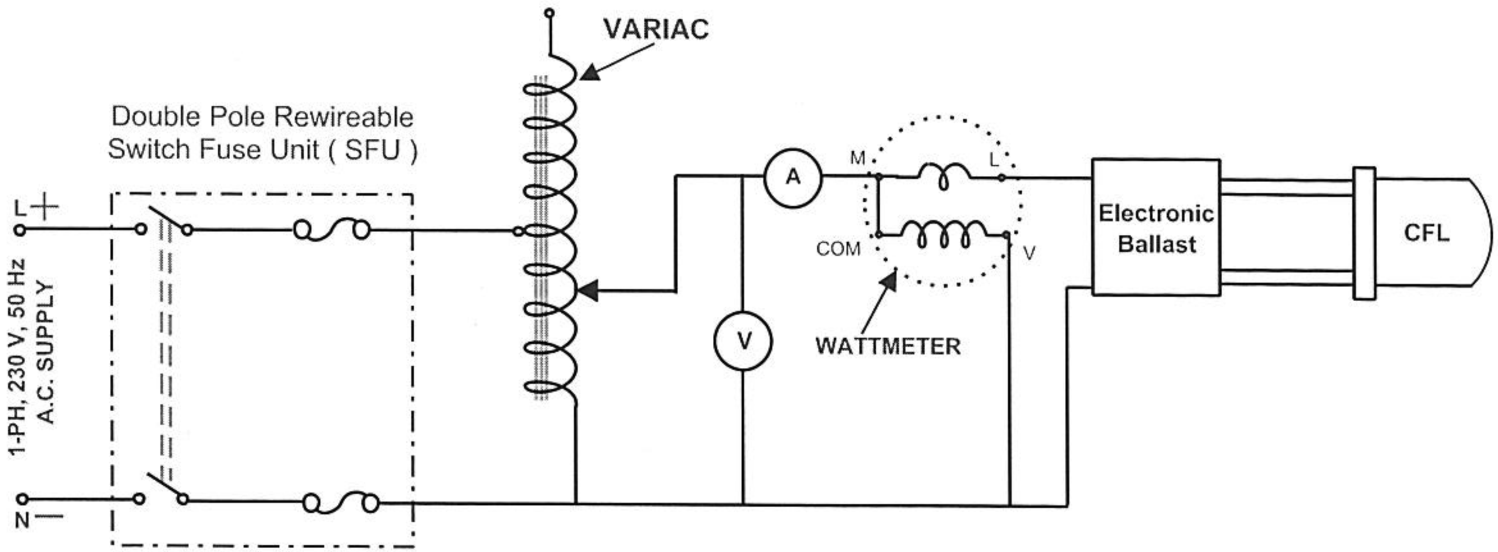

Fig: 6.4 Circuit Diagram For Determination Of Lamp Characteristic With Electronic Ballast (Compact Fluorescent Lamp)

SAMPLE DATA SHEET

TITLE OF THE EXPERIMENT :______________________________

NAME: ________________________ ROLL NO: __________

DATE: __________

Apparatus used: (Add additional rows if needed.)

Sl. No.	Item	Quantity	Range/Rating	Lab No	Maker's Name

Experiment Data:

TABLE-I

For tungsten and carbon filament lamp:

Sl. No.	Tungsten Filament Lamp				Carbon Filament Lamp			
	Voltage	Current	Power	Resistance	Voltage	Current	Power	Resistance

Luxmeter reading of Tungsten Lamp at 230VAC:

For Fluorescent Lamp

TABLE -II(a)

Sl. No.	Type of choke	Striking Voltage	Extinguishing Voltage
	Aluminum choke		
	Copper Choke		
	Electronic Choke		

For Fluorescent Lamp **TABLE-II(b)**

Sl. No.	Type of Choke	Voltage	Current	Power	Luxmeter reading	Power factor of the circuit
	Aluminum choke					
	Copper Choke					
	Electronic Choke					

<u>For Compact Fluorescent Lamp(CFL)</u> **TABLE-III**

Striking Voltage :

Extinguishing Voltage :

Sl. No.	Voltage	Current	Power	Luxmeter reading	Power factor of the input

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INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

BASIC E.E. LABORATORY **First/Second Semester**

Expt. No. 1251/7

TITLE: Verification of three phase voltage, current relationship

Objective : To verify the relationships between line quantities and phase quantities (voltage and current) for a balanced three phase, three wire system with
a) star connected and b) delta connected load

Theory :

A) **Star connected load**

A three phase star connected load(Fig.7.1) is an open network consisting of at least three resistances (impedances) with one terminal of each resistance (impedance) element is connected together at a common point (also known as a star point), the remaining three terminals being left open for connection to the external circuit (here, the supply from variac.

If the values of the resistances (impedances) are equal, then the three phase load is balanced.

Hence $R_1 = R_2 = R_3$ for balanced 3-ph load.

3-Φ supply and star connected load are shown in Fig.7.1.

Line voltage = $V_{RY} = V_{YB} = V_{BR} = V_L$ (for balanced 3-ph supply)

Phase voltage = $V_{RN} = V_{YN} = V_{BN} = V_{Ph}$ (For balanced 3-ph supply) and $V_L = \sqrt{3}\, V_{Ph}$ for star connection.

I_R, I_Y, I_B are line and phase currents (assumed positive) and $I_L = I_{Ph}$ for star connection.

All quantities are expressed in r.m.s.

B) **Delta connected load:**

A three phase delta connected load(Fig.7.3) is a closed network consisting of at least three resistances, each of them being connected between separate pair of terminals, one terminal of a pair is connected to one terminal of another pair in succession. The common terminal thus created for each connection is then made available for connection to the external circuit.

If the values of the resistances are equal, then the three phase load is balanced. Hence $R_1 = R_2 = R_3$ for balanced 3-ph load.

3-Φ supply and delta connected load is shown in Fig.7.3

$V_{RY} = V_{YB} = V_{BR} = V_L = V_{Ph}$ for balanced 3-ph supply and $V_L = V_{Ph}$ for delta connection.

I_R, I_Y, I_B are line currents (assumed positive) and $I_L = \sqrt{3}\, I_{Ph}$ in magnitude for delta connection.

I_{12}, I_{23}, I_{31} are phase currents.

Procedure: [Note the fuse rating. Do not put on supply power without the permission of the teacher/teaching assistant assigned for the experiment.]

A) For Star Connection

1) Make the circuit connection as shown in Fig.7.4
2) Identify the **FIXED RESISTANCE TERMINALS** of each rheostat. Connect one fixed terminal (preferably, maintain symmetry) of each rheostat to form the 'STAR' point.
3) Connect the three remaining terminals of star connected load to three phase variac output terminal.
   ENSURE ZERO VOLTAGE OUTPUT OF THE VARIAC BEFORE CONNECTING IT TO THE CIRCUIT.
4) Switch-on the mains and set variac output to100V. Note the readings of three ammeter. Measure voltage between terminals *R* and *Y*, *Y* and *B*, *B* and *R* by voltmeter, also measure voltages between *R* and *N*, *Y* and *N*, *B* and *N*.
5) Gradually increase the variac output and set it to (a)150V and then to (b) 200V, and repeat the method of step 4.
6) Check the relationships between V_L and V_{Ph}, I_L and I_{Ph} for each reading and complete the table.
7)

B) For Delta Connection

1) Make the circuit connection as shown in Fig-7.4.
2) Repeat steps 2 and 3 stated in star connection (A) above.
3) Switch-on the mains and set variac output to 100 V. Note the readings of ammeters. Measure voltage between *R* and *Y*, *Y* and *B*, *B* and R by voltmeter.
4) Gradually increase the variac output and set it to (a)150V and then (b) 200V .
5) Repeat step 3 and check the relationships between V_L and V_{Ph}, I_L and I_{Ph} for each reading and complete the table.

Report:

1) What is meant by phase sequence of a 3-ph supply ?
2) Is it possible to form a balanced star-connected or delta-connected load using a) pure inductance, b) pure capacitance, c) R-L series combination, d) R-C series combination in each branch of the load?
3) Draw phasor diagram for the following:
   (a) Balanced star connected load with pure resistance
   (b) Balanced delta connected load with pure resistance
4) Calculate the phase angle between the line voltage V_{RY} and the phase current I_{YB} in a delta connected system when the load p.f. is $1/\sqrt{2}$ leading, assume supply phase sequence to be RYB.
5) A 415V, 3-ph 4-wire distribution system has a balanced load of 2.3 kW in each phase. Calculate the neutral current.

6) In Question 4 above, if two supply lines are switched off, calculate neutral current if p.f. is unity.
7) A 3-ph delta connected load consumes a total power of 3 kW. Another 3-ph 415V star connected load consumes a total power of 3 kW.
   Assuming unity p.f. load, calculate phase current, line current, phase voltage, line voltage in both cases. Calculate the power consumed and the load resistance per phase in both the cases.

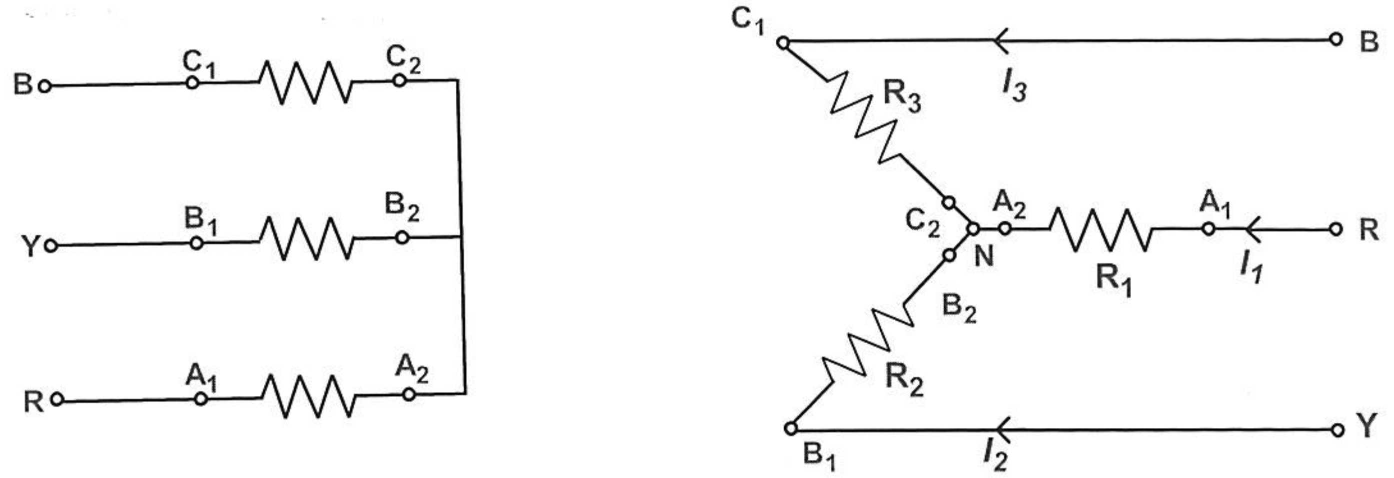

Fig : 7.1 Three Phase Star Connected Load

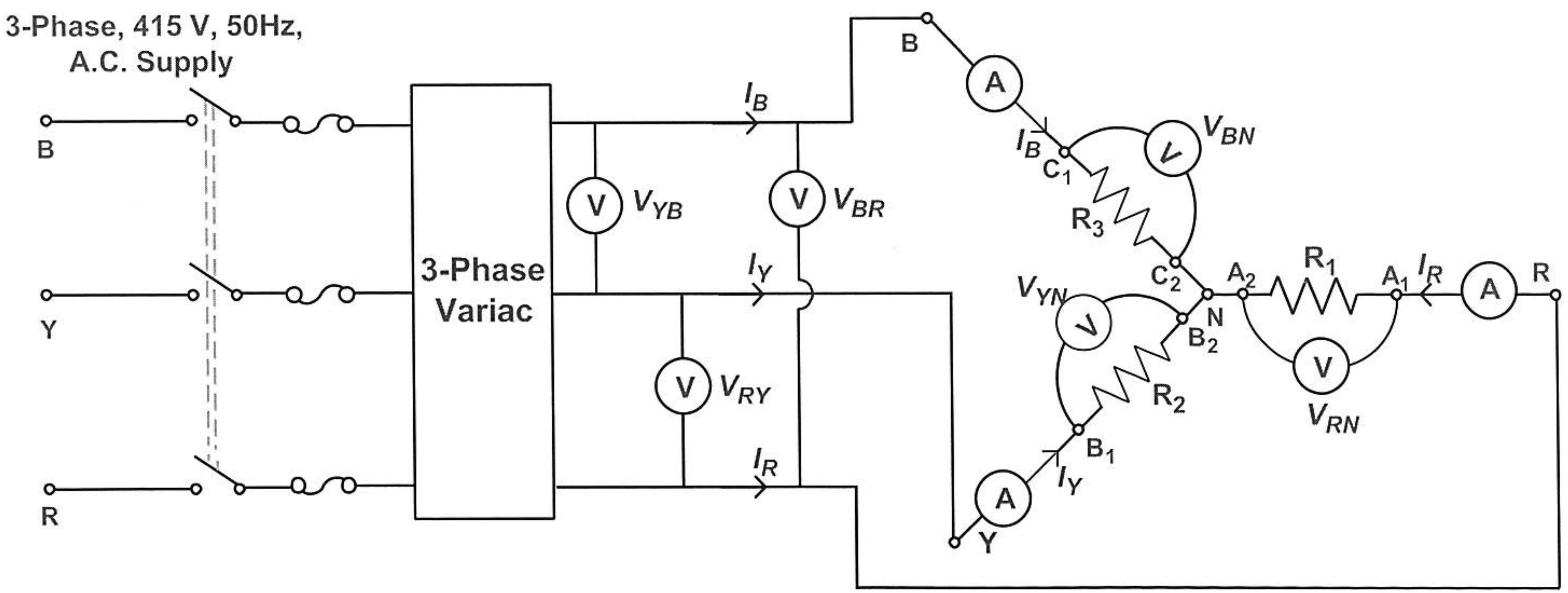

Fig : 7.2 Circuit Diagram of 3-Phase Supply and Star Connected Load

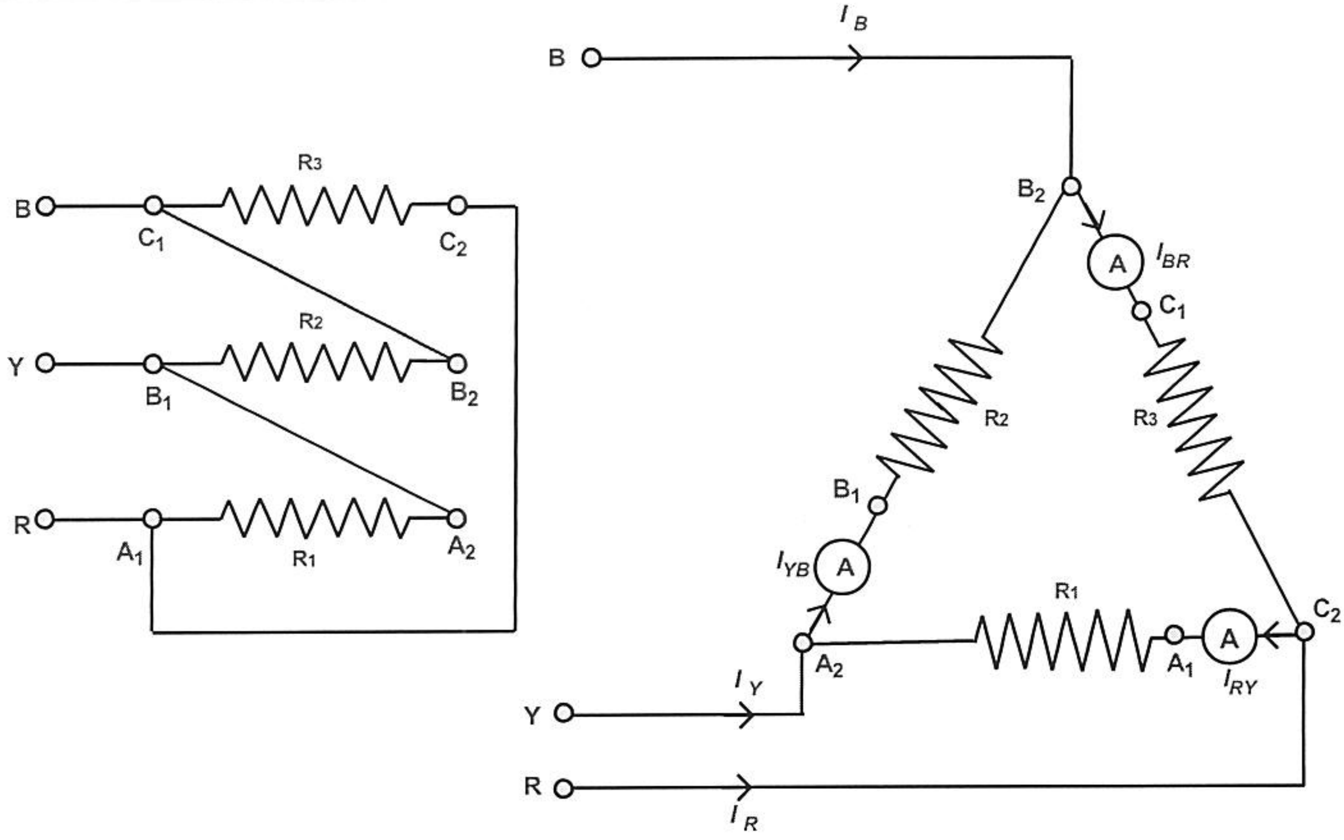

Fig : 7.3 Three phase Delta connected Load

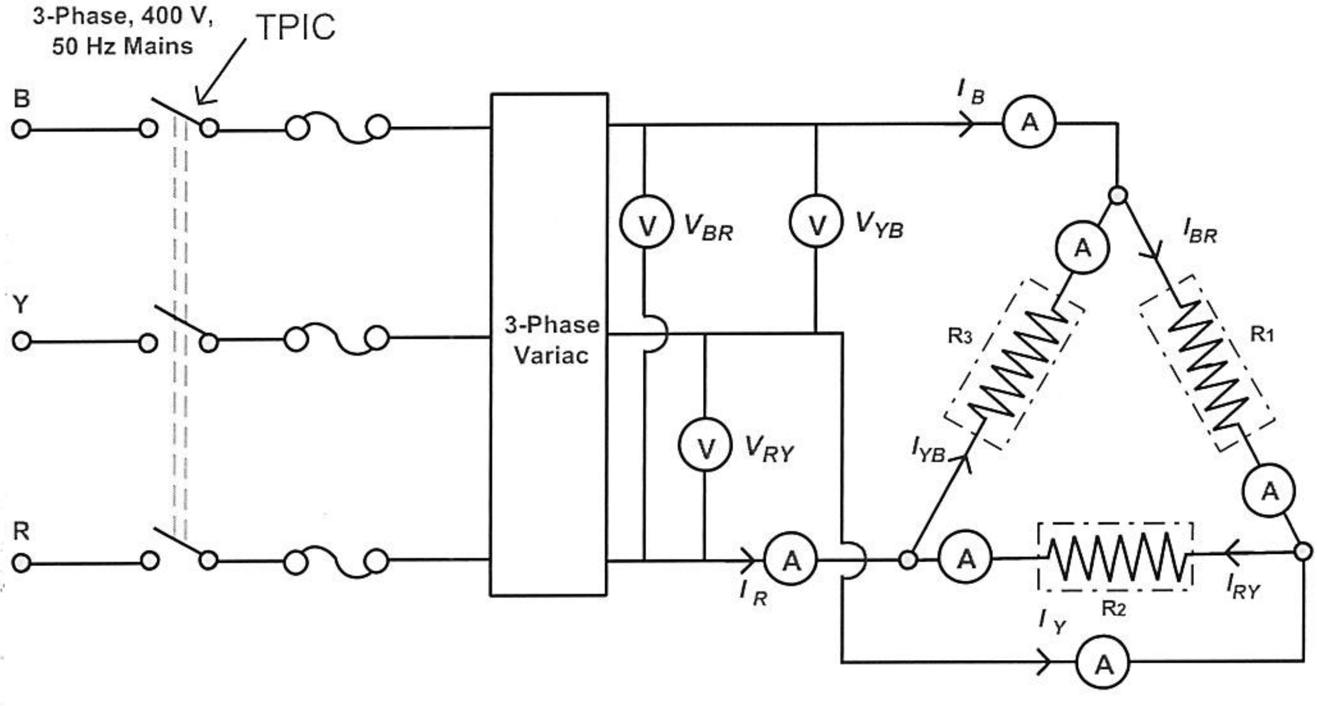

Fig : 7.4 Circuit Diagram Of 3-Phase Supplu and Delta Connected Load

SAMPLE DATA SHEET

TITLE OF THE EXPERIMENT :____

NAME: ______________________________ ROLL NO: __________

DATE: ____________

Apparatus used: (Add additional rows if needed.)

Sl. No.	Item	Quantity	Range/Rating	Lab No.	Maker's Name

Experimental Data:

Sl. No.	Type of connection	Observation												Calculation	
		Line voltage (V_L)			Phase voltage (V_{ph})			Line current (I_L)			Phase current (I_{ph})			V_L/V_{ph}	I_L/I_{Ph}

____

Signature of the Teacher