LIST OF EXPERIMENTS

BASIC ELECTRICAL ENGINEERING

1. **To verify KCL and KVL**
2. **To study the V-I characteristics of an incandescent lamp.**
3. **To measure single phase power by using three ammeter method.**
4. **To measure the single phase power by using three voltmeter method.**
5. **To perform short circuit test on a single phase transformer.**
6. **To perform open circuit test on a single phase transformer.**
7. **To measure three phase power by using two wattmeter method.**
8. **To verify Thevenin's theorem.**
9. **To verify Superposition theorem.**

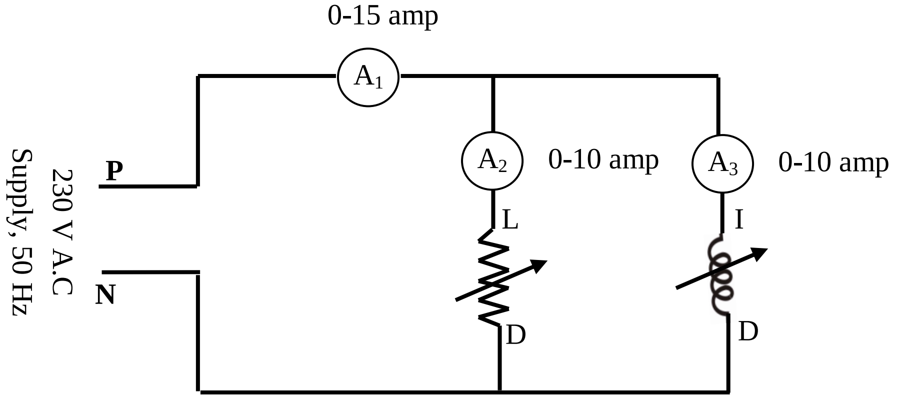
Aim: To verify Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL)

Apparatus Required:

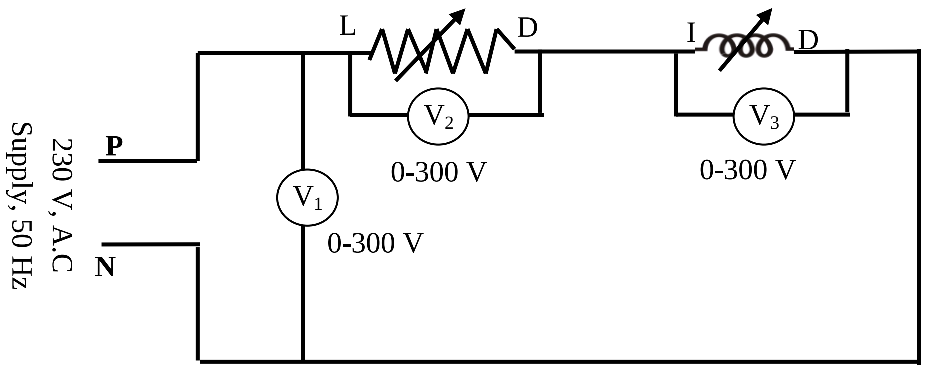
1. A.C. Ammeter- 3 nos. (0-10 amp)
2. A.C Voltmeter - 3 nos. (0-300 V)
3. Rheostat
4. Inductive Load
5. Connecting wires

Circuit Diagram:

KCL



KVL



Theory:

Procedure:

KCL:

1. First measure the least count of all ammeters A_1, A_2, and A_3 and all voltmeters V_1, V_2 and V_3.
2. Connect the circuit as shown in the diagram.
3. Now, vary both the resistive and inductive load to obtain different readings of ammeters A_1, A_2 and A_3 and voltmeters V_1, V_2 and V_3.
4. Repeat the same procedure for different observations.
5. Calculate percentage error.

KVL:

1. Connect the circuit as shown in the diagram.
2. Now, adjust both the rheostat and inductive load to obtain different values of then take V_1, V_2 and V_3.
3. Repeat the same procedure for different observations.
4. Calculate percentage error.

Observation Table:

KVL

Sl.No.	V_1 in (Volts)	V_2 in (Volts)	V_3 in (Volts)	$V_1^{'} = \sqrt{V_2^2 + V_3^2}$	% Error
1					
2					
3					

KCL

Sl.No.	A_1 in (Volts)	A_2 in (Volts)	A_3 in (Volts)	$A_1^{'} = \sqrt{A_2^2 + A_3^2}$	% Error
1					
2					
3					

Calculations:

KCL

% Error = $\left|\frac{A_1^{'} - A_1}{A_1}\right| \times 100$

KVL

% Error = $\left|\frac{V_1^{'} - V_1}{V_1}\right| \times 100$

Precautions:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly.
3. Remove insulations from the connecting wire so as the current will flow properly.
4. Avoid loose connections and don’t touch wire with wet hand.

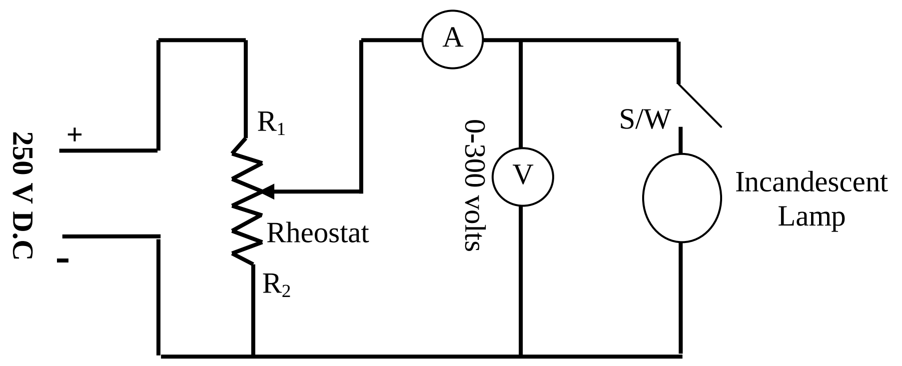
EXPERIMENT NO. 2

Aim of the Experiment: To study the V-I characteristics of an incandescent lamp.

Apparatus Required:

1. Incandescent lamp - 1 no.- (200 Watt)
2. Rheostat – 1 no.- (128 Ohm, 2.3 A)
3. D.C Voltmeter - 1 nos. (0- 300 V)
4. D.C Ammeter - 1 nos. (0-2.5 A)
5. Connecting wires
6. Supply: 250 V D.C

Circuit Diagram:



Theory:

Procedure:

1. Connect the circuit as shown in the diagram with the switch (S/W) is in off position. .
2. Switch on D.C supply, close the switch and vary the rheostat to obtain different voltage and current values. Note the voltage and corresponding current values. Record the Calculate percentage error.
3. Switch of supply then open the switch.

Observation Table:

Sl.No.	*V* in (Volts)	*I* in (Amps)	R=V/I
1			
2			
3			

Plot the V-I characteristics of incandescent lamp.

Remarks: The characteristic is non-linear.

Precautions:

1. Make the connections properly.
2. Note the readings of voltmeters and ammeters properly.
3. Remove insulations from the connecting wire so as the current will flow properly.

Questions:

1. Why V-I characteristics of incandescent lamp is nonlinear.
2. Is it satisfy ohm’s law, and why?

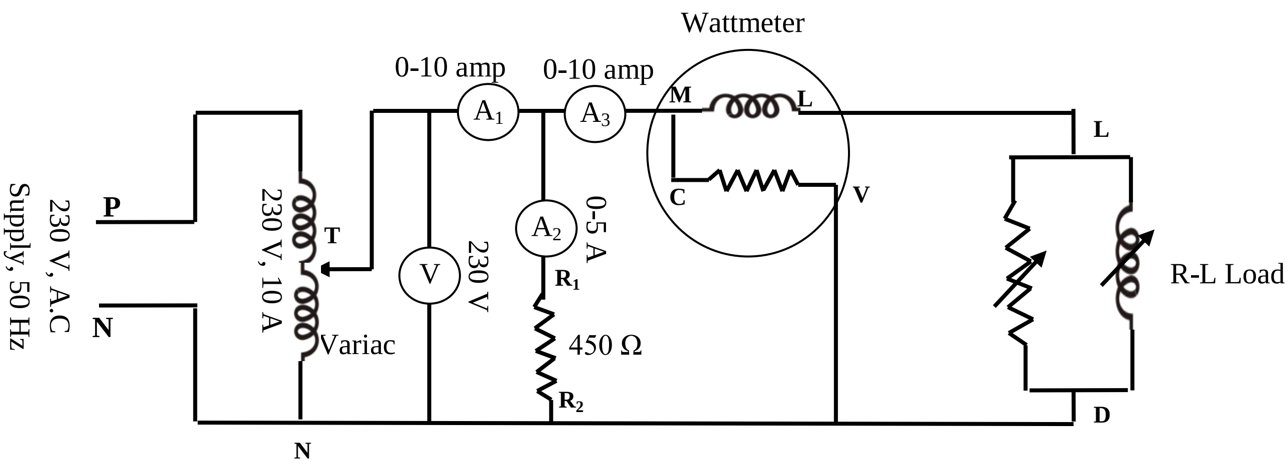
EXPERIMENT NO. 3

Aim of the Experiment: To measure the single phase power in a single phase a.c. circuit by using three ammeters.

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 250 V, 0- amp)
2. A.C Ammeter - 1 nos. (0-10 A)
3. A.C Ammeter - 2 nos. (0-5 A)
4. A.C Voltmeter - 1 nos. (0-300 V)
5. Variac: 230 V, 10 A, 50 Hz, 1-Phase
6. Resistor: 450 ohm
7. R-L Load Box
8. Connecting wires

Circuit Diagram



Theory:

Power consumed by load= $P=VI_3 \cos Ø$ (1)

From the phasor diagram we can write,

$I_1^2=I_2^2+I_3^2+2.I_2.I_3 \cos Ø$ (2)

Power factor, $\cos Ø= (I_1^2-I_2^2-I_3^2)/ 2.I_2.I_3$ (3)

$I_2=V/R$ (Here R= 450 Ohm)

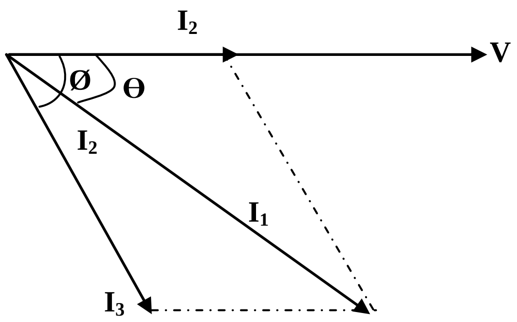
Now,

$P_{calculated} =VI_3 \cos Ø= I_2R\ I_3 \cos Ø$

$= R\ I_2\ I_3\ ((I_1^2-I_2^2-I_3^2)/ 2.I_2.I_3) = (R/2) * (I_1^2-I_2^2-I_3^2)$ (4)

From the above equation it can observed that, the power and power factor in an a.c circuit can be measured by using 3-single phase ammeters, instead of a wattmeter.

Percentage Error = ($P_{calculated}$-Wattemter Reading) / Wattemter Reading



Phasor diagram of the above circuit.

Procedure:

1. Make the connections as per the circuit diagram.
2. Keep the variac at zero position before starting the experiment.
3. Switch on A.C supply.
4. By varying the variac set the voltmeter reading as supply voltage.
5. Vary the RL load to obtain different readings of ammeters, and wattmeter.
6. Repeat step 5 for different observations.
7. Set the variac at zero position and switch of supply.

Tabulation:

Sl.No.	A1 in (amp)	A2 in (amp)	A3 in (amp)	$P_{calculated}$	Wattmeter Reading*M.F	cos Ø
1						
2						
3						
4						

Calculation:

Calculate the value of P, cos Ø.

Percentage Error = ($P_{calculated}$-Wattemter Reading) / Wattemter Reading

Precautions:

1. All connection should be proper and tight.
2. The zero setting of all the meters should be checked before connecting them in the circuit.
3. The current through ammeter should never be allowed to exceed the current rating of variac and load used.

Questions:

1. In an a.c. circuit which power is more apparent or real and why?
2. What is the basic difference between an inductive load and purely inductive load?
3. The practical loads are purely inductive or inductive?
4. What is load factor?

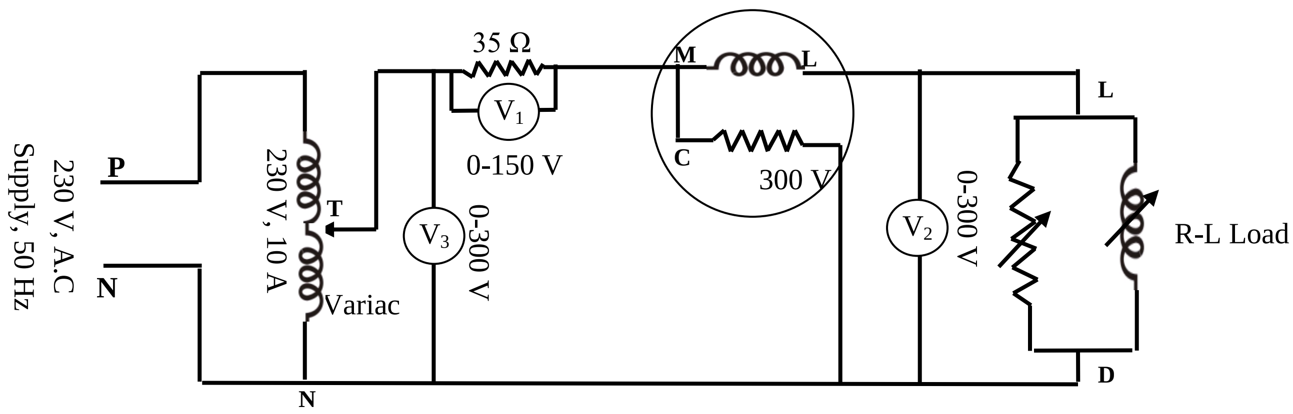
EXPERIMENT NO. 4 T.N. 2 B

Aim of the Experiment: To measure the single phase power in a single phase a.c. circuit by using three voltmeters.

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 300 V, 10- amp)
2. A.C Voltmeter - 1 nos. (0-180 V)
3. A.C Voltmeter - 1 nos. (0-300 V)
4. Variac: 230 V, 10 A, 50 Hz, 1-Phase
5. Resistor: 35 Ω
6. R-L Load Box
7. Connecting wires

Circuit Diagram



Theory:

Power consumed by load= $P=V_2 I \cos Ø$ (1)

From the phasor diagram we can write,

$V_3^2=V_1^2+V_2^2+2.\ V_1.\ V_2 \cos Ø$ (2)

Power factor, $\cos Ø= (V_3^2-V_1^2-V_2^2)/\ 2.\ V_1.\ V_2$ (3)

$I=V_1/R$ (Here R= 35 Ohm)

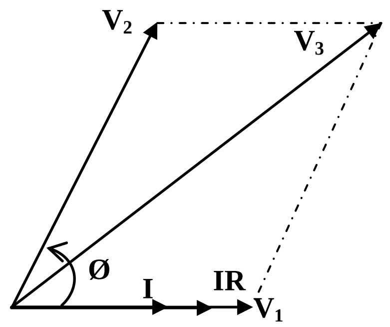
Now,

$P_{calculated} = V_2\ I \cos Ø = V_2\ (V_1/R)\ \cos Ø$

$= (V_1\ V_2/R)\ ((V_3^2-V_1^2-V_2^2)/\ 2.\ V_1.\ V_2) = (1/2R) * (V_3^2-V_1^2-V_2^2)$ (4)

From the above equation it can observed that, the power and power factor in an a.c circuit can be measured by using 3-single phase voltmeters, instead of a wattmeter.

Percentage Error = ($P_{calculated}$-Wattemter Reading) / Wattemter Reading



Phasor diagram of the above circuit.

Procedure:

1. Make the connections as per the circuit diagram.
2. Keep the variac at zero position before starting the experiment.
3. Switch on A.C supply.
4. By varying the variac set the voltmeter reading as supply voltage.
5. Vary the RL load to obtain different readings of voltmeters, and wattmeter.
6. Repeat step 5 for different observations.
7. Set the variac at zero position and switch of supply.

Tabulation:

Sl.No.	V_1 in (volts)	V_2 in (volts)	V_3 in (volts)	$P_{calculated}$	Wattmeter Reading*M.F	cos Ø
1						
2						
3						
4						

Calculation:

Calculate the value of P, cos Ø.

Percentage Error = ($P_{calculated}$-Wattemter Reading) / Wattemter Reading

Precautions:

1. All connection should be proper and tight.
2. The zero setting of all the meters should be checked before connecting them in the circuit.
3. The current through ammeter should never be allowed to exceed the current rating of variac and load used.

Questions:

1. Why current is taken as a reference?
2. How to reduce error in power calculation?

EXPERIMENT NO. 5   T.N. 1 A

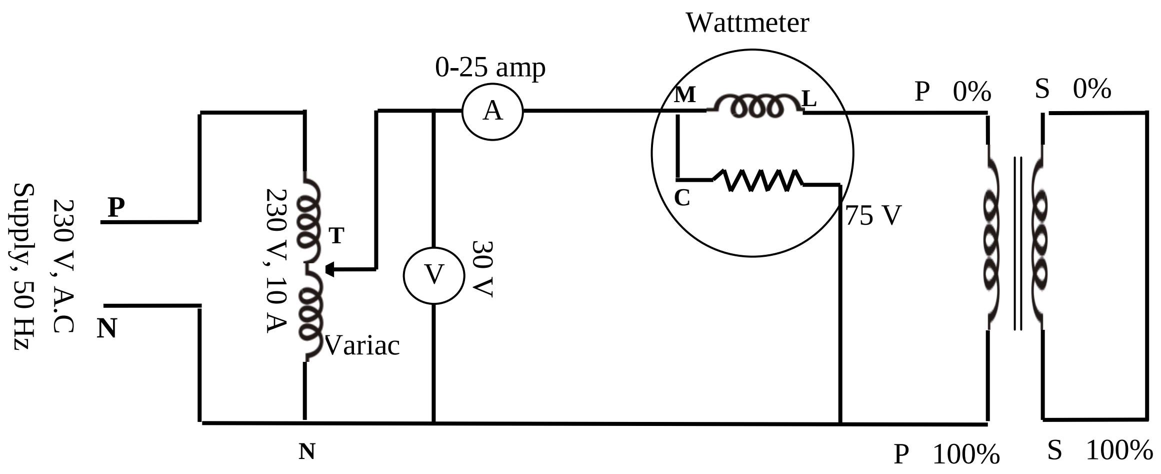
Aim of the Experiment: To perform short circuit test on a single phase transformer to calculate:

1. The copper loss of the transformer.

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 75 W)
2. A.C Voltmeter - 1 nos. (0-300 V)
3. A.C ammeter - 1 nos. (0-25 A)
4. Variac: 230 V, 10 A, 50 Hz, 1-Phase
5. Transformer (1phase, 50 Hz)
6. Connecting wires

Circuit Diagram



Theory:

$$R_{01} = \frac{W_{sc}}{I_{sc}^2}$$

$$Z_{01} = \frac{V_{sc}}{I_{sc}}$$

$$X_{01} = \sqrt{Z_{01}^{\ 2} - R_{01}^{\ 2}}$$

Procedure:

1. Make the connections as per the circuit diagram.
2. Make sure that the secondary side of transformer is shorted.
3. Keep the variac at zero position before switch on the supply.
4. Switch on A.C supply.
5. By varying the variac apply full load current to the transformer and note the reading of voltmeter, wattmeter and ammeter.
6. Keep the variac at zero position and switch of supply.

Tabulation:

Sl.No.	Voltmeter Reading (V)	Ammeter Reading (A)	Wattmeter Reading (W)
1			

Calculation:

Calculate the multiplying factor (M.F) of the wattermeter.

M.F= ((Rating of C.C)*(Rating of P.C)*cosϕ)/(Wattmeter Ratingin)

Copper loss = W_{sc} (in Watts) = Wattmeter Reading*M.F

Short circuit current=Ammeter reading= I_{sc}

Voltmeter Reading = V_{sc}

Copper loss = Wattmeter Reading =W_{sc}

Calculate the values of R_{01}, X_{01}, Z_{01}.

Precautions:

1. All the connections should be tight and clean.
2. Special care should be taken while selecting the ranges of the meters for conducting short-circuit test.
3. While conducting the short-circuit test, the voltage applied should be initially set at zero, and then increase slowly. If a little higher voltage than the required voltage be applied (by mistake), there is a danger of transformer being damaged.

Questions:

1. Why transformer rating is in KVA?
2. What type of losses occur in the primary and secondary windings of a transformer when it is in service?
3. How do copper losses vary with load on the transformer?
4. Which parameters of the equivalent circuit of a transformer can be found through short-circuit test ?

EXPERIMENT NO. 6 N. 2 A

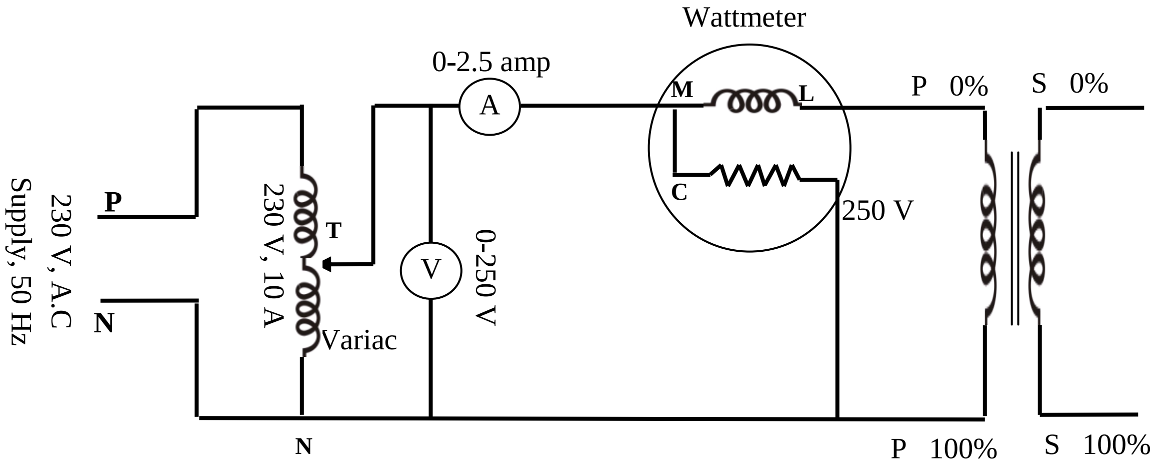
Aim of the Experiment: To perform open circuit test on a single phase transformer to calculate:

2. The equivalent circuit parameters with respect to primary side of the transformer.
3. The open circuit loss or core loss/iron loss of the transformer.

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 250 W)
2. A.C Voltmeter - 1 nos. (0-250 V)
3. A.C ammeter - 1 nos. (0-2.5 A)
4. Variac: 230 V, 10 A, 50 Hz, 1-Phase
5. Transformer (1phase, 50 Hz)
6. Connecting wires

Circuit Diagram



Theory:

$W = V_1 I_0 \cos\phi_0$ $\cos\phi_0 = W/(V_1 I_0)$

$$I_\mu = I_0 \sin\phi_0, I_W = I_0 \cos\phi_0$$

$$X_0 = \frac{V_1}{I_\mu}, R_0 = \frac{V_1}{I_W}$$

$$I_0 = V_1 Y_0 \quad , Y_0 = \frac{I_0}{V_1} \qquad W = V_1^2 G_0 \quad , G_0 = \frac{W}{V_1^2}$$

$$B_0 = \sqrt{Y_0^2 - G_0^2}$$

Procedure:

1. Make the connections as per the circuit diagram.
2. Make sure that the secondary side of transformer is open.
3. Keep the variac at zero position before switch on the supply.
4. Switch on A.C supply.
5. By varying the variac apply full supply voltage i.e. 230V to the primary of the transformer and note the reading of voltmeter, wattmeter and ammeter.
6. Keep the variac at zero position and switch of supply.

Tabulation:

Sl.No.	Voltmeter Reading (V)	Ammeter Reading (A)	Wattmeter Reading (W)
1			

Calculation:

Calculate the multiplying factor (M.F) of the wattermeter.

M.F= ((Rating of C.C)*(Rating of P.C)*cosϕ)/(Wattmeter Ratingin)

Iron loss = W (in Watts) = Wattmeter Reading*M.F

No load current=Ammeter reading= I_0

Supply Voltage =Voltmeter Reading = V_1

Precautions:

1. All the connections should be tight and clean.
2. Special care should be taken while selecting the ranges of the meters for conducting open-circuit test.

Questions:

1. When a transformer is energised what types of losses occur in the magnetic frame of the transformer?
2. What information can be obtained from open circuit test of a transformer?
3. Why in open circuit test HV side is always kept open?
4. What is the power factor of a transformer under no load test situation?
5. What is the magnitude of no load current as compared to full load current?

EXPERIMENT NO. 7 **T.N. 3**

Aim of the Experiment: To measure:

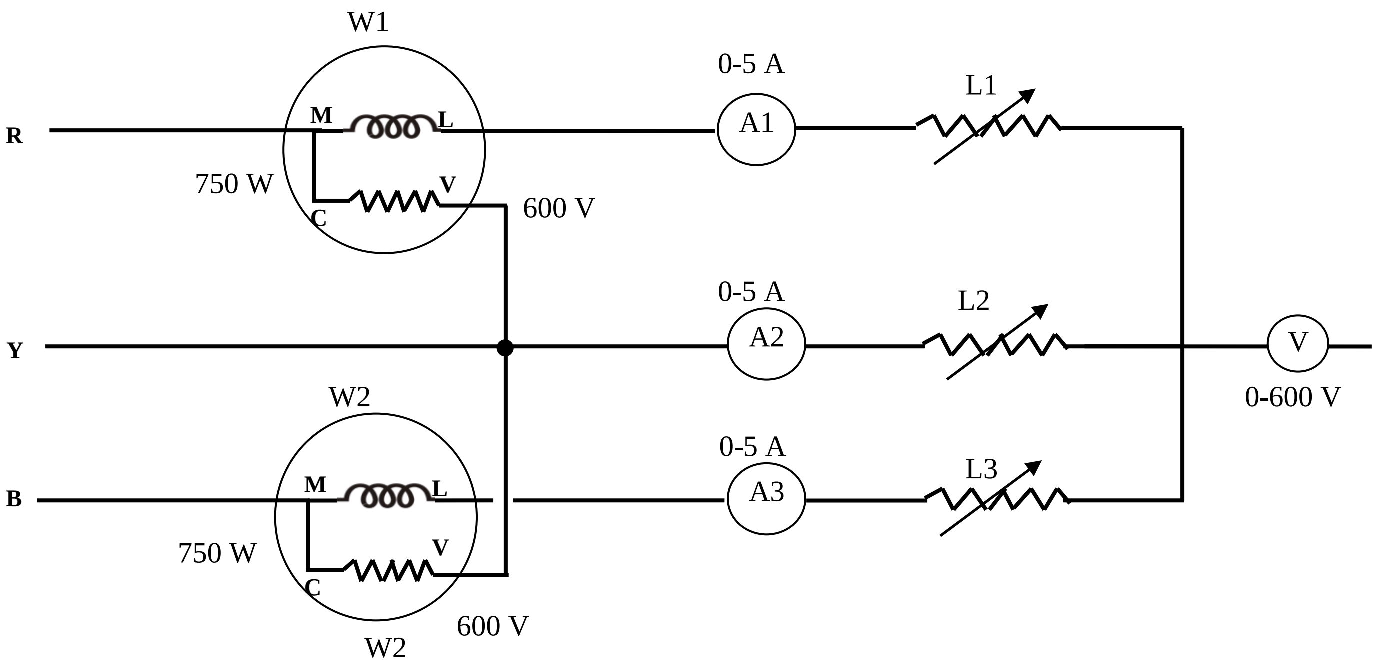
(i) three phase power and power factor in a balanced three phase circuit by using two single-phase wattmeter.

(ii) Calculate the three phase power for unbalance load condition.

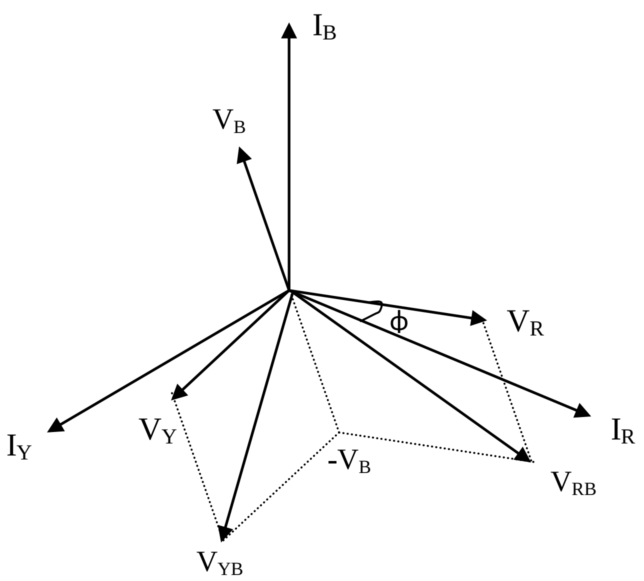
Apparatus Required:

1. A.C Wattmeter - 2 nos. (0- 600 V, 750 W)
2. A.C Voltmeter - 1 nos. (0-600 V)
3. A.C ammeter - 3 nos. (0-5 A)
4. Load Box

Circuit Diagram



Theory: For Balance Load Condition:



Phasor Diagram

$$P_M = W_1 + W_2 \tag{1}$$

$$P_C = 3\,V_{ph}\,I_{ph}\,\cos\phi \tag{2}$$

As it is a balance load condition, $V_a = V_b = V_c$ = Phase Voltage

$I_a = I_b = I_c$ = Phase Current

For resistive load $\cos\phi = 1$. So, $P_C = 3\,V_{ph}\,I_{ph}$

$$W_1 = V_{RB}\,I_R\,\cos(30^0 - \phi) = \sqrt{3}V_{ph}\,I_{ph}\,\cos(30^0 - \phi) \tag{3}$$

$$W_2 = V_{YB}\,I_Y\,\cos(30^0 + \phi) = \sqrt{3}V_{ph}\,I_{ph}\,\cos(30^0 + \phi) \tag{4}$$

$$W_1 + W_2 = \sqrt{3}V_{ph}\,I_{ph}\,[2\cos 30^0\,\cos\phi] = 3\,V_{ph}\,I_{ph}\,\cos\phi = \sqrt{3}\,V_L\,I_L\,\cos\phi \tag{5}$$

The above equation shows that the sum of the two wattmeter readings gives the total power consumed in the three-phase balanced system. We can also calculate the load power factor angle from the measurement of W_1 and W_2.

$$\frac{W_1}{W_2} = \frac{\cos(30^0 - \phi)}{\cos(30^0 + \phi)}$$

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{\cos(30^0 - \phi) - \cos(30^0 + \phi)}{\cos(30^0 - \phi) + \cos(30^0 + \phi)} = \frac{2\sin 30^0\,\sin\phi}{2\cos 30^0\,\cos\phi} = \tan 30^0\,\tan\phi$$

$$\tan\phi = \sqrt{3}\left[\frac{W_1 - W_2}{W_1 + W_2}\right] \tag{7}$$

For Unbalance Load Condition:

$P_M = W_1 + W_2$

$P_C = V_a I_a + V_b I_b + V_c I_c$, % Error = $\frac{P_C - P_M}{P_C} \times 100$

Procedure:

1. Make the connections as per the circuit diagram.
2. Switch on A.C supply.
3. For balanced load condition measured the values of wattmeters, ammeters and voltmeter.
4. Repeat the same process for unbalance load condition.
5. Switch off all the loads and supply.

Tabulation:

Sl. No.	Condition	I_R	I_Y	I_B	V_R	V_Y	V_B	M.F.	W_1	W_2
1	Balanced Load									
2	Unbalanced Load									

Calculation:

Calculate P_M, Pc and % Error.

Precautions:

1. All the connections should be tight and clean.
2. The readings in ammeters should not exceed the current ratings of wattmeters.
3. With negative deflection in wattmeter the connection should be reversed.

Questions:

1. Is it possible to measure reactive power in a three phase circuit using this method?
2. What would be the readings of two wattmeters in this experiment, if the load is purely resistive?
3. What would be the readings of two wattmeters in this experiment, if the load is purely inductive?
4. If one of the wattmeter reads zero, what is the power factor of the load?

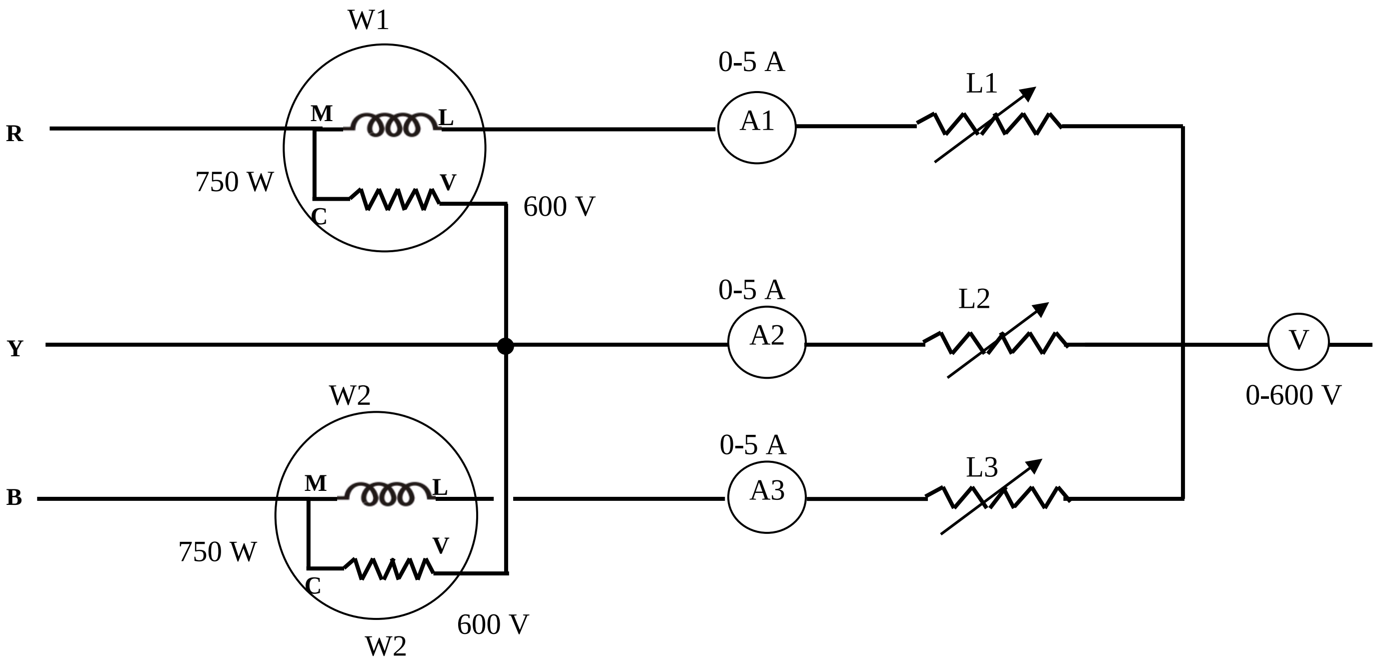
EXPERIMENT NO. 7 T.N. 3

Aim of the Experiment: To measure three phase power using two wattmeter method during balanced and unbalance load condition.

Apparatus Required:

1. A.C Wattmeter - 2 nos. (0- 600 V, 750 W)
2. A.C Voltmeter - 1 nos. (0-600 V)
3. A.C ammeter - 3 nos. (0-5 A)
4. Load Box

Circuit Diagram



Theory:

$$P_M = W_1 + W_2 \quad (1)$$

$$P_C = V_R I_R + V_Y I_Y + V_B I_B \quad (2)$$

For balance load condition, $V_R = V_Y = V_B$ = Phase Voltage
$I_R = I_Y = I_B$ = Phase Current

$$\% \text{ Error} = \frac{P_C - P_M}{P_C} \times 100$$

$$\tan\phi = \sqrt{3}\left[\frac{W_1 - W_2}{W_1 + W_2}\right] \quad (3)$$

$$\cos\phi = ?$$

Procedure:

1. Make the connections as per the circuit diagram.
2. Switch on A.C supply.

3. For balanced load condition measured the values of wattmeters, ammeters and voltmeter.
4. Repeat the same process for unbalance load condition.
5. Switch off all the loads and supply.

Tabulation:

Sl. No.	Condition	I_R	I_Y	I_B	V_R	V_Y	V_B	M.F.	W_1	W_2	$\cos\phi$
1	Balanced Load										
2	Unbalanced Load										

Calculation:

Calculate P_M, Pc and % Error.

Precautions:

1. All the connections should be tight and clean.
2. The readings in ammeters should not exceed the current ratings of wattmeters.
3. With negative deflection in wattmeter the connection should be reversed.

Questions:

1. Is it possible to measure reactive power in a three phase circuit using this method?
2. What would be the readings of two wattmeters in this experiment, if the load is purely resistive?
3. What would be the readings of two wattmeters in this experiment, if the load is purely inductive?
4. If one of the wattmeter reads zero, what is the power factor of the load?