DEPARTMENT OF APPLIED SCIENCE

LAB MANUAL

SUBJECT: BEE

B.TECH -1ST YEAR

KCT COLLEGE OF ENGG & TECH

FATEHGARH

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Sr. no.	Name of Experiment
1	To find voltage-current relationship in a R-L series circuit and to determine the power factor of the circuit.
2	To verify the voltage and current relations in star and delta connected systems.
3	To perform open- and short circuit tests on a single phase transformer and calculate its efficiency.
4	To start and reverse the direction of rotation of a DC motor.
5	To start and reverse the direction of rotation of Induction motor.
6	Experimentally verify the ohm's law.
7	To study the kirchoff's law (KVL and KCL).
8	To study the principle of fluorescent lamp.
9	To verify the rating of compact fluorescent lamp (CFL)

EXPERIMENT-1

Objective:To find voltage, current relationship and power factor of a given R-L circuit.

Apparatus Required: Variac or 1-phase auto-transformer-1, Single-phase ac load [or lamps and choke coils], Moving-iron voltmeter [0-250 V]-1, Moving iron ammeter [0-5 A]-1, Dynamometer .~-pe wattmeter (250 V, 5 A)-1, Double pole, single throw switch (DPST Switch)-1, Connecting ieads.

Theory: Current flowing through an ac circuit is given as

I= V/Z

where V is the ac supply voltage (voltage applied to the circuit) and Z is the impedance of the circuit in ohms.

Power factor of an ac circuit is given as P

Power factor, cos ~ = VI

Where P is power of the given load circuit in watts, V is the voltage applied to the circuit in volts and I is the current in amperes flowing through the circuit. Connection Diagram:

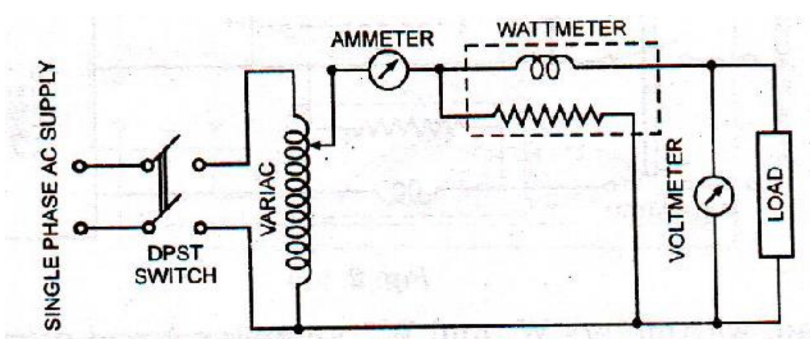


Fig. 1

Procedure: Variac, ammeter, wattmeter, voltmeter, load, (lamps in series with choke coils) are connected, through double pole single throw switch, to single phase supply mains as shown in fig. 1. The readings of ammeter, voltmeter and wattmeter are noted for var~ous settings of variac.

Observations:

S.No.	Voltmeter Reading, V in Volts	Ammeter Reading, I	Wattmeter Reading,	Power Factor of the Circuit,
1. 2. 3. 4.				

Conclusion: 1. Current I increases directly in proportion to applied voltage V.

2. Power factor of the circuit is same through out for a given load.

Note: If required, the readings of the instruments can be recorded with the different loads (by varying the number of lamps and chokes connected in series).

EXPERIMENT-2

Objective: To find out the line voltage, phase voltage relationship, line current and phase Current relationship in case of star-connected and delta connected, 3-phase balanced load.

Apparatus Required: TPIC switch (500 V, 15 A)-1, Moving iron type voltmeter (0-500 V)-2, Moving iron ammeter (0-10 A)-2, 3-phase balanced load (say a 3-phase, 440 V, 50 Hz, 7.5 kW induction motor), Board containing six open terminals-1 and Connecting leads.

Theory: In star-connections

Line voltage, V_L =~ phase voltage =~ V

p Line current, I_L = Phase current, I_p **In**

delta- connections

Line voltage, V_L = Phase voltage, V_p

Line current, I_L =~ phase current I_p

Connection Diagram:

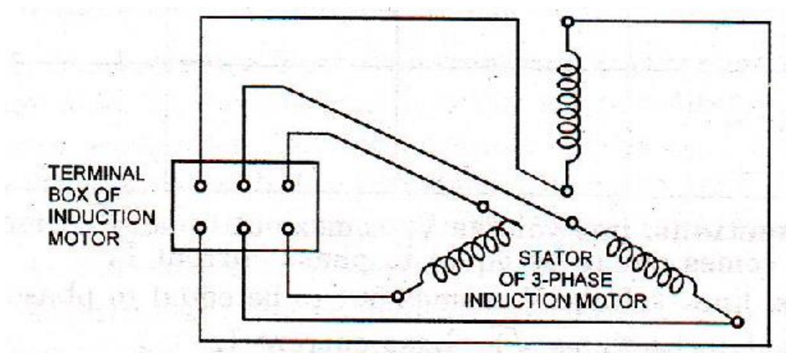


Fig. 3 (a)

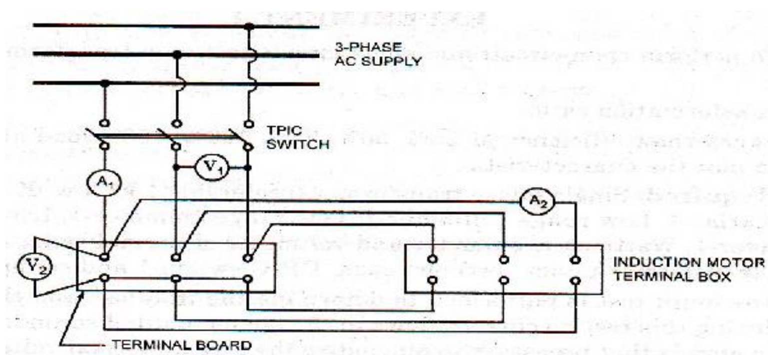


Fig. 3 (b). Star-Connections

Procedure: The connections of the terminal box of the induction motor to the stator phase windings of the motor are shown in fig. 3.3 (a). First of all the connections in terminal box are made, as shown in fig. 3.3 (b). The motor is started and put on load and readings of both voltmeters and ammeters are noted for different loads on the motor.

Now the TPIC switch is made off and the connections in terminal board are changed, as illustrated in fig. 3.3 (c) for delta connections. The motor is started and put on load and the readings of both ammeters and voltmeters are noted for different loads on the motor.

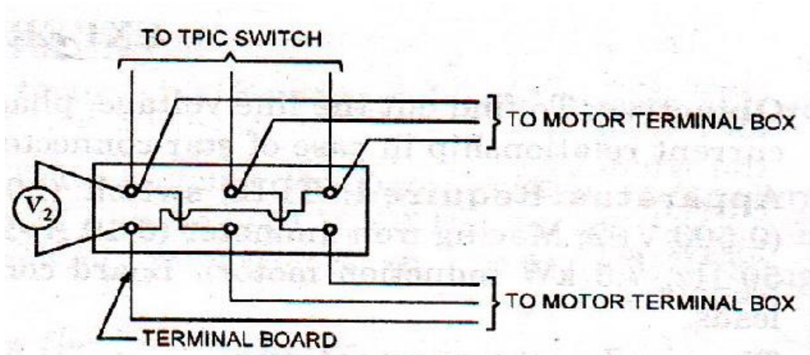


Fig. 3 (c) Delta-Connections

Connections	S. No. ~	Voltmeter Reading V_l, Line Voltage	Voltmeter Reading V_2, Phase Voltage	Ammeter Reading A_l, Line Current	Ammeter ~	V~ V_p	I_P
Star	1 2 3						
Delta	1 3						

Results : In star connections, line voltage V comes out to be ~ times phase voltage V_p and line current I_L comes out to be equal ~o phase current I_p. In delta connections, lines voltage V_L comes out ,;o be equal to phase voltage V_p and line current I_L comes out to be times ~ phase current I_p .

EXPERIMENT-3

Objective: To perform open-circuit and short-circuit test on a transformer and determine the following:

(a.) the transformation ratio.

(b) the transformer efficiency at 25%, 50%. 75%, 100%, l50% load at pf of 0.8 lagging and to pplot the characteristic

Apparatus Required: Single phase transformer (preferably 1 kVA with one winding rated at 230 V)-1, V ariac-1, Low range voltmeter-1, Low range ammeter-1, Low range low power factor wattrneter-1, W~attmeter, ammeter and voltmeter of normal ranges (depending upon the rating of transformer under test) one each, DPIC switch-1 and connecting leads.

Theory: Open-circuit test is performed to determine the iron loss and the transformation ratio. Since during this test no current flows in the open-circuited secondary, the current in the primary is merely that necessary to magnetise the core at normal voltage. Moreover, the magnetising current is very sma11 fractioii of the full-load current (usually 3 to 10 per cent of full-load current) and may be neglected as far as copper loss is concerned consequently, this test gives this core loss alone practically.

The transformation ratio, K-_ Secondary turns _ Secondary voltage on open-circuit Primary turns Voltage applied to primary

$$= V_2 / V_1$$

The short-circuit test is performed to determine the full-load copper loss. In this test ~ince the terminals of the low voltage winding are short-circuited, therefore, the trans:ormer becomes equivaTent to a coil having animpe~arice¯equal--t-o the impedance of both the windings. The applied voltage is very small as it is adjusted to cause flow of rated current in the windings, so the flux linking with the core is very small and, therefore, iron losses are negligible. The power drawn from the supply, therefore, represents full-load copper loss.

Transformer efficiency at any given load is given as

_ Output _______________ x

100 Output + iron loss + copper loss at given load

where Output = Voltmeter reading in open-circuit test, V_1
x ammeter reading during short-circuit test, I_5 xpf

Iron loss, P_i = Power input in open-circuit test with rated voltage = P_o

and Copper loss, P~ = Power input in short-circuit test

Connection Diagrams: See figures 8.20 and 8.21

Procedure: 1. (ipen-circuit Test. The transformer is connected, as shown in fig. 8.20 on the low voltage side. The ammeter A is a low range ammeter and W is a low range and low power factor wattmeter. The high voltage side is kept open-circuited. AC supply at rated voltage is switched on to the transformer through DPIC switch. High range voltmeter V_2 is connected across the secondary of the transformer. Readings of voltmeters V_1 and V_2, ammeter A and wattmeter W are noted and tabulated as below.

2. Short-circuit test. The transformer is connected as shown in fig. 8.21, the low voltage winding is short-circuited by connection having negligible resistance and good contacts. The voltage applied to the primary is increased in steps so that ammeter A carries 0.25, 0.5, 0.75 time rated current, rated current, and 1.5 times rated current.

The efficiency of the transformer is calculated at different loads as mentioned above and a curve is plotted between efficiency and load current.

Observations:

(i) Open-circuit test:

Primary voltmeter reading, V_1 =

.... Secondary voltmeter reading, V_2

= ....

Input power on no load, P_o = Wattmeter reading, W=.........

V _

Transformation ratio, K = V_1

....

***(ii)* Short-circuit test:** Rated primary current,

I Rated kVA X 1,000

- _ ....

f Rated primary voltage

Power factor, cos ~ = 0.8 (lag)

S. No.	Ammeter Reading in Amperes, I_S	Wattmeter Reading in Watts, P_S	Transformer Efficiency, V~ I_S cos~ ~~ = x V1l_S cos~+P_o+P_S V1l_S x0.8+P_a +P_S
1. **2.** 3. 4. 5.			

Result: 1.During short-circuit test, power input, P_S varies as the square of the input current, I_5 i.e. copper loss varies as the square of the load current.

2. The curve plotted between the transformer efficiency and load current [fig. 4) shows that the efficiency becomes maximum when copper loss equals iron loss.

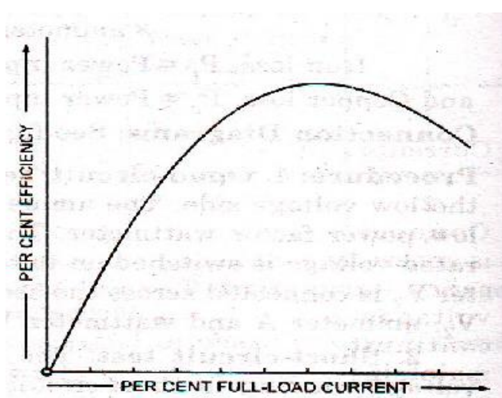


Fig. 4

EXPERIMENT-4

Objective: To study the speed control of a dc shunt motor and to draw the speed variation with respect to change of (a) field current (field control) and (b) armature current (armature control).

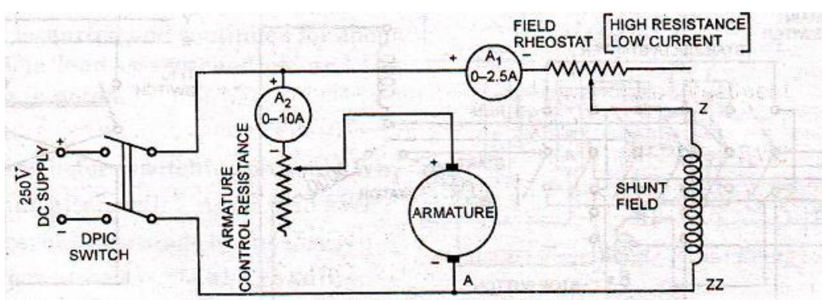
Apparatus Required: 250 V dc shunt motor of capacity, say, 2 kW-1, PMMC ammeter (0-2.5 A)-1 and (0-10 A)-1, Rheostats-high resistance, low current-1 andlow resistance, high current-1, Tachometer-1, DPIC switch-1 and Connecting leads.

Theory: The speed of a dc shunt motor is given as

$$N = K\frac{E_b}{\phi} = K\frac{V - I_a R_a}{I_{sh}}$$

Hence the speed of a dc shunt motor can be changed by either changing the shunt fie7d azn~xit h~~ (by inserting an external resistance in the field circuit) or changing the back emf, *Eh, (i.e.* V- IQ RO) by inserting an external resistance in the armature circuit.

Connection Diagram:



Procedure: The connections are made, as shown in fig. 10, and the rheostats are put in zero positions. The dc supply is switched on by closing the DPIC switch.

Field control: The reading of ammeter A*1* is noted and the speed of the motor is measured by tacliometer. Now the field rheostat setting is changed in steps (increasing the resistance)

and ammeter A_1 readings are noted and the motor speed is measured
and recorded. Now the field rheostat setting is brought back to zero.

Armature Control: Resistance is increased in steps in the armature circuit for armature resistance control. The ammeter A_Z readings are noted and the motor speeds are measured
and recorded.

Armature control rheostat is brought back to zero and the supply is switched off through DPIC switch.

Observations:

S.No.	Field Control		Armature Control	
	Ammeter A_1 Readings in Amperes, I_{sh}	Speed of Motor in RPM	Ammeter A~ Readings in Amperes, I_o	Speed of Motor in RPM
1				
2				
3				
4				
5				

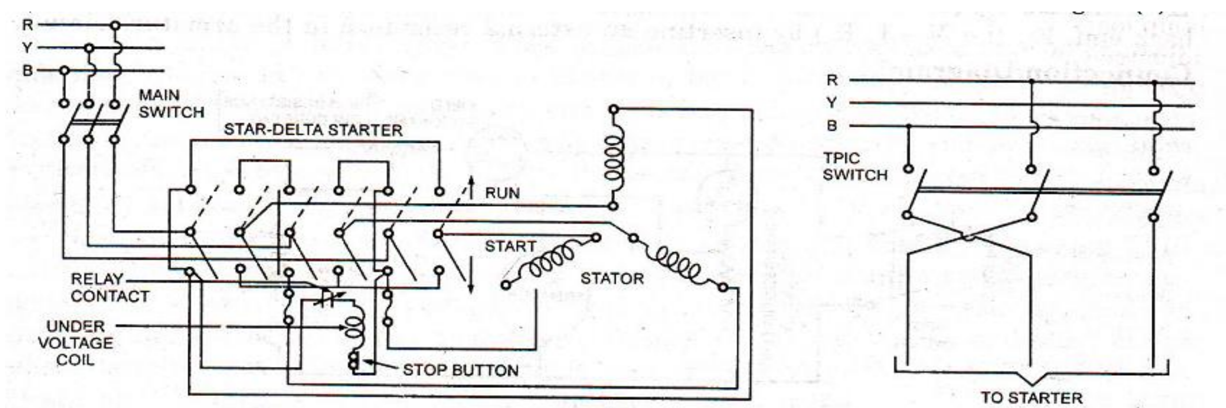
Result: l. With the increase in resistance in the field circuit, the field current decreases *i.e.* field becomes weaker and, therefore, speed increases.

2. With the increase in resistance of the armature circuit, voltage drop in armature increases *i.e.* back emf E_h decreases and, therefore, speed decreases.

EXPERIMENT-5

Objective: To connect, start and reverse the direction of rotation of a 3-phase induction motor.

Apparatus Required: Three phase induction motor-1, Star-delta starter-1, TPIC switch1, Tools such as screw driver, plier, test pen etc. and connecting leads.
Theory: Motor is connected to the 3-phase ac supply mains through star-delta starter and TPIC switch, as shown in fig. 11 (a). The direction of rotation of a 3-phase induction motor can be reversed by interchanging any two terminals at the TPIC switch, as shown in fig.1 l(b)



Procedure: The connections of a 3-phase induction motor are made to the star-delta starter and to the TPIC switch, as shown in fig. 11 (a). The TPIC switch is closed and the motor is started !-y taking the lever of the starter to the start (star) position and then with a jerk to the run position (or delta connections). The direction of the rotation of the motor is observed. Say, it is in clock-wise direction. Now the motor is stopped by pushing the stop button and supply to the motor is r'emoved by opening the TPIC switch. The two leads of the motor are interchanged to the T1~I~C\switch, as shown in fig. 11 (b). TPIC switch is closed and the motor is started again. Tl,~e direction of rotation of the motor is observed.
The push button is pushed and the TPIC switch is made off.

Observations and Results: The direction of rotation of the motor in second case is found opposite to that in first case.

EXPERIMENT-6

Objective: Experimentally verify the ohm's law.

Apparatus:

DC Power Supply
DC current source
Few Resistors
Wheatstone bridge
Multimeter

THEORY:

Ohm's Law:

The voltage across an element is directly proportional to the current through it. The ohm's law can be written mathematically as:

$$V \square IR$$

where R = Resistance
V = voltage across the resistance R
I = Current through the resistance R

PROCEDURE:

A. Ohm's Law:

1. Connect the circuit as shown in figure 2.
2. Set the DC voltage supply to 10 Volts.
3. Set the resistance R to 100 ohms.
4. Measure the voltage across the resistor and the current through the resistor and write the results in Table 1.
5. Determine the value of the resistance using Ohm's law R=V/I and record in the Table 1.
6. Repeat step 2 to 5 for the other resistors (1000 ohms, 10 K ohms).

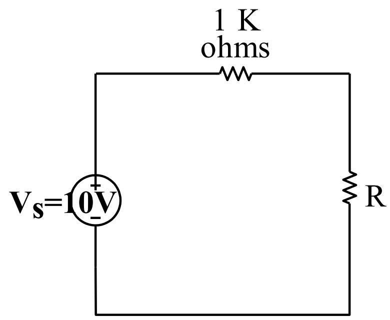


Figure 1: Ohm's Law

TABLE 1

Resistor (Nominal Value)	100 □	1 K □	10 K □
Ohm-meter Reading			
R = V / I			
Percent Deviation from Nominal Value			

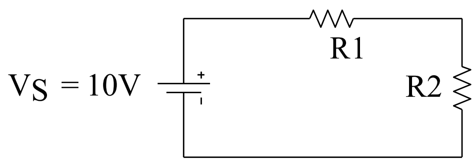
Percent Deviation = (Nominal Value – Ohm-meter Reading) / (Nominal Value)

EXPERIMENT -7

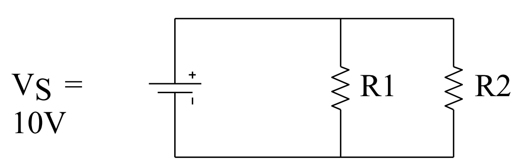
Objective: To study kirchoff's Laws (KVL and KCL)

- To verify Kirchhoff's Voltage law in a series circuit.
- To verify Kirchhoff's Current law in a parallel circuit.

Series Circuit



Parallel Circuit



Kirchhoff's Voltage law: $V_S = V_{R1} + V_{R2}$ in a loop

Kirchhoff's Current law: $I_T = I_{R1} + I_{R2}$ at a junction

Part A - Series Circuit:

1. ***Calculate*** the total resistance, circuit current and voltage drop across each resistor if wired in a series circuit as shown in the figure.

   Total Resistance: ______________________________ Circuit Current: ________________

   Voltage Drop across the 470 Ohm Resistor, R1: ___________________________________

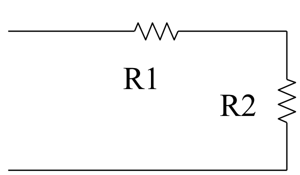
   Voltage Drop across the 1K Ohm Resistor, R2 : ___________________________________

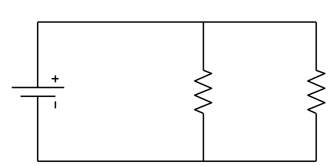
   Power-supply *Voltage* using Kirchhoff's Voltage law : ____________________________
   (should be equal to the sum of the voltage drops)

2. Obtain a 470 Ohms and a 1K Ohms resistors and make sure you got the correct ones. Measure and record their actual resistances.

   R1 = ____________________ R2 = ____________________

3. Using the Breadboard, ***connect*** the resistors in SERIES as shown in the figure below: R1 is the 470 Ohm resistor and R2 is the 1K Ohm resistor.

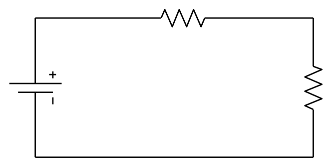




4. ***Measure*** the total circuit resistance.

   Total Resistance: ______________________________

5. ***Connect*** the Power-supply to the SERIES resistors as shown in the figure below.



6. Set the Power-supply to 10 Volts.

7. ***Measure*** the voltage drop across each resistor and the Power-supply voltage.

   - *Voltage Drop* across the 470 Ohm Resistor: ______________________
   - *Voltage Drop* across the 1K Ohm Resistor: ______________________
   - Power-supply *Voltage* (should be equal to the sum of the voltage drops): __________

EXPERIMENT-8

AIM: To study fluorescent lamp.

THEORY: CONSTRUCTION:

The fluorescent lamp is a low pressure mercury discharge lamp. It is generally consist of a long glass tube (G) with an electrode on each end (E1 & E2). These electrodes are made of coiled tungsten filament coated with electron emitting material. The tube is internally coated with a fluorescent powder & contains small amount of argon with a little mercury at a very low pressure. The control ckt. of tube consist of a starting switch (S) known as starter, an iron cored inductive coil called a choke (L),& two capacitors C1 & C2.

OPERATION:

A starting switch namely the glow type (voltage operated device) is used in tube operation. The starter is glow type starter (S) shown in fig. Consist of two electrodes sealed in glass tube filled with mixture of Helium & Hydrogen. One electrode is fix & another is U-shaped bimetallic strip made up of two different metals having two different temperature co-efficient. Contacts are normally open. When the supply is switched ON, heat is produced due to glow discharge between electrodes of starter is sufficient to bend bimetallic strip until it makes contact with fixed electrode. Thus ckt, between two electrode E1 & E2 is completed & relatively large current circulated through them. The electrodes are then heated to incandescence by this circulating current & gas in their immediate vicinity is ionized. After a second or two, due to absence of glow discharge a bimetallic strip cools sufficiently. This causes to break contact & sudden reduction of current induces an emf of the order of 800-1000V in choke coil. This voltage is sufficient to strike an arc between two electrodes E1 & E2 due to ionization of Organ. The heat generated in the tube vaporizes mercury & potential difference across the tube falls to 100-110V. This potential difference is not sufficient to restart glow in starter.

FUNCTION OF AUXILLARY CIRCUIT COMPONENTS: CHOKE

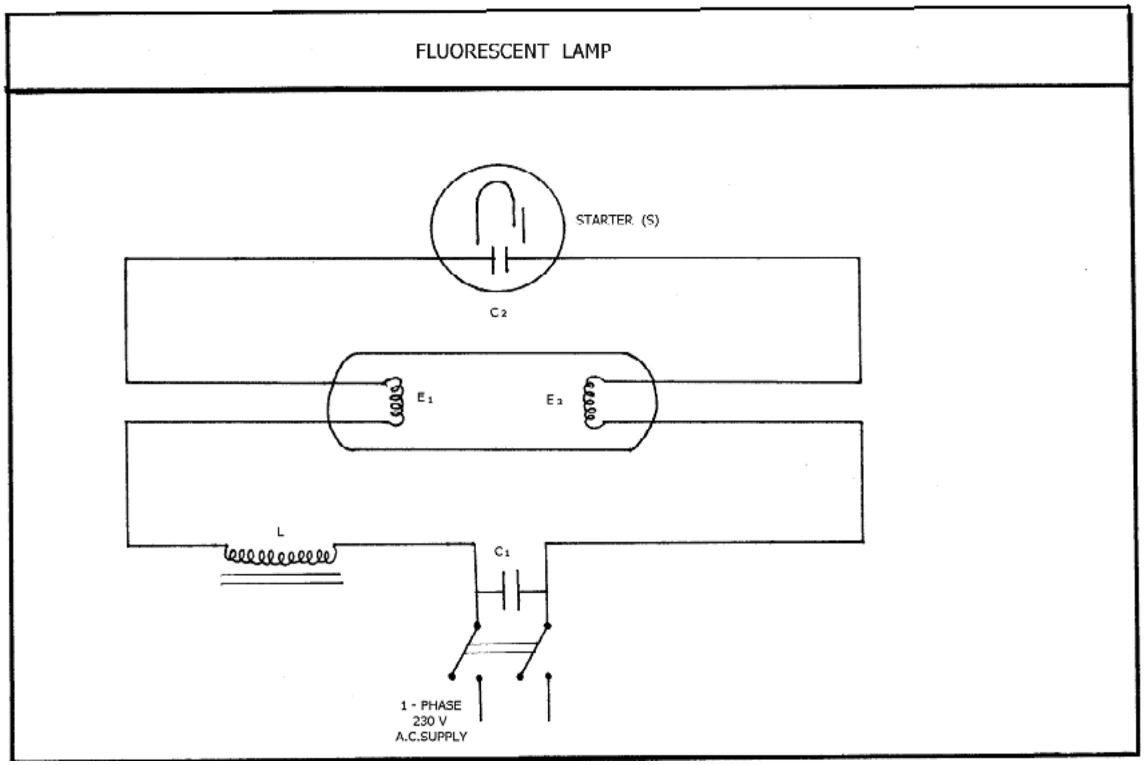
1. It provides a necessary high voltage to start discharge in the tube.
2. Since the voltage required across the tube during normal operation is small, the excess voltage drop across the tube.
3. It acts as a stabilizer.

CAPACITOR(C1) The choke lowers a power factor of the ckt. C1 connected across the supply Improves this power factor.

CAPACITOR(C2)

It is connected across starting switch to suppress radio interference due to high frequency voltage oscillation which may occur across it’s contacts.

CIRCUIT DIAGRAM:-



ADVANTAGES:

1. Low power consumption.
2. Longer life which is about 3 to 4 times that of the filament life.
3. Compared to filament lamp efficiency is also about 3 to 4 times, it gives more light for the same wattage.
4. Superior quality of light.
5. No warming up period is required as in case of another discharge lamp.
6. Different colour light can be obtained, by using different types of fluorescent powder.
7. Low heat radiation.

DISADVANTAGES:

1. Initial cost of the lamp along with auxiliary equipment needed is very high
2. With frequent operation life reduces.
3. Voltage fluctuation affect it but not to the extent that filament lamp is affected.
4. Produce radio interference.
5. Fluctuating light output produces undesirable stroboscopic effect with rotating machinery.

APPLICATION:

They are very popularly used for interior light in residential buildings, shops & hotels.

They are also extensively used with reflectors for street lightings. Due to their glare free shadow less light, they are ideal for workshop, factories, laboratories & drawing rooms.

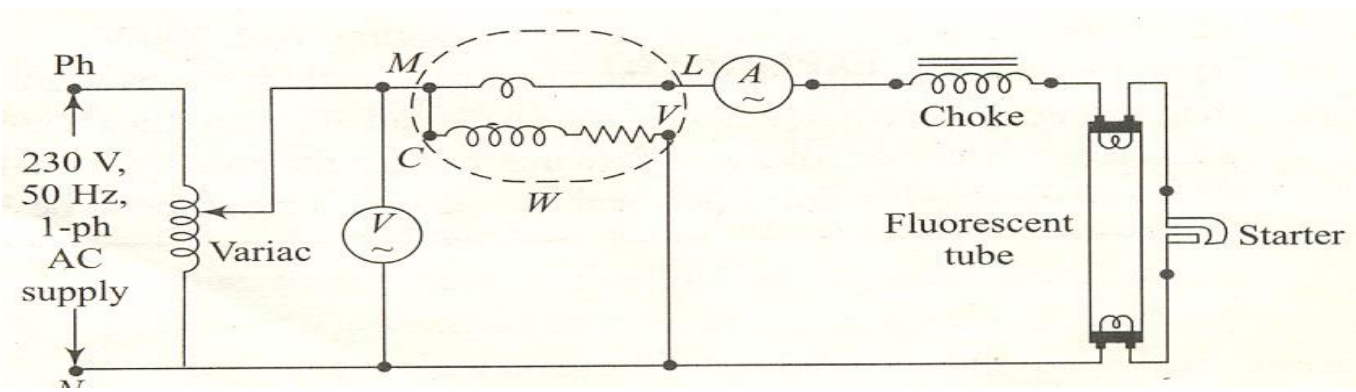
EXPERIMENT-9

AIM OF THE EXPERIMENT: Connection and measurement of power consumption of a fluorescent lamp.

APPARATUS REQUIRED:

SL NO	ITEM DESCRIPTION	SPECIFICATIO	TYP	QUANTIT
01	Ammeter	0-	MI	1
02	Voltmeter	0-	MI	1
03	Wattmeter	230V,5/10A	DM	1
04	Choke	40W,230V	IRON CORE	1
05	Starter	230V,50Hz	GLOW	1
06	Fluorescent Tube	40W,230V,50Hz	-	1
07	Varia	1-PH,0-300V,5A	-	1
08	Connecting Wire	3/20SWG	PV	L

CIRCUIT DIAGRAM:



THEORY:

Fluorescent lamp constitutes a glass tube whose inside is coated with a fluorescent powder. When the two filaments of the lamp are maintained at potential difference sufficient enough t produce electric discharge through the gap, then electron are emitted from one electrode and move towards the other electrodes. In the mean time, these electrons collide with the fluorescent coating and emit cool light. In most fluorescent lamp, a mixture of argon and mercury gas contained in a glass tube is stimulated by an electric current, producing ultraviolet ray. These rays strike fluorescent phosphorous coating on the interior surface of the bulb. Unfortunately a fluorescent lamp can't just work as is case of incandescent lamp. The main reason is that it is normally takes a voltage greater than the typical line voltage to start. It requires several hundreds of volts (700-800v). The second problem is that

PROCEDURE:

- Do the connection as per the circuit diagram.
- Keep the variac in the zero position and switch on the power supply.

- the variac voltage slowly until the fluorescent tube flickers and glows. Measure the current, voltage, and power.
- Take another 4 sets of ammeter, voltmeter, and wattmeter reading at different positions of variac while the tube is glowing.
- Record the reading in observation table.
- Switch off the power supply.

OBSERVATION TABLE:

SL NO	Voltmeter Reading(V)	Ammeter Reading(A)	Wattmeter Reading(W)	Power Factor

CALCULATION:

(I) Power Factor, Cos ϕ= W/VI. (II) Calculate mean power factor.

CONCLUSION:

From the above experiment we connected the fluorescent lamp and measured the different values of power and power factors