2023

EDITION ONE

BASIC ELECTRICAL ENGINEERING
LAB MANUAL

Department of Electrical Engineering

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e-content: www.gcekjr.ac.in

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BASIC OF EXPERIMENTS

INTRODUCTION

Experiments are extremely important aspect in all branches of engineering in general and in Electrical Engineering in particular. This helps in understanding the physical concepts & develops confidence in theoretical study.

OBJECTIVE OF EXPERIMENTS

The purpose of conducting the experiments in the laboratory is the following:

- To get familiar with the basic components, measuring instruments and other equipment's.
- To observe the basic phenomena and understand the same.
- To learn the measurement of basic electrical and non -electrical quantities.
- To know about the limitations & accuracies of measuring instruments.
- To develop practice in circuit connection of different electrical apparatus.

INSTRUCTIONS

In electrical laboratory students have to work on machines and equipment's operating on either 220V or 230V d.c supply, 50Hz single phase a.c supply or 440V 3 -phase a.c supply. The safety precautions against electric shocks should be observed. The general instructions for working in any of the electrical engineering laboratory are given below.

- Never work alone in the laboratory.
- Don't touch any terminal or switch without ensuring it is turned off.
- Stay away from all moving parts as far as possible.
- Always wear the shoes with rubber soul. Never wear loose dress while working in the laboratory.
- Use sufficiently long connecting wires rather than joining two or three small ones.
- In this case you have open joints, which are dangerous, you should always cover joints by insulating tape.
- Before giving power supply you should make sure that electrical connections are right and tight.
- The circuit should be switched off before changing any connection.
- Familiarize yourself with the shock-chart instructions given in the laboratory.

PRECAUTIONS

Following are the general precautions to be observed while doing experiments in electrical engineering. Complete specifications of the machines and equipment's to be used in the experiment should be noted down from the nameplate of the respective equipment. The range of all the instruments to be used in the experiment is to be decided according to the specification.

- Special care should be taken to see that the upper as well as lower limit of voltage, current, power and speed etc. should not exceed.
- Suitable type of wires should be used for different parts of the circuit. Flexible wires may be used for connecting voltmeters and pressure coil of wattmeter because current is negligible. Thicker wires of sufficient cross section should be used for the current carrying circuits.
- Never apply full voltage to a motor at the time of starting. Use starter or variac. Apply low voltage while switching on and increase the voltage gradually as per instruction.
- Whenever an electrical load is to be applied, do so gradually. Similarly, the electrical loads should be switched off gradually.
- Keep all the instruments used for the experiment in their proper position
- The supply to any electric circuit should be switched on only after ensuring the correctness of the connections.
- Any live terminal should not be touched while supply is on.

SUPPLY SYSTEMS

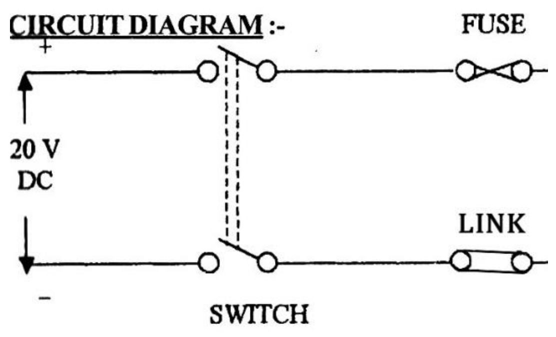
These can be classified into two groups:

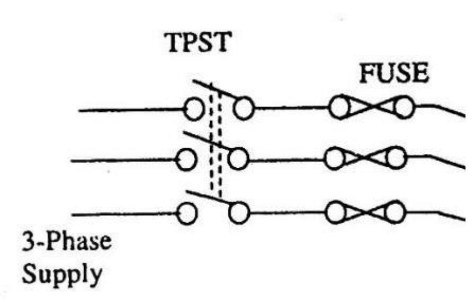
- The available supply system (with fixed supply voltage).
- Systems to obtain variable voltage.

THE AVAILABLE SUPPLY SYSTEM

Following electricity supply systems are normally available in the laboratories related to electrical engineering.

1. **A.C** SUPPLY **SYSTEMS:** These are of two types namely: Single phase 230 volts: In this system, we have two wires, one is known as phase line and the other is known as neutral.

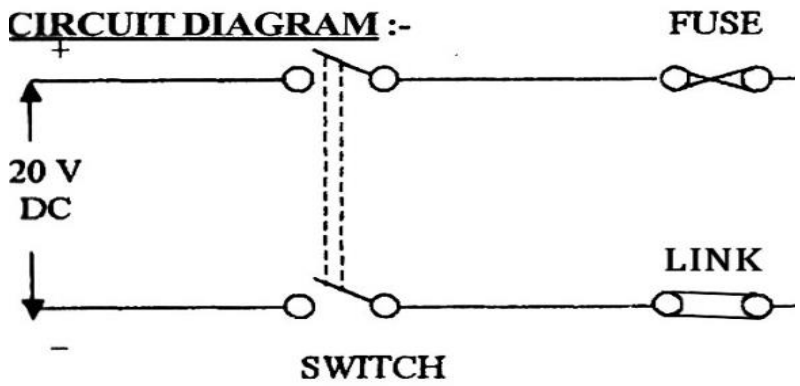




2. **Three phase 430v (Line to Line):** The system may be having three wires one for each phase/line. The system may also have four wires three for phase/line and one for neutral.

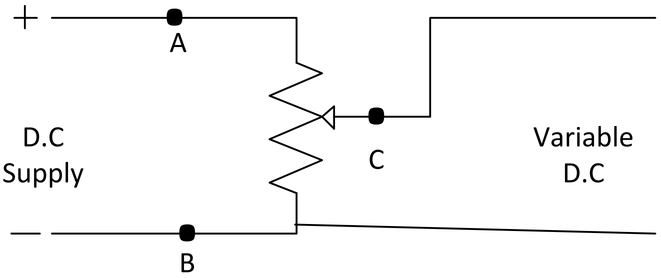
D.C SUPPLY SYSTEMS: These are of two types namely.

1. **From battery 6v or 12v**: We may use rectifiers for 6v or 12v d.c supply for lower current requirements if a regular 6v or 12v d.c. supply is not available in the laboratory. This system has two wires one is positive another being negative. Out of the electric supply systems discussed above the 230v, 50 Hz a.c supply system is available in our house as well.



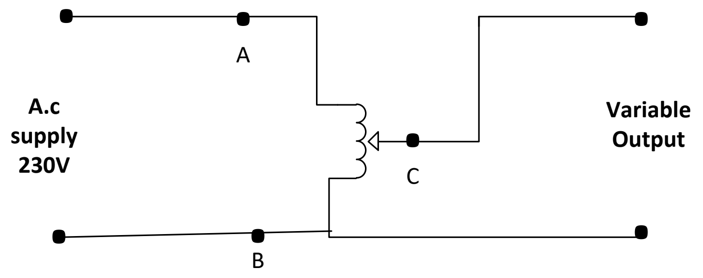
2. **Systems to obtain variable voltage supply from the available supply system**

DC CIRCUIT: A variable d.c voltage can be obtained by using a rheostat and the arrangement is shown below. Where A and B are the fixed terminals and represents the two ends of the rheostat and C represents the variable terminal of the rheostat.



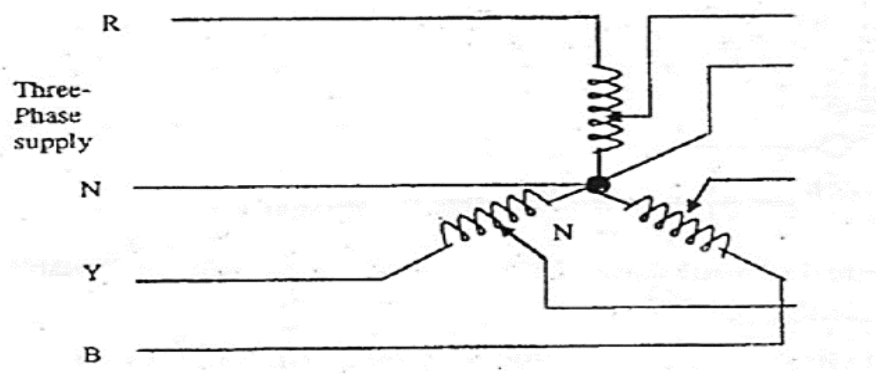
AC CIRCUIT: A variable a.c voltage can be obtained by an autotransformer or variac. Variac is a coil wound on a magnetic core with its two ends A and B brought out and a point C brought out, which slides Over the coil AB. If the total number of turns of the coil AB is N_I and the number of turns in the portion BC is N_2 then the output voltage available would be (N_2/N_1) x input voltage.

$$\left(\frac{N_2}{N_1}\right) \text{ X input voltage}$$



THREE-PHASE CIRCUIT:

If three single phase variac’s are connected in the manner shown in the figure below, it serves the purpose of three-phase Variac.

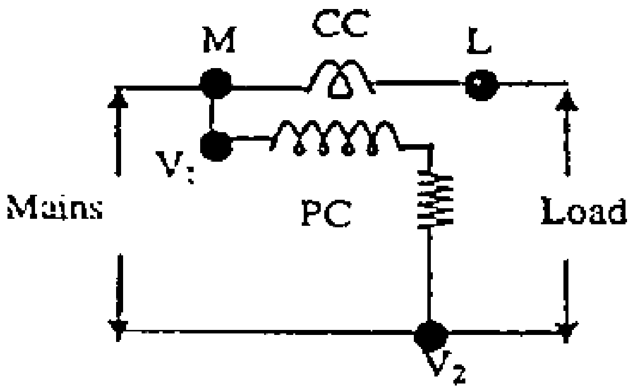


3. **Description of instruments used in basic electrical engineering laboratory:**

(a) AMMETER AND VOLTMETER: Ammeter is an electrical measuring instrument used to measure the current in a circuit and voltmeter measure the potential difference across any two points of the circuit. The Ammeters are always connected in series with the circuit. Voltmeters are always connected in parallel with the circuit. There are three types of voltmeters and ammeters generally used in electrical engineering.

i) **Moving coil type:** Used for D.C. only. Also available in multiple range
ii) **Moving iron type**: Used for AC and DC both. Also available in multiple range
iii) **Electronic voltmeters and ammeters:** These are digital instruments that give digital display. Their loading affect is very low.

(b) WATTMETERS: In D.C. circuit power is given by product of voltage and current. The real power in a A.C circuit is given by the expression VI cosθ where cosθ is power factor. The measurement of real power in A.C circuits is done by using an instrument, which is known as wattmeter. A wattmeter comprises of two coils namely current coil and pressure coil. The current coil is connected in series with load and pressure coil is connected across the load. The most commonly used watt meters are of dynamometer indicating type of coil is fixed and pressure coil is moving coil. The working of this type of wattmeter depends upon electromagnetic force exerted between the current coil and pressure coil. wattmeter's are available in dual range for voltage and current.e.g.5/10amp,150/300volt. There is only one scale on wattmeter. For different combinations of ranges of voltages and currents, the rating of wattmeter would be different. In order to take down correct reading from wattmeter a multiplying factor is to be used. The various values of multiplying factors are mentioned on the meter. These are in accordance to the range used for voltages and currents. The terminals of current coil are marked as ML abbreviation for mains and loads. The terminals of pressure coils are marked as V_1 and V_2.The terminals M of the current coil and v_1 of pressure coil are joined together, and that junction is known as common terminal(C). The connection of wattmeter to an ac circuit is made as shown below. The current coil has low resistance and hence the symbol for inductor is used. The pressure coil of wattmeter has high resistance and hence the symbol for resistance and inductance is used.

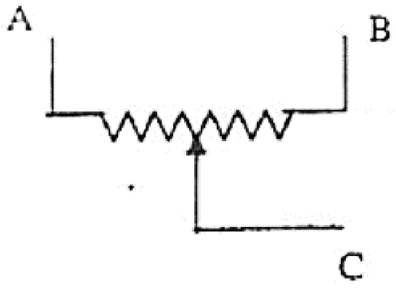


(c) MULTIMETER: As the name indicates, a multimeter can be used to measure various electrical quantities i.e voltage (ac/dc), current (ac/dc) and resistance. In fact, a multimeter is a three in one instrument. It can be used as a voltmeter, a milliammeter and an ohmmeter. It also incorporates the means of the selecting various ranges for the quantity to be measured. It is a constant companion of an electronic technique. By using a function switch one can select the mode of measurement. By using this function switch we can use a multimeter as a voltmeter/ammeter/ohmmeter, as may be needed. Another important switch provided with multimeter is the range switch, through which we can select the range of measuring quantity.

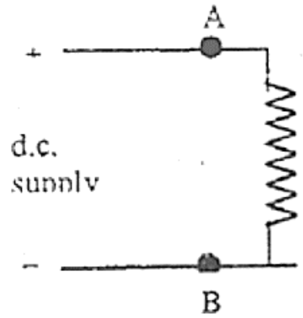
(d) ENERGYMETER: Energy meter is an instrument, which is used to measure the consumption of electrical energy. It measures in KWH (kilo watt hour). The principle of operation of an energy meter is similar to that of a wattmeter except that due to the power through the meter, a disc rotates. The revolution made by the disc is counted with the help of a gear train and read on the dial. Like wattmeter's the energy meters can be of single-phase type as well as three phase type.

(e) TACHOMETER: Tachometer is an instrument used for measurement of speed in RPM (revolution per minute). The speed of a rotating shaft is measured by the tapered projected shaft of the tachometer into the tapered hole in rotating shaft of which the speed is to be measured. The tachometer can be analog type or digital type. Another way of measuring speed is by using STROBOSCOPE.

(f) RHEOSTAT: Rheostats are made up of high resistivity materials like nickel chromium iron alloy closely wound over a circular tube. These are employed at places where resistance of a circuit is to be varied without breaking the circuit. The resistance value and the current it can handle are specified on rheostat. Normally it is 1000ohm, 1.2A and 100ohm,5A. Rheostats are used as variable resistance (see fig:1)and as potential divider(see fig:2)



(Fig.1)



(Fig.2)

(g) LOADING DEVICES: The most commonly used loading devices are

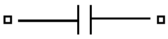
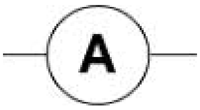
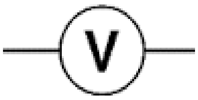
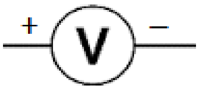
(i) Lamp bank

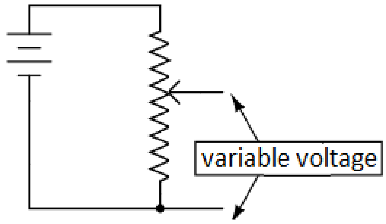
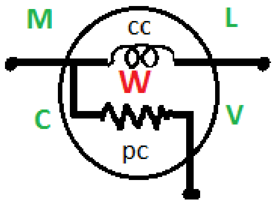
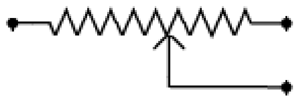
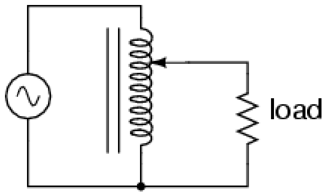
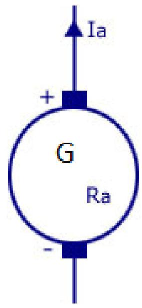
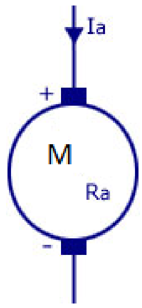
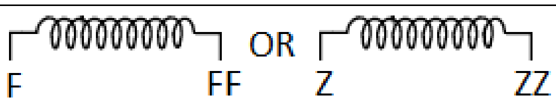
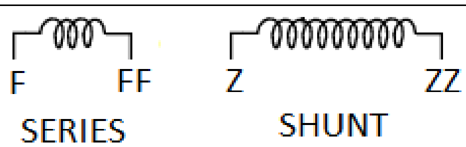
(ii) Loading rheostat

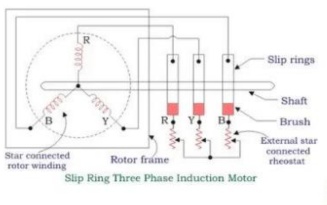
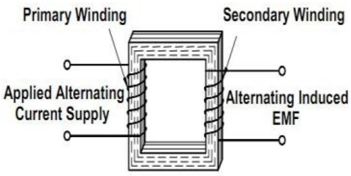
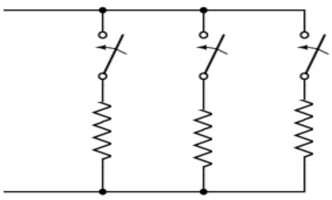
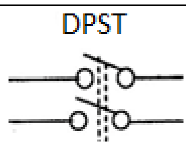
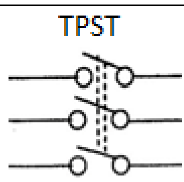
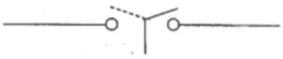
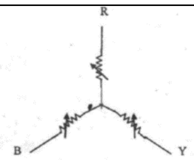
Lamp bank load consists of a number of lamps connected to form a load. These are suitably connected and controlled by a number of switches. The switches are provided in a manner that it should be possible to switch on any required number of lamps at a time. A loading rheostat type of electrical load consists of a number of identical resistive elements. These elements are suitably connected in series, parallel and combinations thereof. This combination should be associated with proper switching scheme so that a large number of resistances in steps can be selected as per requirement.

CONVENTIONS AND SYMBOLS:

Sl.no	**Item**	**Symbolic representation**
1.	Power	W(P)
2.	Current	I

3.	Voltage	V
4.	Phase current	I_{ph}
5.	Line Current	I_L
6.	Phase Voltage	V_{ph}
7.	Line Voltage	V_L
8.	Power Factor	Cosϕ
9.	Power Factor Angle between Voltage and current	Cosϕ
10.	Armature Resistance	R_a
11.	Shunt field Resistance	R_{sh}
12.	Resistance	R ohm(Ω) 
13.	Inductance	L Henry(H) 
14.	Capacitance	C Faraday(F) 
15.	Variable resistance	 RΩ 
16.	Ammeter	 M.I(A.C)  M.C(DC) 
17.	Voltmeter	 M.I(A.C)  M.C(D.C) 
18.	Potential Divider	

		
19.	Wattmeter	
20.	Rheostat	
21.	Variac or Autotransformer	 
22.	Armature terminals of DC Machine	 
23.	Field Terminals	
24.	Series and shunt winding terminals of a DC Generators	
25.	Three phase Induction Motor	

		 
26.	Single Phase Transformer (Two winding)	 
27.	Single Phase Variable Resistive Load	 
28.	Single Pole Single Through Switch	
29.	Double Pole Single Through Switch	
30.	Triple Pole Single Through Switch	
31.	Single Pole Double Through Switch (SPDT)	
32.	Three Phase Variable Resistive Load	

EXPERIMENT-01

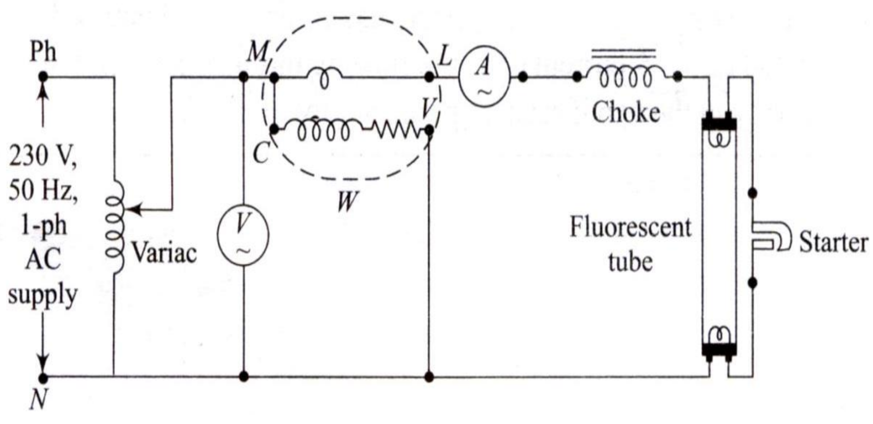
AIM OF THE EXPERIMENT: Measurement of Power Consumption and Power Factor of a Fluorescent Lamp.

APPARATUS REQUIRED

Sl. No	Item description	Specification	Type	Quantity
1.	Ammeter			
2.	Voltmeter			
3.	Wattmeter			
4.	Choke			
5.	Starter			
6.	Fluorescent tube			
7.	Variac			
8.	Connecting wires			

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 this 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. 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). Hence power factor of a fluorescent lamp can be calculated by the equation is:

$$\text{Power Factor} = \frac{\text{Real Power (in Watts)}}{\text{Apparent Power (Volt} - \text{Amps)}}$$



CIRCUIT DIAGRAM

Student should draw the circuit diagram below with proper specification of instruments used.

PROCEDURE

1. Do the connection as per the circuit diagram given in the above fig.
2. Keep the variac in zero position and switch on the power supply.
3. Increase the variac voltage slowly until the fluorescent tube flickers and glows.
4. Measure the current, voltage and power.
5. Take another four sets of ammeter, voltmeter and wattmeter readings at different positions of variac while tube is glowing.
6. Record the readings in observation table.
7. Bring the variac to zero position.
8. Switch off power supply.

OBSERVATION TABLE

Sl. No.	**Voltmeter reading(V)**	**Ammeter reading(I)**	**Wattmeter reading(W)**	**Power factor**
1				
2				
3				
4				
5				
6				

CALCULATIONS

CosΦ = $\frac{W}{VI}$

Mean cosΦ =

PRECAUTIONS

1. All the connection should be right & tight.
2. The voltmeter & ammeter should be carefully chosen.
3. Supply should be switched on after ensuring correctness of connections
4. Any live terminal should not be touched while supply is on

CONCLUSIONS

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

QUESTIONS TO BE ANSWERED

1. What is the necessity of a choke?
2. What is the necessity of a starter?
3. What will happen if the starter is removed while the tube is glowing?
4. What can you do in order to improve the power factor?
5. Why does the choke get heated up while the tube is glowing?
6. What is the difference between wire wound choke and electronics choke?
7. What is power factor?

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: ……………   Sem: ………………..   Branch: ………………

EXPERIMENT-02

AIM OF THE EXPERIMENT

Determination of current, voltage, power & power factor in a series RLC circuit excited by a single-phase AC supply.

EQUIPEMENTS REQUIRED

Sl. No.	Item description	Specification	Type	Quantity
1.	Ammeter			
2.	Voltmeter			
3.	Wattmeter			
4.	Rheostat			
5.	Inductor (choke)			
6.	Capacitor			
7.	Variac			
8.	Connecting wire			

THEORY: OA represented VR, AB and AC represented the inductive and capacitive load, Vl and Vc. So out of phase with each other. Subtracting Bo from AB, we get net reactive crop AD I (XL – XC).The applied voltage v is represented OD and is the vector sum of OA and AD.

OD = $\sqrt{OA + AD} = \sqrt{(IR)^2 + (IXL - IXC)^2}$

$=\sqrt{(\llbracket (IR) \rrbracket ^2 + I^2 + (XL - XC))^2}$

$=I\sqrt{R^2} + (XL - XC)^2$

$I = \frac{V}{\sqrt{R2+(XL-XC)^2}} = \frac{V}{2}$

The term $\sqrt{R^2 + (XL- Xc)^2}$ is known as the impedance of the circuit .

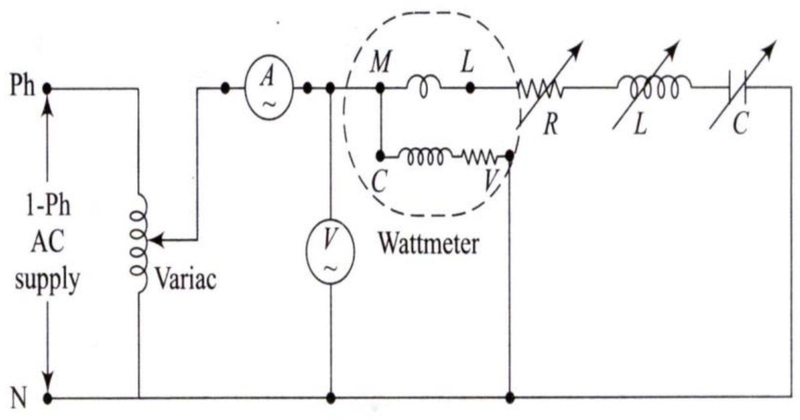
(Impedance) = $R^2 + (XL- Xc)^2 = R^2 + \mathbf{X}^2$.

Phase angle ($\boldsymbol{\Phi}$)= tan $\boldsymbol{\Phi}$ = XL- Xc

$\text{Cos}(\Phi) = \frac{R}{\sqrt{R2 + \mathbf{X}2}}$

In a series R-L-C circuit , current leads or lags the voltage depends upon the relative values of the term wl and $^{1}/_{wL}$.

CIRCUIT DIAGRAM



Student should draw the circuit diagram below with proper specification of instruments used.

PROCEDURE

1. Connect the circuit as per circuit diagram.
2. Set the variable point of the rheostat to its maximum value
3. Set the variance to zero value
4. Switch on the AC supply.
5. Set the variac to a suitable value so that the reading in all the meters are just readable.
6. Note down the voltage reading we are taken for different voltage at that time the rheostat at its maximum voltage
7. Note the readings of all the meters.
8. Set the variac upto rated voltage to the circuit and set that value.
9. Change the setting of variable point b of rheostat at and note down the meter reading.
10. Repeat the step-9 and take sufficient reading.
11. Record the observation.

OBSERVATION TABLE

SL. NO.	VOLTAGE	CURRENT	POWER	V_R	V_L	V_C	Wattmeter Reading.

CALCULATION

$\text{Cos}\Phi = \frac{W}{VI}$

P= V.I CosΦ

$\text{Cos}\Phi = \frac{\mathbf{VR}}{\sqrt{(\mathbf{VR}) + (\mathbf{VL-Vc})}}$

P = Wattmeter reading in watt

V = Total voltage supplied to circuit (Voltmeter Reading in volt)

I=Ammeter reading in ampere.

Vr, Vc, and voltage across resistor, capacity or and inductor respectively

CosΦ -Power factor of the circuit

PHASOR DIAGRAM

Proof of relation between V, V_R , V_L, V_c (PHASOR DIAGRAM)

- **V_L > Vc**
- **Vc > V_L**

PRECAUTION

1. All the connection should be right & tight.
2. The voltmeter & ammeter should be carefully chosen.
3. Supply should be switched on after ensuring correctness of connections
4. Any live terminal should not be touched while supply is on.

CONCLUSION

The voltage, current, power and power factor of series RLC circuit was found out and the values are ____________________

QUESTIONS

1. Why is the wattmeter reading not equal to product of the voltage and current?
2. Define inductance, inductive reactance, capacitance, capacitive reactance, impedance and relation between them.

3. Draw the voltage triangle if voltage across the inductor is greater than voltage across the capacitor?

4. What do you mean by resonant condition?

5. Define power factor. It is lagging or leading. Justify the answer?
6. Draw the impedance triangle for both the cases $\mathbf{X_L > X_c}$ **and** $\mathbf{X_c > X_L}$

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: …………… Sem: …………….….. Branch: ………………

EXPERIMENT-03

AIM OF THE EXPERIMENT

To measure the three-phase power by two wattmeter method and also to determine the power junction of the load.

EQUIPMENTS REQUIRED

Sl. No	Item description	Specification	Type	Quantity
1.	Ammeter			
2.	Voltmeter			
3.	Wattmeter			
4.	Three-phase Auto transformer			
5.	Connecting wires			

THEORY

This is the generally used method for measure of power in three phase, 3-wire circuits ,the current coil of two wattmeter are inserted in any two lines and pressure coil is connected from its own current coil to the line without a current coil.

Total power of the circuit **I, p=$\mathbf{w_1 + w_2}$** Hence the algebraic sum of two wattmeter reading gives the total power of the circuit irrespective of the fact that the factthe circuit is balanced or imbalanced and stay data connected.

From the phase diagram, we can determine P.F at the load. because of the inductive load, current lays three voltage real power **P** = $\mathrm{V}/_{\mathbf{cos\Phi}}$ .Where $\boldsymbol{\Phi}$ is the phase angle between Voltage and current ($\mathrm{V_R}$ and $\mathrm{I_R}$)

$$\mathrm{w_1 = V_L I_L \cos\Phi = V_{RY}\, I_R \cos\Phi}$$

$$\mathrm{w_2 = V_L I_L COS\ \Phi = V_{BY} I_R COS\Phi}$$

From the phasor diagram,

$$\mathrm{w_1 = V_L I_L\ Cos\ (30° + \theta)}$$

$$\mathrm{w_2 = V_L I_L\ Cos\ (30° - \theta)}$$

$$\mathrm{w = w_1 - w_2}$$

$$\mathrm{= V_L I_L\ [\cos\ (30 + \theta) + \cos\ (30 - \theta)]}$$

$$= V_L I_L\ 2\cos 30\ .\cos\ = V_L I_L.\cos\theta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$= P = w = \ w_1 - w_2 = V_L I_L.\sin\theta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Dividing the equation 2 and 1

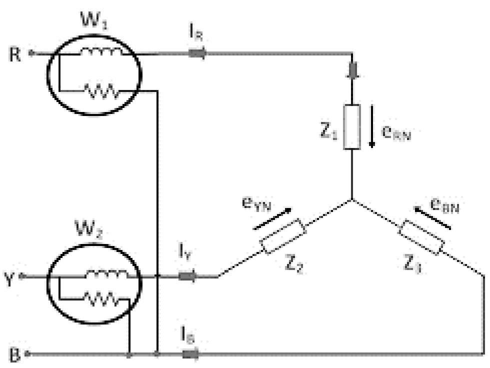
$$\frac{w_1 - w_2}{w_1 + w_2} = \frac{V_L I_L.\sin\theta}{V_L I_L\sqrt{3}.\cos\theta} = {}^{1}\!/\!_{\sqrt{3}}\tan\theta$$

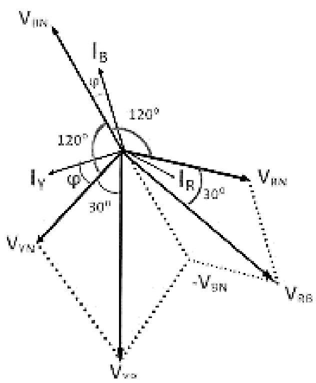
$$=\sqrt{3}\left(\frac{w_1 - w_2}{w_1 + w_2}\right) = \tan\theta$$

$$= \theta = \tan^{-1}\sqrt{3}\left({}^{w_1 - w_2}\!/\!_{w_1 + w_2}\right)$$

$$= \theta = \tan^{-1}\sqrt{3}\left[\frac{\text{Higher reading} - \text{lower reading}}{\text{Higher reading} + \text{lower reading}}\right].$$

CIRCUIT DIAGRAM





Student should draw the circuit diagram below with proper specification of instruments used.

PROCEDURE

1. Connection is made as per circuit diagram and rate supported should be given to the 3***Φ*** Auto transformer.
2. Initially keep the 3***Φ*** Variable (Auto transformer) in minimum position.
3. Set the inductive load at (0-100) 20%, 40%, 60%, 80%.
4. Varying the auto transformer from (0 - 415) v slowly and note down the reading of voltmeter and Ammeter respectively.
5. Calculate total power and power factor for each of set of readings.

OBSERVATION TABLE

Sl. No.	VOLTAGE	CURRENT	w_1	w_2	$w_1 + w_2$	$w_1 - w_2$

CALCULATION

Total power $\mathbf{w} = \mathbf{w_1} + \mathbf{w_2}$
Power factor, cos$\boldsymbol{\Phi}$

PRECAUTIONS

1. All the connection should be right & tight.
2. The voltmeter & ammeter should be carefully chosen.
3. Any live terminal should not be touched while supply is on.
4. With negative detection in wattmeter the connection should be reversed.
5. Switch off the supply before doing any changes in the circuit in between pursuing the experiment.

CONCLUSIONS

The sum of the wattmeter reading gives the power.

QUESTIONS TO BE ANSWERED

1. Name the components of no-load current?
2. What is the function of magnetizing current and working current?
3. what do you mean by ideal transformer?
4. Why does the transformer draw a primary current even when the secondary winding is kept open? Explain.
5. Why Transformer rated in KVA?
6. Why Transformer not operated in D.C?
7. What is the purpose of no-load test?

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: ……………　　　　　Sem: ………………..　　　Branch: ………………

EXPERIMENT-04

AIM OF THE EXPERIMENT

Verification of Superposition theorem for D.C network.

APPARATUS REQUIRED

Sl. No.	Name of apparatus	Specification	Quantity
1	Superposition trainer kit		
2	Connecting wires		

THEORY

In a linear bilateral network containing more than one source of energy. The response in anyone of the branch is equal to the algebraic sum of the response caused by individual sources.

THEORITICAL CALCULATION

For Finding V_L,

Applying KVL in mesh (1) and (2) we get

$2I_1 - I_2 = 8 - I_1 - 2I_2 = -12$

Now solving equation (1) and (2), we get,

$I_1 = \frac{4}{3}\,t = 1.33t\,, I_2 = \frac{-16}{3}A = -5.33A$

Hence, the current through load resistance R_2 is

$I_1 - I_2 = \frac{4}{3} - \frac{-16}{3} = \frac{20}{3}A$ =6.66A.

Therefore, the total load voltage is$\frac{20}{3} \times 1 = 6.66A.$ $V_1 = 6.66A.$

For Finding V_{L1},

Applying L_1V_L in mesh (1) and (2) we get

$$2I_1 - I_2 = 8$$

$$-I_1 - 2I_2 = 0$$

Now solving equation (1) and (2), we get,

$I_1 = \frac{16}{3}$ A $= 5.33t$, $I_2 = \frac{8}{3}A = -2.66A$

Hence, the current through load resistance is

$I_1 - I_2 = 5.33 - 2.66 = 2.67$ A.

Therefore, the value of V_{L1} is$= 2.66$ V, $V_1 = 2.66V$.

For Finding V_{L2},

Applying $L_1 V_L$ in mesh (1) and (2) we get

$2I_1 - I_2 = 0$

$-I_1 - 2I_2 = -12$

Now solving equation (1) and (2), we get,

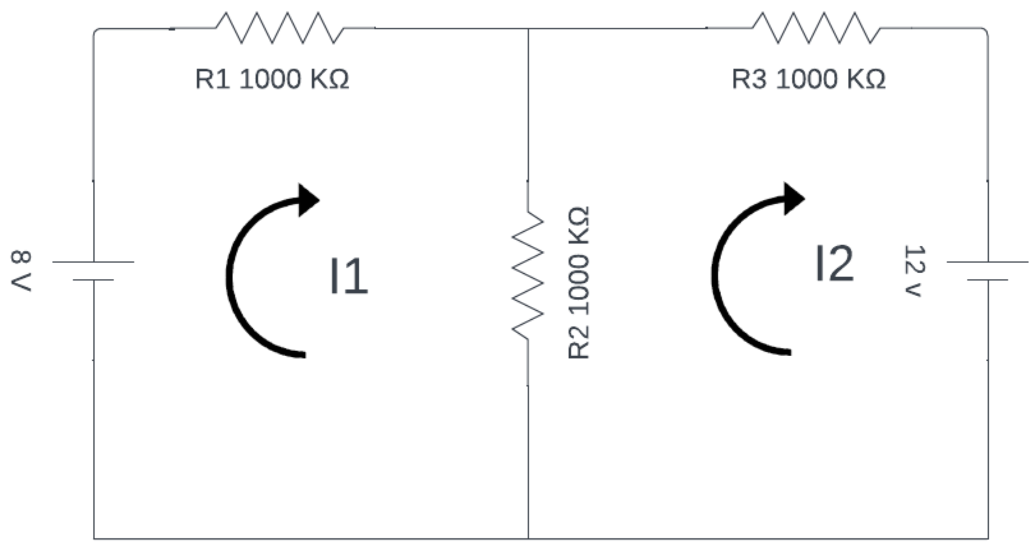
I_1=$-4A$, $I_2 = -8A$

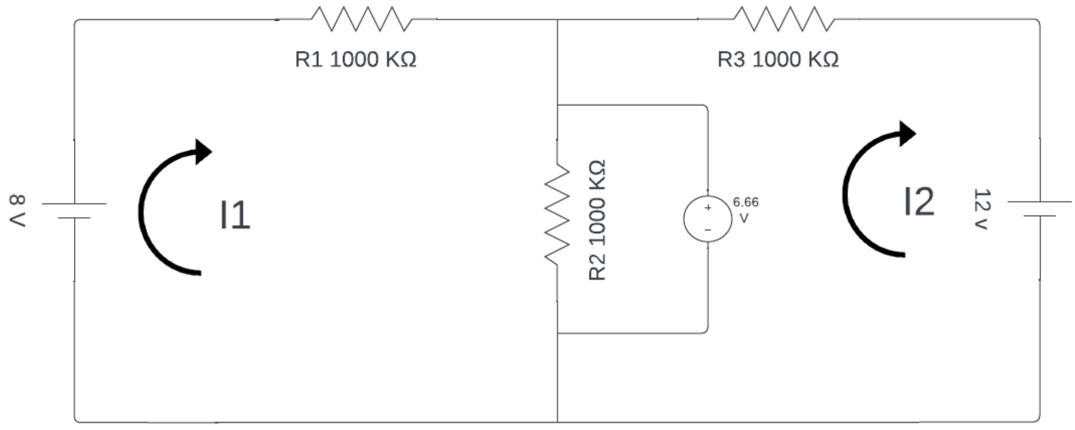
Hence, the current through load resistance is

$I_1 - I_2 = -4A - -8 = 4A$.

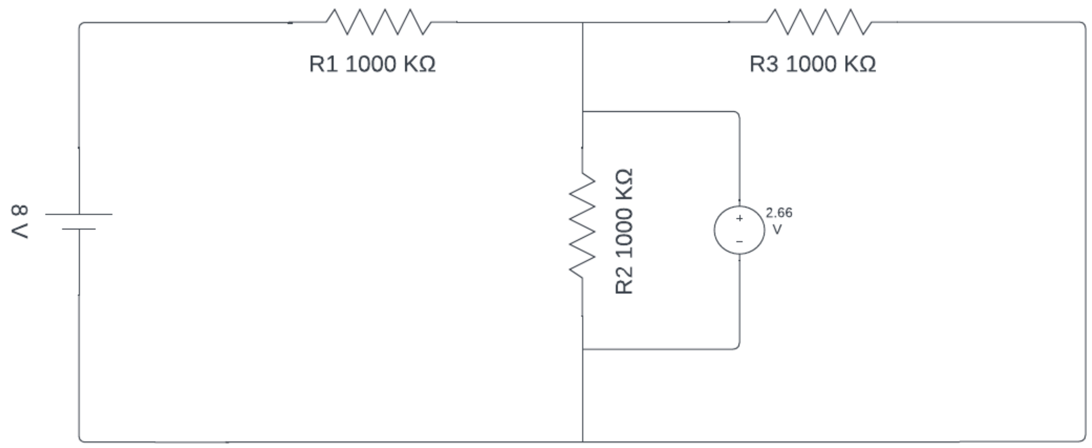
Therefore, the value of V_{L2} is$= 4$ V, $V_1 = 4V$.

CIRCUIT DIAGRAM





Circuit Drigram for V_I



Circuit Drigram for V_{I1}

PROCEDURE

1.For V_{Total}

- Connect the circuit as per the circuit diagram.
- Short the ground of (0-15) V power supply to the terminal of (0-30) V power supply.
- Switch on both the power supplies. Adjust (0-15) Supply to +10V and (0-30) V
- Supply to -5V.
- Measure the voltage (V_{Total}).

2.For V_{L1}

a) Disconnect the (0-15) V supply and short the terminals on module keeping -5V from (0-30) V power supply.

3.For V_{L2}

b) Disconnect the (0-30) V supply and short the terminals on module keeping +10V from (0-15) V power supply.

4.So, $V_{Total} = V_{L1} + V_{L2}$.Thus superposition theorem is proved.

OBSERVATION

Sl. NO.	V_{Total} THEORITICAL VALUE	PRACTICAL VALUE	V_{L1} THEORITICAL VALUE	PRACTICAL VALUE	V_{L2} THEORITICAL VALUE	PRACTICAL VALUE
1						
2						

PRECAUTIONS

1. All the connection should be right & tight.
2. The voltmeter & ammeter should be carefully chosen.
3. Supply should be switched on after ensuring correctness of connections
4. Any live terminal should not be touched while supply is on.

CONCLUSION

As V_{Total} V_{L1} and V_{L2} calculated is matched accurately with as measured. Thus, superposition theorem is verified.

QUESTIONS TO BE ANSWERED

1. What is an Energy meter?
2. What type of load will be used to calibrate the energy meter at UPF and why?
3. Define electrical energy and write its unit?
4. What do you mean by one unit of energy?
5. Which type of energy meter is used in domestic purpose?
6. What is meter constant?
7. Difference between wattmeter and energy meter?

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: …………… Sem: ……………….. Branch: ………………

EXPERIMENT-05

AIM OF THE EXPERIMENT

To verify the Thevenin's theorem.

EQUIPEMENT REQUIRED

Sl. No.	Name of the apparatus	Quantity
1	Thevenin's theorem trainer kit	
2	DC power supply	
3	Voltmeter	
4	Multimeter	

THEORY

It states that any linear lateral network irrespective of its network can be reduced into Thevenin equivalent circuit having Thevenin equivalent circuit having Thevenin equivalent voltage (V_{th}) in series with thevenin's equivalent resistance (R_{th}) in series with load resistance (R_L).

THEORITICAL CALCULATION

For Finding V_L,

Applying $L_L V_L$ in mesh (1) we get

$2I_1 - I_2 = 10$

Similarly for mesh (2) we get

$I_1 - 3I_2 = 0$

Now solving equation (1) and (2), we get,

$I_2 = 2MA$

$I_1 = 6MA$

Hence, the voltage across load resistance is $2MA \times 1k\Omega$.

For Finding V_{th},

Current flowing through the resistance 1 k$\Omega = (I_2 - I_1) = (2 - 6) = -4$mA.

So, the V_{th} will be $= -V_{th} + 4 = 0, \quad V_{th} = 4.$

For Finding R_{th} :

Now R_1 and R_2 are in parallel and equivalent of R_1 and R_2 is in series connection with R_3 .

$R_{th} = (R_1||R_2) + R_3$ =1.5kΩ.

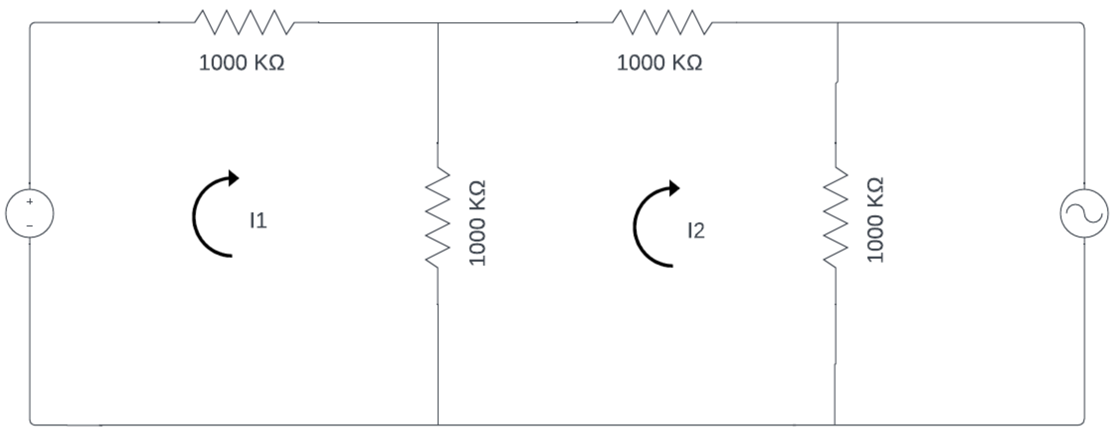
For Finding V_{L2} :

Now applying KVL in the given mesh, we get,

$I_L = \frac{V_{th}}{R_{th}+R_2} = 1.6mA$

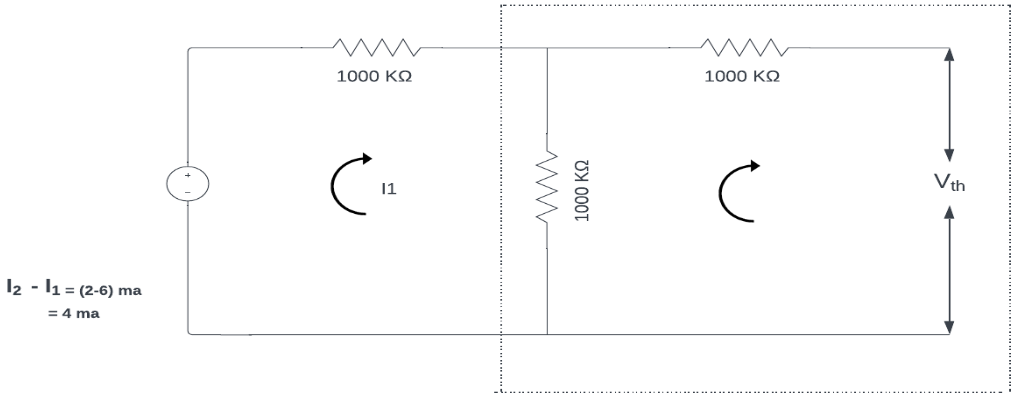
$V_{L2} = I_L \times I_R = 1.6V.$

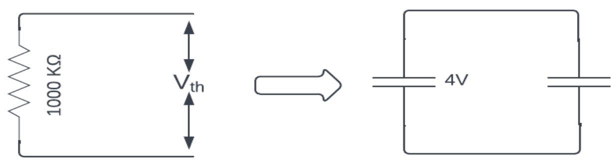
CIRCUIT DIAGRAM



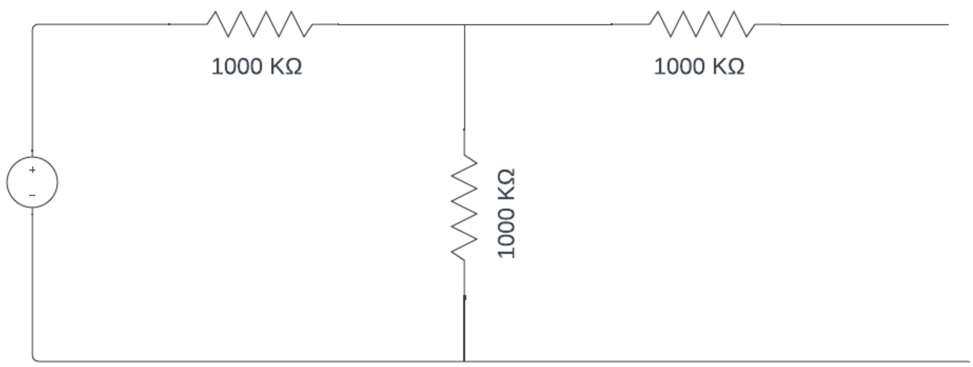
Circuit Drigram for determination of V_{li}

Circuit Drigram for determination of V_{th}

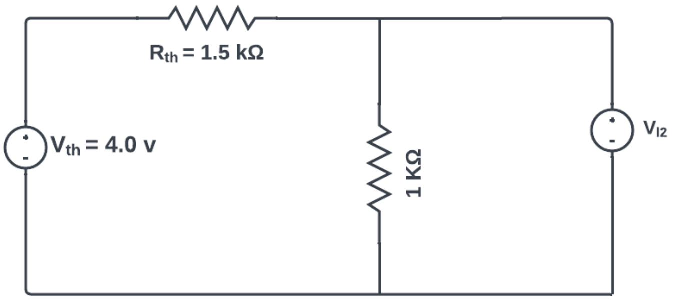




Circuit Drigram for determination of R_{th}



Circuit Drigram for determination of Thevnin equivalent Circuit



PROCEDURE

1)Connect the circuit as per the circuit diagram.

a) Applying 10V input voltage and measure V_{out} when load is connected.
b) Note clown the voltage V_{out}.This voltage is only for comparison and to the composed with. Find output voltage of Thevenin's equivalent circuit as illustrated.

2) Remove load resistance in the circuit diagram and keep those two terminals of open circuit

a) Remove voltage across as This is the Thevenin's voltage called V_{th}.

3) Connect the circuit as per the circuit diagram 3.

a) Measure the value of R_{th}.

4)For equivalent circuit:

a) Connect the circuit as per the circuit diagram constructed the circuit by setting power supply of voltage equal to Thevenin's theorem R_{th} and R_2.

5)Compare V_{out}/V_{L1} with V_{L2}, there will be same which verified the Thevenin's theorem.

6)From the Thevenin's equivalent circuit 'we can also measurement the current flowing through load resistance.

$$I_L = \frac{V_{th}}{R_{th} + R_L}$$

OBSERVATION TABULATION

Sl.No	V_{L1} Theoretical Value	Practical Value	V_{th} Theoretical Value	Practical Value	R_{th} Theoretical Value	Practical Value	V_{L2} Theoretical Value	Practical Value
1								
2								

PRECAUTIONS

1. All the connection should be right & tight.
2. The voltmeter & ammeter should be carefully chosen.
3. Supply should be switched on after ensuring correctness of connections
4. Any live terminal should not be touched while supply is on.

CONCLUSION

As the calculated value of the matched in both practical and theoretical, so Thevenin's theorem is vertical.

QUESTIONS TO BE ANSWERED

1. What do you mean by D.C compound Motor?
2. How many windings present in a DC machine,
3. Why the armature resistance of a DC shunt motor is less than the field resistance?
4. Which winding rotate during the operation of a DC machine
5. What are the types of DC motor?

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: …………… Sem: ……………….. Branch: ………………

EXPERIMENT-06

AIM OF THE EXPERIMENT

To verify Norton's theorem.

EQUIPEMENT REQUIRED

Sl. No.	Name of the apparatus	Quantity
1	Norton's theorem trainer kit	
2	DC power supply	
3	Voltmeter	
4	Multimeter	

THEORY

In any bi-directional network having more number of active and passive elements can be replaced by single equivalent circuit containing of a single current source in parallel with on resistance (impedance),the equivalent current source is the short circuit current is measured at that terminal and the equivalent resistance.

THEORITICAL CALCULATION

For Finding V_L,

Applying KVL in mesh (1) and (2) we get

$2I_1 - I_2 = 8$

$I_1 - 3I_2 = 0$

Now solving equation (1) and (2), we get,

$I_2 = 1.6mA$

Hence, the value of V_{L1} =16MA×1kΩ.=1.60 V

2) For determination of I_n,

To calculate I_n, the load resistance is removed, again applying KVL in mesh (1) and (2) we get

$2I_1 - I_2 = 8$

$I_1 - 3I_2 = 0$

Now solving equation (1) and (2), we get,

$I_2 = 2.67\text{mA}$

3) For determination of R_n,

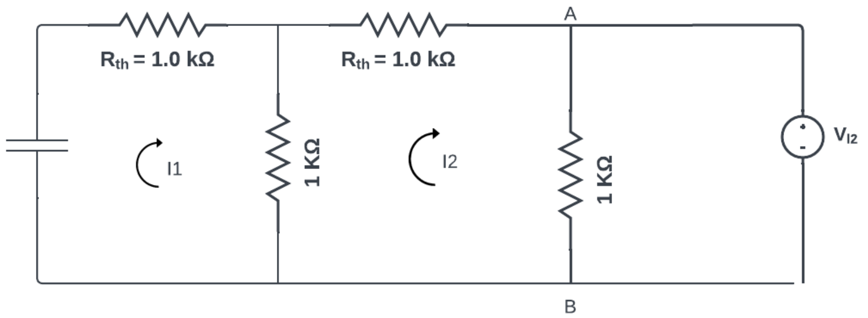
Now the R_1 and R_2 are in parallel andR_3 in series with previous one equivalent resistance of R_1 and R_2, Hence the Norton's equivalent resistance R_N is

$R_N = (R_1||R_2) + R_3$

=1.5KΩ.

4) For determination of V_{L2},

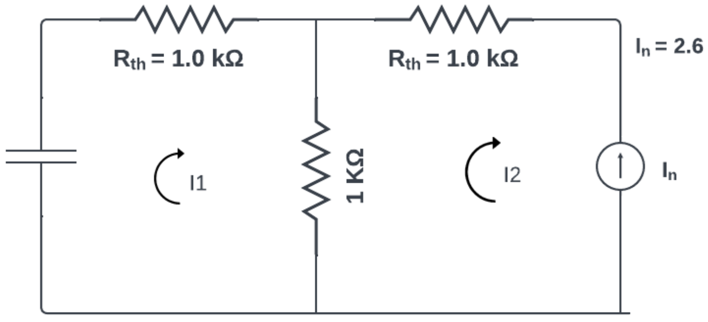
Now the value of is determined by the product of the resultant resistance and short circuit current or calculation the current in load resistance of the equivalent circuit.



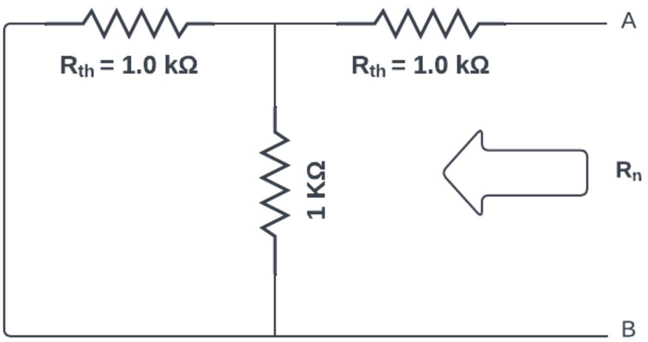
$I_L = \frac{R_N I_N}{R_L + R_N} = \frac{3.92}{2.47} = 1.59\text{mA}.$

$V_L = I_L + R_L = 1.59\text{V}$

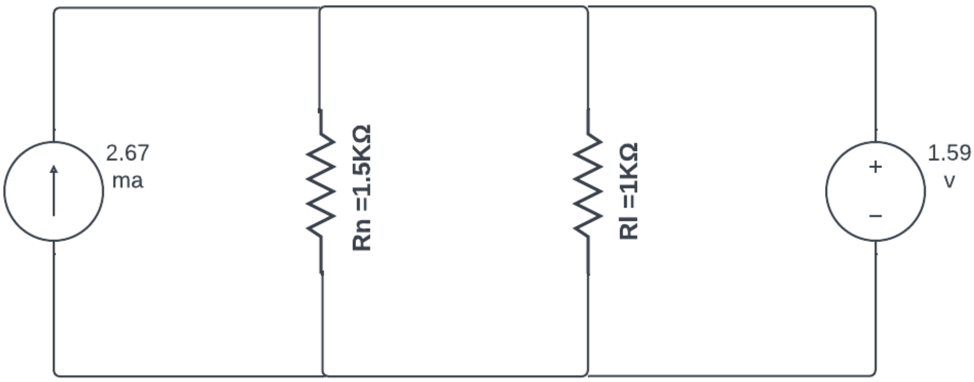
CIRCUIT DIAGRAM



Circuit Drigram for determination of R_n



Circuit Drigram for determination for nortons equivalent circuit for determination of V_{l2}



PROCEDURE

1. For V_{L1}.
   - Connect the circuit as per the circuit diagram
   - Find V_{L2} across R_L.
2. For finding I_N
   - Connect the circuit as per the circuit diagram
   - Remove the load resistance and switched on the supply adjust
   - Voltage to 10V.
   - Measure the value of I_N.
3. For finding R_N
   - Connect the circuit as per the circuit diagram
   - Measure the Norton's equivalent resistance $R_N$using digital multi meter.
   - Measure the value of I_N.
4. For finding V_{L2}

- Now connect the equivalent Norton’s circuit as per the circuit diagram
- Set the 10k pot to the value of R_N.
- First apply +10V power supply and attach an ammeter to measure and adjust the output current to the value of I_N.
- And provide measured short circuit current I_N and Norton’s equivalentb resistance R_N.
- Measure the value ofVL_2

5. Prove $VL_1 + VL_2$, then Norton’s theorem proved

$VL_1 = VL_{2.}$ (Hence Norton’s Theorem is proved).

OBSERVATION TABULATION

Sl. No.	I_N **THEORITICAL VALUE**	I_N **PRACTICAL VALUE**	R_N **THEORITICAL VALUE**	R_N **PRACTICAL VALUE**	V_{L1} **THEORITICAL VALUE**	V_{L1} **PRACTICAL VALUE**	V_{L2} **THEORITICAL VALUE**	V_{L2} **PRACTICAL VALUE**
1								
2								

PRECAUTION

1. All the connection should be right & tight.
2. The voltmeter & ammeter should be carefully chosen.
3. Supply should be switched on after ensuring correctness of connections
4. Any live terminal should not be touched while supply is on.

CONCLUSION

As V_{L1} calculated is matches accurately with the V_{L2} as measured thus

Norton’s theorem is verified.

QUESTIONS TO BE ANSWERED:

1. Why is the necessity of a starter in a DC motor?
2. What is the function a No Volt Coil in three-point starter?
3. What type of starter is most widely used?
4. What does the nameplate of a DC motor indicate?
5. What is the function of OLRC?

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: ……………   Sem: ………………..   Branch: ………………

EXPERIMENT- 07

AIM OF THE EXPERIMENT

Plotting of B-H curve of magnetic material and calculation of hysteresis loss.

THEORY

The rms voltage induced in a transformer is given by

$$E = 4.44\Phi mfN \tag{1}$$

where, is maximum value of the flux in the core, f is operating frequency and N is number of turns in the coil. This flux in the coil is given by

$$\Phi m = B_m Ac \tag{2}$$

where, B_m is the maximum flux density in core, and Ac is the cross-sectional area of the core. So, we have

$$E = 4.44 B_m AcfN \tag{3}$$

The value of induced voltage E is thus dependent upon B_m, which can be setup in the core. **DC Magnetization Curve.** We know from Biot-Savart's law that a current carrying conductor produces magnetic field. "Magnetic field strength" **H** is proportional to the current which produces the field. From Ampere's Circuital law, it can be proved that **H** is proportional to current I. If a current carrying coil produces magnetic flux which traverses an average length of I in complete flux path, then

$$Hl = N\,I \tag{4}$$

In a magnetic circuit, this field is represented by magnetomotive force. It is analogous to the electro-motive force in electrical circuit. This field is responsible to "set up" certain flux, which in turn gives rise to certain flux density B. Note that, here H is cause and B is its effect. The amount of flux which can be setup in a material is determined by an inherent property of the material, called as permeability, denoted by μ.

$$B = \mu\,H \tag{5}$$

Let us consider materials used in the laminations of transformers. They are called ferromagnetic materials. A piece of ferromagnetic material is composed of several "domains". In each domain, magnetic moments of all atoms are aligned in one direction. In general, the domains are randomly oriented. When external magnetic field **H** is applied to a material, all the domains align in a particular direction, setting up "net flux" in the material. Due to domain alignment B (ie. the magnitude of **B**) increases. However, after a certain value of B, the slope of B-H curve starts reducing as shown in Fig. 1: 0-S, represents the linear region and S-S, represents the saturation region". Note that

$$\frac{dB}{dH}\Big|_{0\text{-}S} > \frac{dB}{dH}\Big|_{S_1 - S_2}\Big| \tag{6}$$

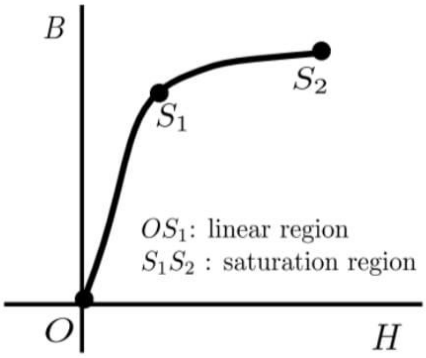


Figure 1: DC magnetization curve

Hysteresis Loop

Removing external magnetic field is equivalent to reducing H from H to 0. Due to this, the domains which were aligned in the direction of external field, "became free" of the external magnetic force. However, now they do not attain completely random orientation as they had at (B=0), H=0). Some domains maintain the direction of external magnetic field. This results in remanent magnetic thus density B. In short, while # traverses the trajectory 0-H-0; magnetic flux density & travers 0-Ber-Br, as shown in Fig. 2. In order to reduce flux density to aero we have to apply external magnetic field in the opposite direction or on the negative H-axis If external field is increases in the opposite direction, the behaviour of magnetic material is seen analogous to that of the positive quadrant. Complete B-H curve for is shown in Fig. 2. It is also called as "Hysteresis loop" traced by the flux density in the material.

Determination of B-H curve of a material

We cannot "measure" B and H directly. Further if we have transformer, we only have terminal measurements at our disposal. Hence, it is required to "process" the signals to get values of B and H. From Faraday's law,

$$V = N\frac{d\phi}{dt}$$

Also, from equation 2, Bis directly proportional to flex o. A signal proportional to B by integrating the voltage signal. The voltage can be integrated approximately by using an RC circuit. Care should be taken in the choice of R and C values. The transfer function of the circuit is given by

$$\frac{Vc(s)}{Vin(s)} = G(s) = \frac{1}{1+sT}$$

The time constant τ = RC should be chosen mach that, in frequency domain (1+jω) =jωT

CIRCUIT DIAGRAM

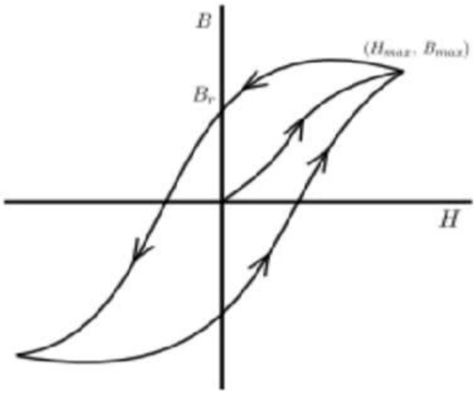
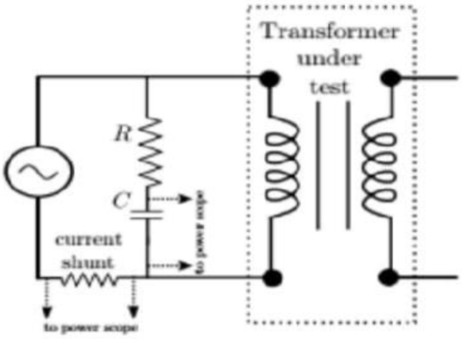


Figure 2: $B - H$ curve or Hysteresis loop



OBSERVATION TABLE

Sl.No.	Variable resistance (k)	Sensitization of CRD	Area of B-H Curve	Energy loss E=0.5 area of BH curve

PRECAUTION

1. The beam spot on the CRO screen should be highly intense and it's required to be focused exactly on the centre of the screen.

2. The input resistance applied should be measured by only in open circuit condition.

RESULTS

The energy losses due to hysteresis per unit volume of the given ferromagnetic material is observed to ____________Joule/sec/m^3.

QUESTIONS TO BE ANSWERED

1. What is meant by hysteresis loss in BH curve experiment?
2. Why area under the B-H curve is taken as energy loss?
3. Why both B and H are measured in voltage?
4. What is magnetic field?
5. What does the area of BH loop represents what is the use of this study?

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: …………… Sem: ……………….. Branch: ………………

EXPERIMENT-08

AIM OF THE EXPERIMENT

OC and SC test of 1-phase transformer.

APPARATUS REQUIRED

Sl. No.	Name of the apparatus	Specification	Quantity
1	Voltmeter		
2	Ammeter		
3	Wattmeter		
4	Autotransformer		
5	Transformer		

THEORY

Transformer is a device which transforms the energy from one circuit to other circuit without change of frequency. The performance of any transformer calculated by conducting tests. OC and SC tests are conducted on transformer to find the efficiency and regulation of the transformer at any desired power factor.

OC TEST

The objectives of OC test are:

1. To find out the constant losses or iron losses of the transformer.

2. To find out the no load equivalent parameters.

SC TEST

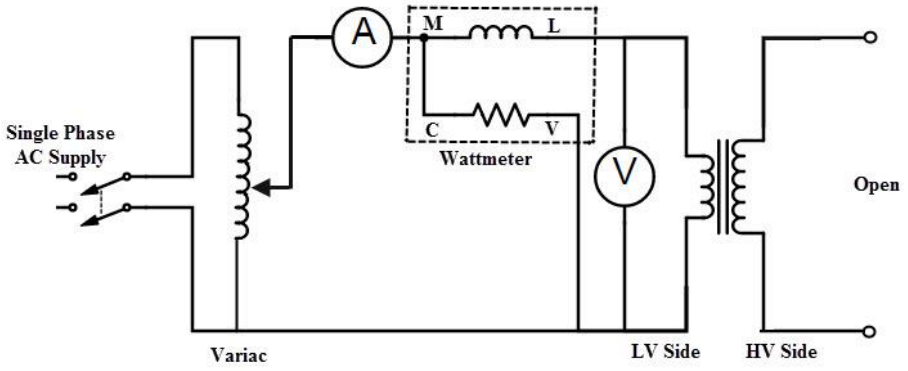
The objectives of OC test are:

1. To find out the variable losses or copper losses of the transformer.

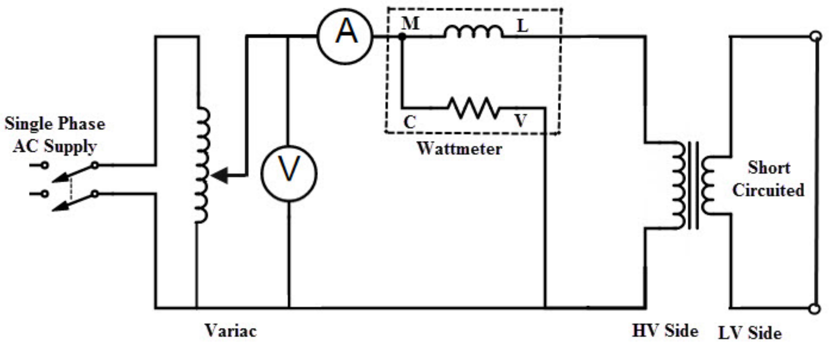
2. To find out the short circuit equivalent parameters.

By calculating the losses and equivalent parameters from the above tests the efficiency and regulation can be calculated at any desired power factor.

CIRCUIT DIAGRAM



(Diagram of OC test)



(Diagram of SC circuit)

PROCEDURE (OC TEST)

1. Connections are made as per the circuit diagram

2. Initially variac should be kept in its minimum position

3. Close the DPST switch.

4. By varying Auto transformer bring the voltage to rated voltage

5. When the voltage in the voltmeter is equal to the rated voltage of HV winding note down all the readings of the meters.

6. After taking all the readings bring the variac to its minimum position

7. Now switch off the supply by opening the DPST switch.

(SC TEST)

1. Connections are made as per the circuit diagram.

2. Short the LV side and connect the meters on HV side.

3. Before taking the single phase, 230 V, 50 Hz supply the variac should be in minimum position.

4. Now close the DPST switch so that the supply is given to the transformer.

5. By varying the variac when the ammeter shows the rated current

(i.e13.6A) then note down all the readings.

6. Bring the variac to minimum position after taking the readings and switch off the supply.

OC TEST OBSERVATION

S.NO	**V_0 (VOLTS)**	**I_O(AMPS)**	**W_O(WATTS)**

SC TEST OBSERVATION

S.NO	**V_0 (VOLTS)**	**I_O(AMPS)**	**W_O(WATTS)**

CALCULATION

(i) Parameters calculation from OC test

$\cos\phi_0 = \frac{W_o}{V_o I_o}$ =

$I_w = I_0 \cos\phi_0$ =

$R_0 = \frac{V_1}{I_w}$ =

$I_\mu = I_0 \sin\phi_0$ =

$X_0 = \frac{V_1}{I_\mu}$ =

$K = \frac{V_2}{V_1}$ =

(ii) Parameters calculation from SC test

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

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

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

(b) Calculations to find efficiency:

For 'n ' fraction of full load

Cupper losses = $n^2 \times W_{sc}$ watts

where W_{sc} = full load copper losses

Constant losses = W_0 watts

Output = n x KVA x cos φ [cos φ may be assumed]

Input = output + Cu. Loss + constant loss

$\%\ efficiency = \frac{Output}{Input} x\ 100$ =

(C)Calculation of Regulation at full load:

$\%\ Regulation = \frac{I_1 R_{01} \cos\phi \pm I_1 X_{01} \sin\phi}{V_1} x\ 100$ =

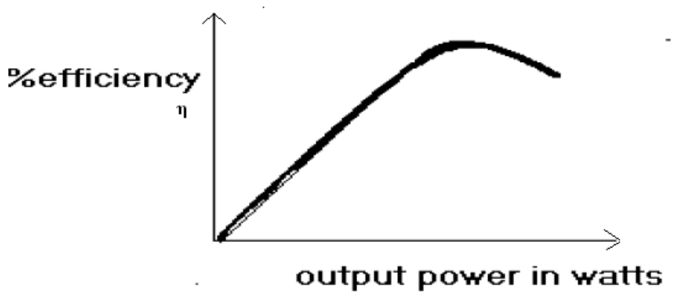
'+' for lagging power factors

'_' for leading power factors

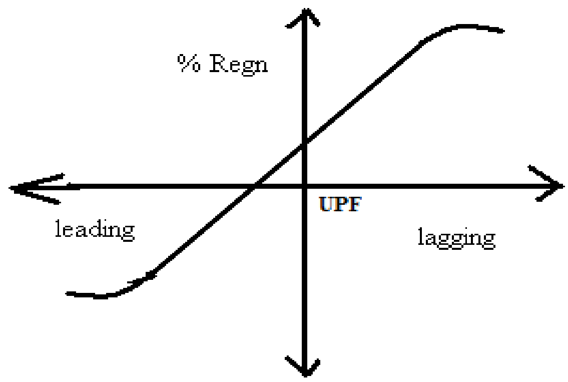
TABULAR COLUMN

S.NO	% OF LOAD	EFFICIENCY

1. **EFFICIENCY VS OUTPUT**



2. REGULATION VS POWER FACTOR



QUESTIONS

1) What is a transformer?

2) Draw the equivalent circuit of transformer?

3) What is the efficiency and regulation of transformer?

PRECAUTIONS

1. Before giving the supply, check whether the variac is in its zero position or not.
2. In SC test, increase the variac position very slowly.

CONCLUSION

In the above experiment we performed open circuit and short circuit test on single phase transformer and from OC test we get core loss and as watt and in SC test we get core loss watts.

QUESTIONS TO BE ANSWERED

1.What is a transformer?

2. Draw the equivalent circuit of transformer?

3. What is the efficiency and regulation of transformer**?**

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: ……………   Sem: ………………..   Branch: ………………

EXPERIMENT-09

AIM OF THE EXPERIMENT

Study the wiring of house.

THEORY (BASIC CONCEPTS OF HOUSEHOLD WIRING)

Single phase supply consists of one phase wire called hot wire and one neutral wire connected in Energy meter by PSPCL as input supply 220V.

• The output 220V supply is taken from Energy meter to MCB distribution box.

• ELCB, DP MCB / Isolator is used as main control.

• Number of SP-MCBs are installed in MCB Box to provide phase to individual switch board of rooms etc. in a house.

• Neutral wire from MCB Box neutral link is connected to each switch board socket and other loads.

• Switches are installed on switch board of each room to operate its respective load i.e., fan, light and TV, fridge, press, washing machine etc. through sockets.

• Any load (single phase) when connected with 220 V supply duly controlled by switch is called a circuit.

HOW TO DO HOUSE WIRING?

Wiring a lamp and a switch

The diagram shows a very simple configuration which can be used for powering a lamp and the switching arrangement is also provided in the form of a switch. This provided in the form of a switch. This provides the basic connecting data and the same may be used for wiring up other electrical appliances also(for ex a fan).

Wiring a lamp and a Fan in parallel

Again, the configuration employed is similar to the above and is just repeated for the fan. The input phase and the return path natural are common for both the electrical gadget or rather for all appliances that may be further included. Note that the fan speed regulator is also a load (mostly resistive) which should be connected in series with the fan and the switch by adjusting the regulator knob we actually reset the flow of current into the tail there by checking or varying its speed is desired.

Wiring up plug socket

There is no different from the above once. Here the load points are just replaced with the socket terminal or in simple words it's a for receiving through a series switch flushed in line with in phase.

CIRCUIT DIAGRAM

QUESTIONS TO BE ANSWERED

1. What is house wiring?
2. What are the basic concepts of house wiring?
3. How do you test house wiring?
4. Define fusing current?
5. Why fuses cannot provide on heavy short circuits?
6. A fuse performs which type of functions?
7. Fuse, Circuit breaker which is better and why?

SIGNATURE OF PROFESSOR

Name of student: …………………

Roll.no: …………………………………

Grade: …………… Sem: ……………….. Branch: ………………