## COURSE LABORATORY MANUAL

## A. LABORATORY OVERVIEW

| | | | |
|---|---|---|---|
| Degree: | BE | Programme: | EC |
| Semester: | I | Academic Year: | 2020-21 |
| Laboratory Title: | Basic Electrical engineering Laboratory | Laboratory Code: | 18ELEL17 |
| L-T-P-S: | 0-0-2-0 | Duration of SEE: | 3 Hrs |
| Total Contact Hours: | 32 | SEE Marks: | 60 |
| Credits: | 2 | CIE Marks: | 40 |
| Lab Manual Author: | Mrs Sowmya Anil | Sign: Sowmya Anil | 09/20/20 |
| Checked By: | Mrs Nirupama K | Sign: निरुपमा | 09/23/20 |

## B. DESCRIPTION

1. PREREQUISITES:

- Basic Electrical Engineering -18ELE13/23

2. BASE COURSE:

- Fundamental of Physics 18PHY12/22.
- Fundamentals of Mathematics 18MAT11

3. COURSE OUTCOMES:

1. Identify the common electrical components/ DC Machine/ AC Machine/ UPS and measuring instruments used for conducting experiments based on circuit laws in electrical laboratory.
2. Compare the power factors of lamp.
3. Determine impedance of an electrical circuit and power consumed in single and three phase load.
4. Determine earth resistance and understand two way and three way control of lamp and also find short and open circuit conditions in simple circuits.

4. RESOURSES REQUIRED:

- Trainer Kit
- Wires
- CRO

Sowmya Anil      निरुपमा

Prepared by:Mrs Sowmya Anil      Checked by: Mrs Nirupama K      HOD

5. RELEVANCE OF THE COURSE:

- Network Theory (18EC32)
- Electronic Devices & Instrumentation Laboratory(18ECL37)

6. GENERAL INSTRUCTIONS:

- Shoes shall be worn that provide full coverage of the feet.
- Do not displace or remove laboratory equipment without instructor or technician authorization.
- Before equipment is made live, circuit connections and layout should be checked by the

instructor.

- Never make any changes to circuits without first isolating the circuit by switching off and removing connections to supplies.
- Remove metal bracelets or watchstraps while conducting experiments.
- Do not use damaged cords, cords that become hot, or cords with exposed wiring. Inform the instructor about damaged cords.

7. CONTENTS:

| Expt No. | Title of the Experiments | RBT | CO |
|---|---|---|---|
| 1 | Verification of KCL and KVL for DC circuits. | L3 | CO1 |
| 2 | Measurement of current, power and power factor of incandescent lamp, fluorescent lamp, and LED lamp. | L2 | CO2 |
| 3 | Measurement of resistance and inductance of a choke coil using 3 volt-meter method | L2 | CO3 |
| 4 | Determination of phase and line quantities in three phase star and delta connected loads | L3 | CO3 |
| 5 | Measurement of three phase power using two wattmeter method. | L2 | CO3 |
| 6 | Two way and three way control of lamp and formation of truth table | L2 | CO4 |
| 7 | Measurement of earth resistance | L3 | CO4 |
| 8 | Study of effect of open and short circuit in simple circuits. | L2 | CO4 |
| 9 | Demonstration of fuse and MCB separately by creating a fault | L2 | CO4 |
| 10 | Demonstration of cut out sections of electrical machines (DC machines, Induction machines and synchronous machines). | L2 | CO1 |
| 11 | Understanding AC and DC supply. Use of tester and test lamp to a cer-tain the healthy status of mains | L2 | CO1 |
| 12 | Understanding of UPS. | L2 | CO1 |
| 13 | Open ended experiment - 1 | | |
| 14 | Open ended experiment - 2 | | |

8. REFERENCE:

- Basic Electrical Engineering D C Kulshreshtha Tata McGraw Hill, Revised First Edition
- Principles of Electrical Engineering & Electronics V.K. Mehta, Rohit Mehta S.Chand Publications
- Fundamentals of Electrical Engineering and Electronics B. L. Theraja S. Chand & Company Ltd, Reprint Edition 2013.
- Electrical Technology E. Hughes International Students 9th Edition, Pearson, 2005
- Basic Electrical Engineering D. P. Kothari and I. J. Nagrath Tata McGraw Hill, 2017

## C. EVALUATION SCHEME

For CBCS 2018 scheme:

1. Laboratory Components : 30 Marks
   (Record writing, Laboratory performance and Viva-voce)
2. Laboratory IA tests: 10 Marks
   2 IAs are mandatory. For the final IA test marks, average of the 2 IA test marks shall be considered and converted to maximum of 10
3. Continuous Internal Evaluation (CIE) = 30 + 10 = 40 Marks

4. *SEE* : 60 Marks

## D1. ARTICULATION MATRIX CO v/s PO

| Mapping of CO to PO | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | POs | | | | | | | | | | | |
| COs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1. Identify the common electrical components/ DC Machine/ AC Machine/ UPS and measuring instruments used for conducting experiments based on circuit laws in electrical laboratory. | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 |
| 2. Compare the power factors of lamp. | 3 | 3 | - | - | - | - | - | - | - | - | - | - |
| 3. Determine impedance of an electrical circuit and power consumed in 3 a phase load | 3 | 3 | - | - | - | - | - | - | - | - | - | - |
| 4.Determine earth resistance and understand two way and three way control of lamp and also find short and open circuit conditions in simple circuits | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 |

## D2. ARTICULATION MATRIX CO v/s PSO

| Mapping of CO to PSO | | |
|---|---|---|
| | PSOs | |
| COs | 1 | 2 |
| 1. Identify the common electrical components/ DC Machine/ AC Machine/ UPS and measuring instruments used for conducting experiments based on circuit laws in electrical laboratory. | 2 | - |
| 2. Compare the power factors of lamp. | - | - |
| 3. Determine impedance of an electrical circuit and power consumed in 3 a phase load | - | - |
| 4.Determine earth resistance and understand two way and three way control of lamp and also find short and open circuit conditions in simple circuits | - | - |

## E. EXPERIMENTS

| |
|---|
| 1. EXPERIMENT NO:1 |
| 2. TITLE: Verification of KCL and KVL for DC circuits. |
| 3. LEARNING OBJECTIVES:<br>1) Identify the resistance values using colour code<br>2) Verify KVL and KCL for DC circuit |
| 4. AIM: To verify Kirchhoff's voltage law (KVL) and Kirchhoff's current law (KCL) in a resistive network |
| 5. MATERIAL / EQUIPMENT REQUIRED:<br>• Regulated DC power supply<br>• DC Ammeter<br>• DC Voltmeter<br>• Resistors |

- Connecting wires

6. THEORY / HYPOTHESIS:

In 1845, a German physicist, Gustav Kirchhoff developed a pair or set of rules or laws which deal with the conservation of current and energy within electrical circuits. These two rules are commonly known as: Kirchhoff Circuit Laws with one of Kirchhoff s laws dealing with the current flowing around a closed circuit, Kirchhoff's Current Law, (KCL)while the other law deals with the voltage sources present in a closed circuit, Kirchhoff's Voltage Law, (KVL).

Kirchhoff 's First Law – The Current Law, (KCL)

Kirchhoff 's Current Law or KCL, states that the "total current or charge entering a junction or node is exactly equal to the charge leaving the node ". In other words the algebraic sum of all the currents entering and leaving a node must be equal to zero, I(exiting) + I(entering) = 0. This idea by Kirchhoff is commonly known as the Conservation of Charge

Kirchhoff 's Second Law – The Voltage Law, (KVL)

Kirchhoff 's Voltage Law or KVL, states that "in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop" which is also equal to zero. In other words the algebraic sum of all voltages within the loop must be equal to zero. This idea by Kirchhoff is known as the Conservation of Energy.

7. FORMULA / CALCULATIONS:

KVL

$V1=V2+V3;$

$V1= IR1+IR2$

KCL

$\Sigma I = 0$

$I1=I2+I3$

8. PROCEDURE :

Verify KVL

1.Connect the circuit as shown in the figure 1.1.

2. Now, vary the DC supply and note down the readings of voltmeters V1, V2 and V3.

3. Repeat the same procedure for different DC input voltage.

4. Sum up the voltmeter readings (voltage drops) should be equal to applied voltage.

5. Thus KVL is verified practically.

To Verify KCL

1. Connect the circuit as shown in the figure 1.2.

2. Now, vary the DC supply and note down the readings of ammeters I1, I2 and I3.

3. Repeat the same procedure for different DC input Currents.

4. Sum up the Ammeter readings I2 and I3 that should be equal to total current I1.

5. Thus KCL is verified practically.

9.CIRCUIT KVL CIRCUIT:

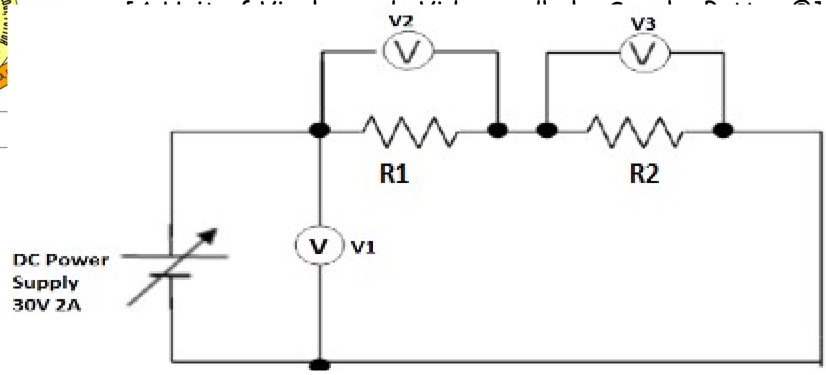



Fig 1.1

KCL CIRCUIT:

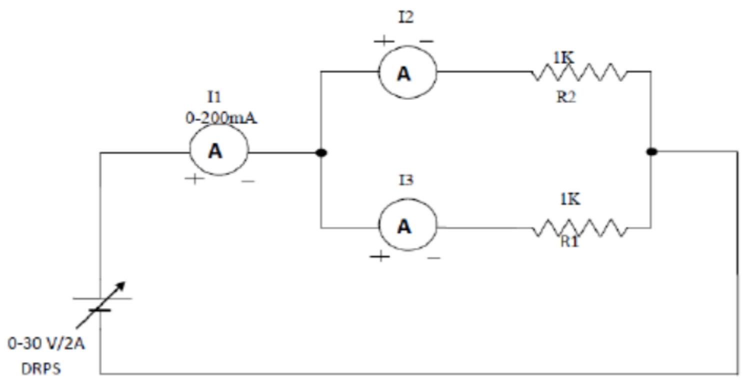



Fig 1.2

10. OBSERVATION TABLE:

KVL VERIFICATION TABLE:

| Sl no | V1(V) | V2 (V) | V3 (V) | V1= V2+V3 (V) |
|---|---|---|---|---|
| 1 | 10 | | | |
| 2 | 15 | | | |
| 3 | 20 | | | |

KCL VERIFICATION TABLE:

| Sl no | V(volts) | I1 (mA) | I2 (mA) | I3 (mA) | I1= I2+I3 (mA) |
|---|---|---|---|---|---|
| 1 | 10 | | | | |
| 2 | 15 | | | | |
| 3 | 20 | | | | |

11. RESULTS & CONCLUSIONS:

It is found that in the series circuit the current remains the same and the voltage divides according to the load connected. In a series circuit, the Kirchhoff's voltage law is applied and the sum of all the voltages equals zero. For the parallel circuit, the voltage remains the same however, the current divides into the branches. In parallel circuit, Kirchhoff's current law is applied.

12. LEARNING OUTCOMES :

It was seen that in a circuit for closed loop using KVL Σ Vdrop = Σ Vrise and at a node Using KCL ΣI entering =ΣI leaving

13. APPLICATION AREAS:

KCL and KVL are very important in solving the circuits where direct formula can't be applied. Basically it is used for Circuit Analysis.

14. REMARKS:

- -

1. EXPERIMENT NO:2

2. TITLE: Measurement of current, power and power factor of incandescent lamp, fluorescent lamp, and LED lamp.

3. LEARNING OBJECTIVES:

- To compare the power consumed by incandescent lamp, fluorescent lamp, and LED lamp
- To Study the power factor due to each of these loads

4. AIM:To measure the current, power factor and power consumed incandescent lamp, fluorescent lamp, and led lamp.

5. MATERIAL / EQUIPMENT REQUIRED:

- Multi function energy meter
- Incandescent lamp
- Fluorescent Lamp
- CFL
- LED
- Connecting Wires

6. THEORY / HYPOTHESIS:

**The fluorescent lamp**:

The fluorescent lamp circuit consists of a choke, a starter, a fluorescent tube and a frame. The length of the commonly used fluorescent tube is 100 cm, its power rating is 40 W and 230V. The tube is filled with argon and a drop of mercury. When the supply is switched on, the current heats the filaments and initiates emission of electrons. After one or two seconds, the starter circuit opens and makes the choke to induce a momentary high voltage surge across the two filaments. Ionization takes place through argon and produces bright light.

**Incandescent Lamp**

An incandescent bulb typically consists of a glass enclosure containing a tungsten filament. An electric current passes through the filament, heating it to a temperature that produces light. The only trouble is that an incandescent lamp has to produce an incredible amount of heat to produce some amount of light. Roughly 95 percent of the electricity you feed into a lamp like this is wasted as heat.

Incandescent light bulbs usually contain a stem or glass mount attached to the bulb's base which allows the electrical contacts to run through the envelope without gas/air leaks. Small wires embedded in the stem support the filament and/or its lead wires

**CFL:**

It's also known as the Compact Fluorescent Light bulb, or CFL. CFLs contain argon and mercury vapor housed within a spiral-shaped tube. They also have an integrated ballast, which produces an electric current to pass through the vapor mixture, exciting the gas molecules. When the gas gets excited, it produces ultraviolet light. The ultraviolet light, in turn, stimulates a fluorescent coating painted on the inside of the tube. As this coating absorbs energy, it emits visible light.

**LED:**
A light-emitting diode is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated. When a suitable current is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. Light-emitting diodes (LED) are semiconductors. As electrons pass through this type of semiconductor, it turns into light. Compared to incandescent and CFL bulbs, LED lights are more efficient at turning energy into light. Therefore, less of the energy radiates from the bulb as heat.

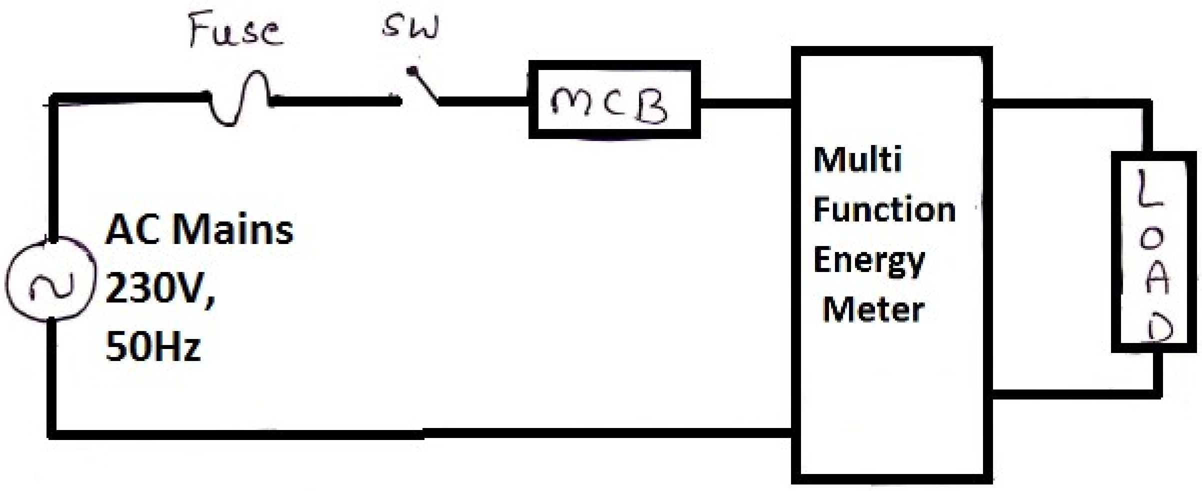
7. FORMULA / CALCULATIONS:

$P= VI \cos\phi$

$Q= VI \sin\phi$

8. PROCEDURE:
1. Connect the circuit as shown in the diagram with Incandescent bulb in the holder.
2. Switch on A.C supply, close the switch and observe the voltage, current and Power factor values in Power Factor meter.
3. Repeat the same for Fluorescent Lamp, CFL bulb and LED Bulb.
4. Now compare power factor , active, reactive and apparent Power of all the bulbs used.

9. BLOCK / CIRCUIT




10. OBSERVATION TABLE / LOOKUP TABLE / TRUTH TABLE:

| | Lamp | Voltage (V) | Current (A) | Cosϕ | P= VI Cosϕ (W) | Q= VI Sinϕ (VAR) | S=VI (VA) |
|---|---|---|---|---|---|---|---|
| 1 | Incandescent | | | | | | |
| 2 | Fluorescent | | | | | | |
| 3 | CFL | | | | | | |
| 4 | LED | | | | | | |

11. RESULTS & CONCLUSIONS:
The power consumed by ___________ is more and the power consumed by the ______________ is less.

12. LEARNING OUTCOMES :
Light Emitting Diode (LED) as one of the lighting system instead of fluorescent and others, because

of its energy saving characteristic. Since the power consumed by the LED bulb is less is is cost efficient and since it is mercury free its environment friendly

13. APPLICATION AREAS:
Domestic the Industrial application.

14. REMARKS:
- -

1. EXPERIMENT NO:3

2. TITLE: Measurement of resistance and inductance of a choke coil using 3 voltmeter method

3. LEARNING OBJECTIVES:MTo measure the resistance and inductance of the choke coil

4. AIM:To measure parameters of a choke coil by 3 voltmeter method  method

5. MATERIAL / EQUIPMENT REQUIRED:
- Choke coil
- Ammeter
- Voltmeter
- Single phase auto transformer
- Rheostat
- Connecting wires

6. THEORY / HYPOTHESIS:
The 3 voltmeter method allows you to determine the Real, Reactive, and Apparent power in a circuit. The three voltmeter is used in an inductive circuit to measure the value of the power factor. A choke coil is usually represented by a pure inductance in series with equivalent resistance. This equivalent resistance takes into effect the iron losses in the core of the choke coil and inherent resistance of the choke coil. As seen on Figure , one voltmeter is used to measure the voltage of the circuit (Vs), the second one measures the voltage on the non-inductive resistance ($V_R$) that is connected in the series with the load branch and the third voltmeter is used to measure the voltage of the load ($V_L$). For optimal accuracy, the non-inductive resistance should be large enough so that the voltmeter (or multimeter) can measure it with satisfactory accuracy, but not too large, otherwise the voltage available to the load would be too small. Ideally, it should be close or equal to load impedance.

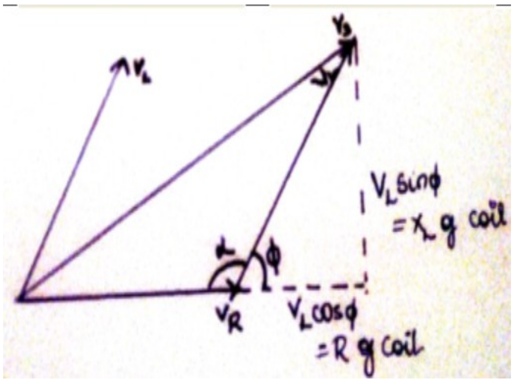
7. FORMULA / CALCULATIONS:
7.

$$V_s^2=(V_R+V_L\cos\Phi)^2+(V_L\sin\Phi)^2$$

$$V_s^2=V_R^2+V_L^2\cos\Phi^2+2V_RV_L\cos\Phi+V_R^2\sin\Phi^2$$

$$V_s^2=V_R^2+V_L^2+2V_RV_L\cos\Phi$$

$$\cos\Phi=\frac{V_s^2-V_R^2-V_L^2}{2V_RV_L}$$




- Resistance = $\frac{V_L\cos\Phi}{I}$ = _______ **Ω**
- Inductive reactance of the coil = $X_L$= $\frac{V_L\sin\Phi}{I}$ = ___________ **Ω**

- Inductance L = $\frac{X_L}{2\pi f}$ = ______ H, where f is the frequency of supply in hertz = 50Hz

8. PROCEDURE / PROGRAMME / ACTIVITY:

- Make the connections as per the circuit shown in figure 3.1
- Initially keep the autotransformer in minimum position.
- Close supply DPST switch.
- By varying the auto transformer and rheostat set the rated current by through the choke coil
- Note down the readings of all the meters.

9. CIRCUIT DIAGRAM:

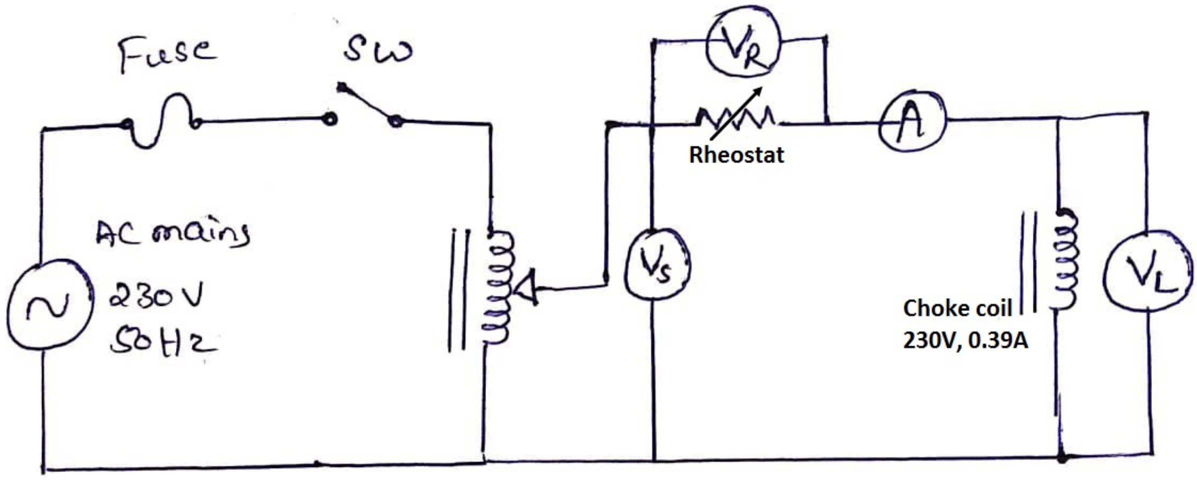



Fig 3.1

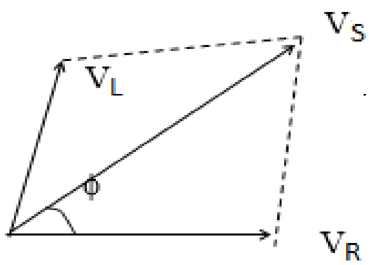
10. OBSERVATION TABLE / LOOKUP TABLE / TRUTH TABLE:

**Voltmeter method :**

| Sl.No | $V_S$ (V) | $V_R$ (V) | $V_L$ (V) | I (A) | Pf = CosΦ = | Resistance R (Ω) | Inductive reactance $X_L$ (Ω) | Inductance (H) |
|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | |
| 2 | | | | | | | | |

11. GRAPHS / OUTPUTS:

**Phasor diagrams :**



12. RESULTS & CONCLUSIONS:
- The value of L=______Henry
- The value of R= _________Ω

13. LEARNING OUTCOMES :
- The value of L and R will be same for different values of input.

14. APPLICATION AREAS:
- Choke coils are used in communication circuits
- They are used in relays.

15. REMARKS:
- -

1. EXPERIMENT NO:4

2. TITLE: Determination of Phase and Line quantities in three phase Star and Delta connected loads

3. LEARNING OBJECTIVES:
- To understand the concept of three phase star and delta connected loads.
- To find the relationship between line and phase quantities in star and delta connected loads.

4. AIM: Determination of phase and line quantities in three phase star and delta connected loads

5. MATERIAL / EQUIPMENT REQUIRED:
- Three phase auto transformer
- Three phase resistive load (5A in 5 steps)
- AC voltmeter
- AC ammeter
- Connecting wires

6. THEORY / HYPOTHESIS:
Any three phase system, either supply system or load can be connected in two ways either star or delta
(i) Star Connection
In this connection, the starting or termination ends of all winding are connected together & along with their phase ends. This Common point is also brought out called as neutral point.
(ii) Delta Connection
If the terminating end of one winding is connected to starting end of other & if connection are continued for all other windings in this fashion we get closed loop. The three supply lines are taken out from three junctions. This is called as three phase delta connected system. The load can be connected in similar manner. In this experiment we are concerned with balanced load.
The load is said to be balanced when
i. Voltages across three phases are equal & phases are displaced by 120°electrical.
ii. The impedance of each phase of load is same.
iii. The resulting current in all the three phases are equal & displaced by 120°electrical from each other
iv. Active power & reactive volt amperes of each is equal.

7. FORMULA / CALCULATIONS:
For star connection of load-
- Line voltage ($V_L$)= √3 Phase voltage ($V_{ph}$)
- Line current ($I_L$)= Phase current ($I_{ph}$)

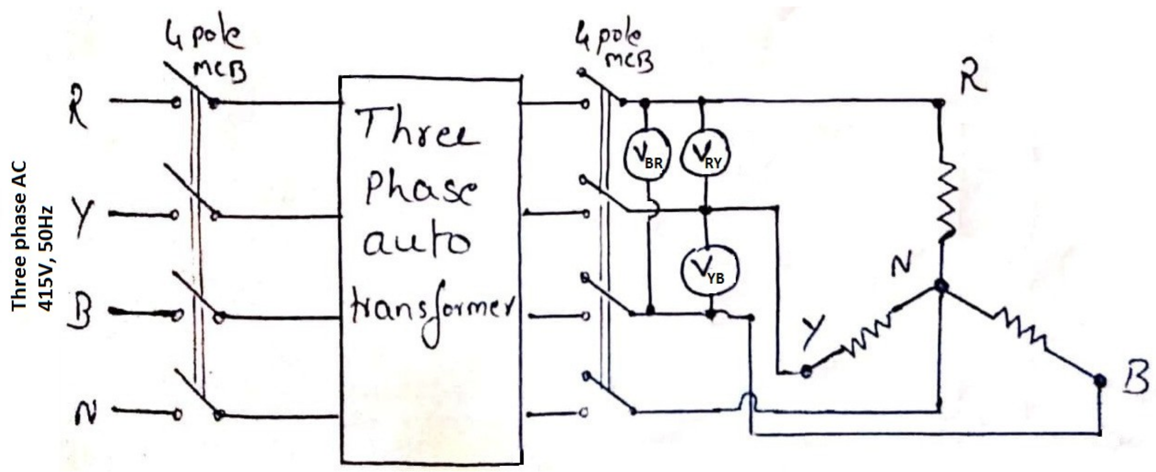
For delta connection of load-
Line voltage ($V_L$)= Phase voltage ($V_{ph}$)
Line current ($I_L$)= √3 Phase current($I_{ph}$)

P= power consumed by the load = $\sqrt{3}V_L I_L \cos(\phi)$ ; Where $\phi$ is phase angle between phase voltage and phase current & it depends on type of load i.e. inductive, capacitive or resistive.

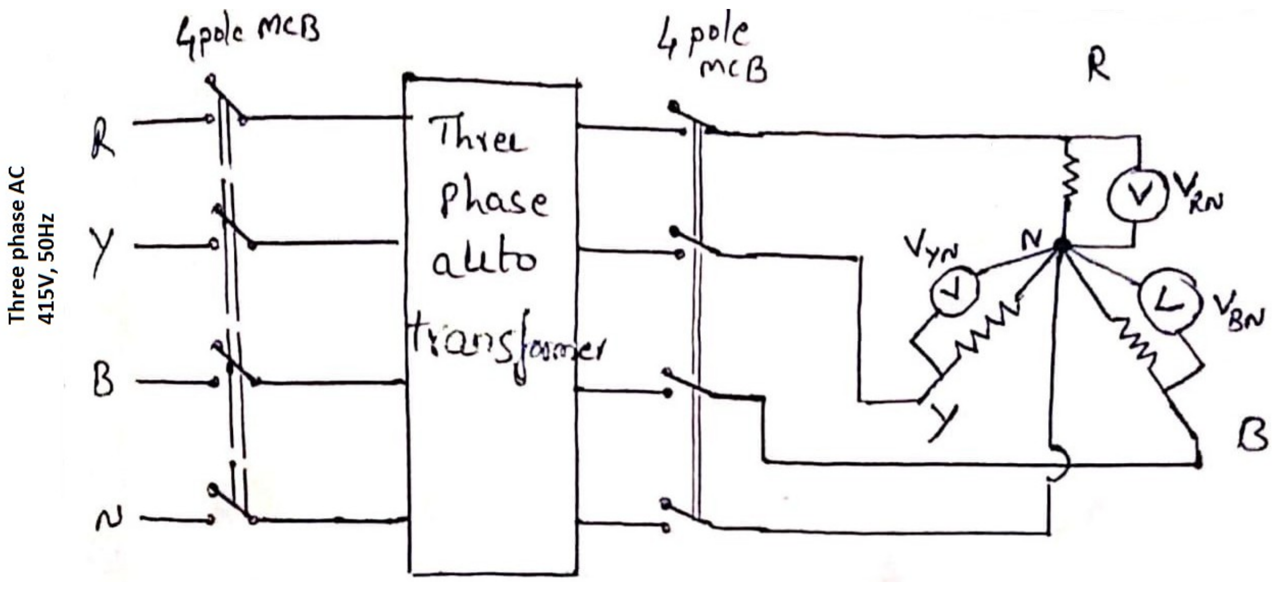
8. PROCEDURE :

- Make the connections as per the circuit shown in figure below.
- Initially keep the auto-transformer in minimum position.
- Close supply switch.
- Vary the applied voltage by varying the auto-transformer until rated current flows through circuit.
- Note down the readings of current and voltages in star and delta connections.
- Observe the relation between Phase and Line quantities

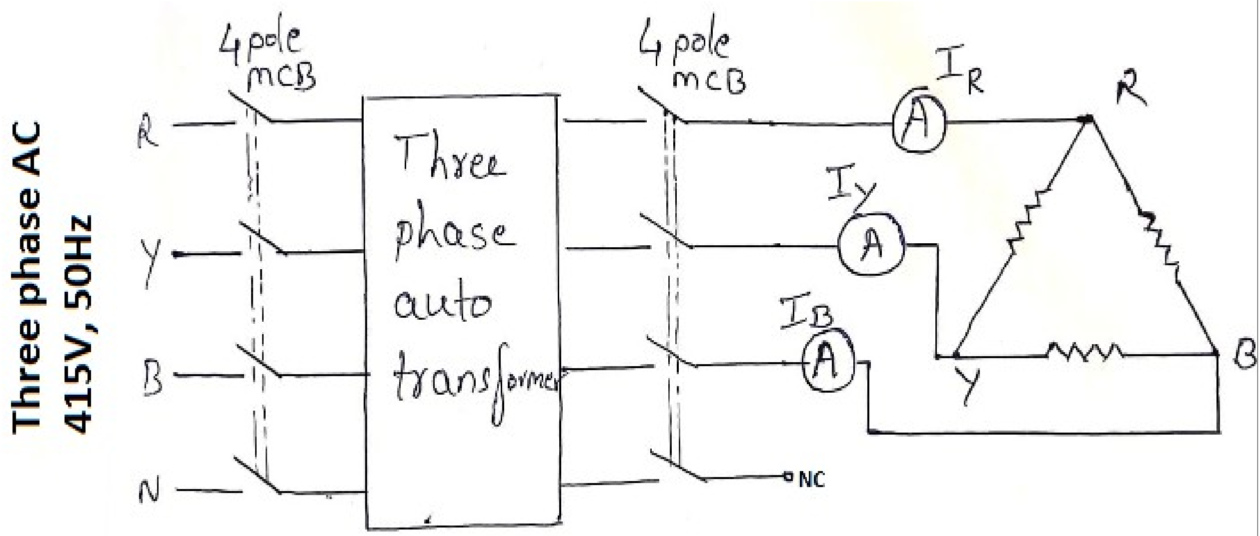
9. CIRCUIT DIAGRAM :i)To measure line voltage in star connection:



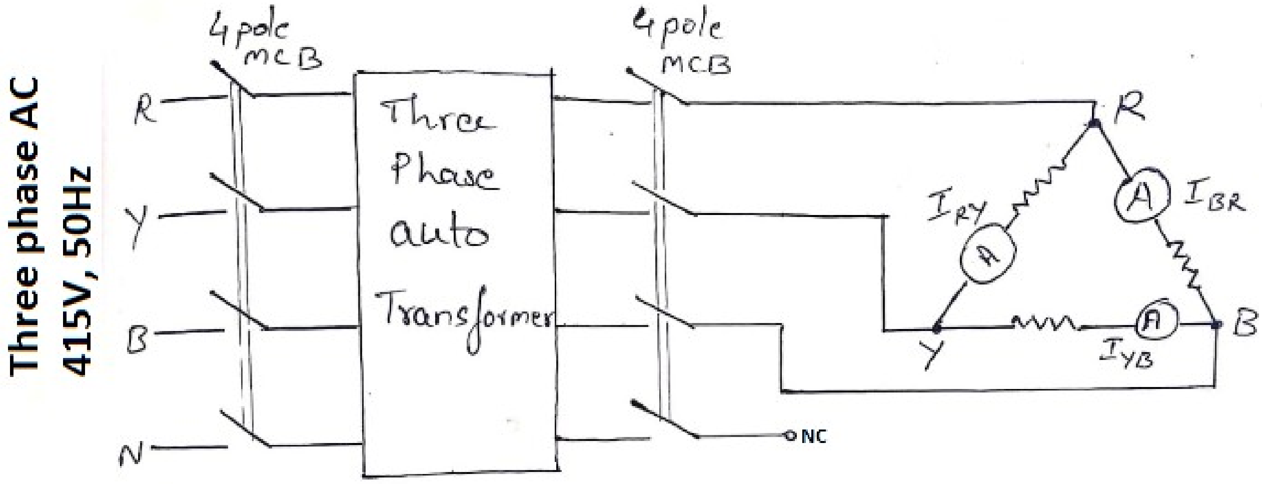

ii)To measure phase voltage in star connection:




iii) To measure line Current in Delta Connection:




iv)To measure Phase Current in Delta Connection:



10. OBSERVATION TABLE :

i)Line Voltage in star connection:

| Sl.No | $V_{RY}$ (Volts) | $V_{YB}$ (Volts) | $V_{RB}$ (Volts) | $V_{L(AVG)} = (V_{RY}+V_{YB}+V_{RB})/3$ (Volts) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |

ii)Phase Voltage in star connection:

| Sl.No | $V_{RN}$ (Volts) | $V_{YN}$ (Volts) | $V_{BN}$ (Volts) | $V_{ph(AVG)} = (V_{RN}+V_{YN}+V_{BN})/3$ (Volts) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |

iii)Relationship between line and phase voltage:

| Sl.No | $V_L$ (Volts) | $V_{ph}$ (Volts) | $V_L/V_{ph}$ (Volts) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |

iv)Line current in delta connection:

| Sl.No | $I_{RY}$ (Amps) | $I_{YB}$ (Amps) | $I_{BR}$ (Amps) | $I_{L(AVG)} = (I_{RY}+I_{YB}+I_{BR})/3$ (Amps) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |

v)Phase current in delta connection:

| Sl.No | $I_R$ (Amps) | $I_Y$ (Amps) | $I_B$ (Amps) | $I_{ph\ (AVG)} = (I_R+I_Y+I_B)/3$ (Amps) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |

vi)Relationship between line and phase current:

| Sl.No | $I_L$ (Amps) | $I_{ph}$ (Amps) | $I_L/I_{ph}$ (Amps) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |

11. RESULTS & CONCLUSIONS:

- $V_{L(avg)} =$

- $V_{ph(avg)}$ =
- $I_{L(avg)}$ =
- $I_{ph(avg)}$ =

12. LEARNING OUTCOMES:
- Three phase star and delta connected loads concept understood and able to find the relationship between line and phase quantities.

13. APPLICATION AREAS:
- Three-phase wiring for industrial applications.
- To make the system neutral.
- In industries to run motor/transformer in star and delta connection.

14. REMARKS:

1. EXPERIMENT NO:5
2. TITLE: Measurement of three phase power using two wattmeter
3. LEARNING OBJECTIVES:
- To understand the concept of three phase power.
- To calculate the power and power factor.

4. AIM: To measure three phase power and power factor in a balanced three phase load by using two single-phase wattmeters.

5. MATERIAL / EQUIPMENT REQUIRED:
- Three phase auto transformer
- Three phase resistive load (5A in 5 steps)
- AC voltmeter
- AC ammeter
- AC wattmeter
- Connecting wires

6. THEORY / HYPOTHESIS:
A wattmeter is an instrument with a potential coil or pressure coil (PC) and a current coil (CC) so arranged that its deflection is proportional to $VI\cos\phi$, where V is the voltage (rms value) applied across the potential coil, I is the current (rms value) passing through the current coil, and $\phi$ is the angle between V and I. The three-phase power can be measured by three single-phase wattmeters having current coil in each line and potential coils connected across the given line and any common junction. Since this common junction is completely arbitrary, it may be placed on any one of the three lines, in which case the wattmeter connected in that line will indicate zero power because its potential coil has no voltage across it. Hence, that wattmeter may be dispensed with, and three-phase power can be measured by means of only two single-phase wattmeters having a common potential junction on any of the three lines in which there is no current coil. This is known as the two-wattmeter method of measuring three-phase power. In general, m-phase power can be measured by means of $m - 1$ wattmeters. The method is valid for both balanced and unbalanced circuits with either the load or the source unbalanced.

**In Delta connection**

$$v_{RY}+v_{YB}+v_{BR}=0$$

*where* $v_{RY}, v_{YB}, v_{BR}$ *are instantaneous voltage*

*instantaneous power*

$$p=i_R*v_{BR}+i_Y*v_{RY}+i_B*v_{YB}$$

$$p=W_1+W_2$$

**In Star connection**

$i_R+i_Y+i_B=0$ *where* $i_R, i_Y, i_B$ *are instantaneous currents*

$$p=i_R*v_{RN}+i_Y*v_{YN}+i_B*v_{BN}$$

$$p=W_1+W_2$$

Power in 3 phase system= $\sqrt{3}\, V_L I_L \cos\varphi$

7. FORMULA / CALCULATIONS:

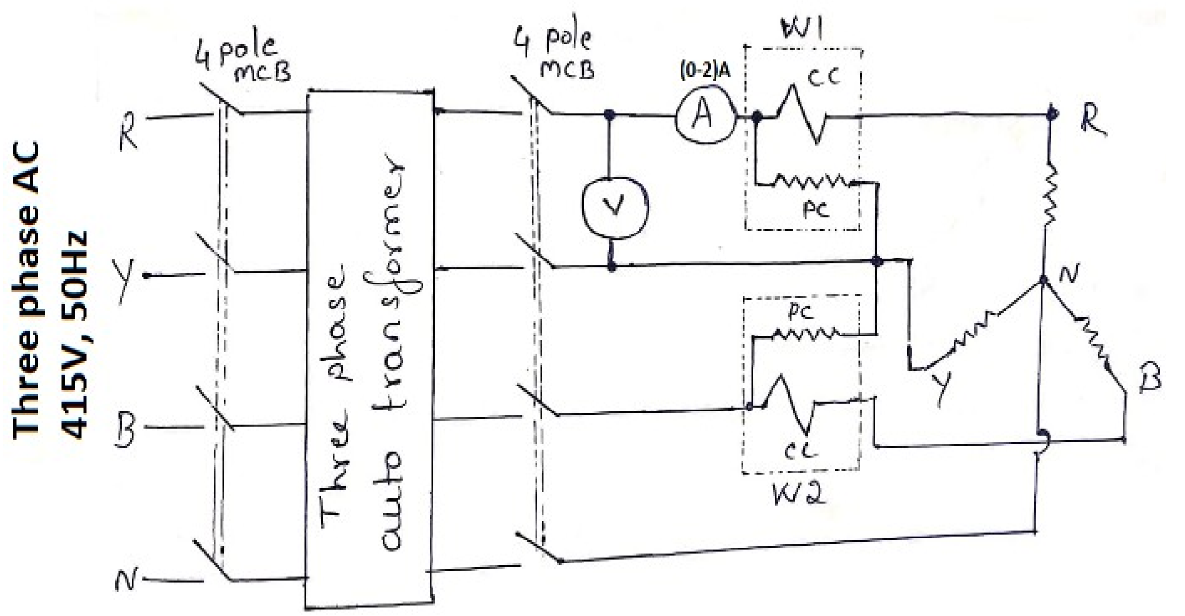
- Three phase power= $\sqrt{3}\, V_L I_L \cos\varphi$
- power factor angle $\Phi=\tan^{-1}\left[\frac{\sqrt{3}(W_2-W_1)}{W_2+W_1}\right]$

8. PROCEDURE / PROGRAMME / ACTIVITY:

- Connect the circuit as per figure.
- The output voltage of 3-phase variac is set at zero or low.
- Switch on the 3- phase supply.
- Apply a certain voltage to the circuit and note down the readings of two wattmeters. Connected in the circuit.
- Reduce the voltage applied to 3-phase load and then switch off the supply.

9. BLOCK / CIRCUIT / MODEL DIAGRAM / REACTION EQUATION:

For Star Connection:




10. OBSERVATION TABLE :

| S.No | $W_1$ (watts) | $W_2$ (watts) | $W=W_1+W_2$ (Watts) | cosϕ | $V_L$ (volts) | $I_L$ (Amps) | $P=\sqrt{3}V_LI_L\cos\phi$ (watts) |
|---|---|---|---|---|---|---|---|
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |

11. RESULTS & CONCLUSIONS:
- Power=
- Power factor =

12. LEARNING OUTCOMES:
- The power and power factor of the balanced three phase circuit calculated using two wattmeter method.

13. APPLICATION AREAS:
- To measure power in electrical circuit.
- Industry

14. REMARKS:
- -

1. EXPERIMENT NO:6
2. TITLE:Two way and three way control of lamp and formation of truth table.
3. LEARNING OBJECTIVES:
- To understand the concept of two way and three way control of lamp
- To formulate the truth table of two way and three way lamp.

4. AIM: To control the lamps in two way and three way using two way and intermediate switch.

5. MATERIAL / EQUIPMENT REQUIRED:

- Two way switch- 2
- Intermediate switch- 1
- Lamp- 1
- Connecting wires

6. THEORY / HYPOTHESIS:

A 2-way switching connection means you can control an electrical equipment like bulb by two switches placed at different places, generally used in the staircase. Two way switch can be operated from any of the switch independently, Means whatever be the position of other switch(ON/OFF), you can control the light with other switch.

Three-way and four-way switches make it possible to control a light from multiple locations, such as the top and bottom of a stairway, either end of a long hallway, or multiple doorways into a large room. These switches appear externally similar to single pole, single throw (SPST) switches, but have extra connections which allow a circuit to be controlled from multiple locations. Toggling the switch disconnects one "traveler" terminal and connects the other.

7. PROCEDURE / PROGRAMME / ACTIVITY:

- Connect the circuit as per figure 6.1 for two way control.
- Switch on the Mains power.
- Now operate the Switches and check for the desired output as per Truth Table.
- Now repeat the above procedure for three way control by connecting as shown in figure 6.2.

8.CIRCUIT DIAGRAM

i)Two way control

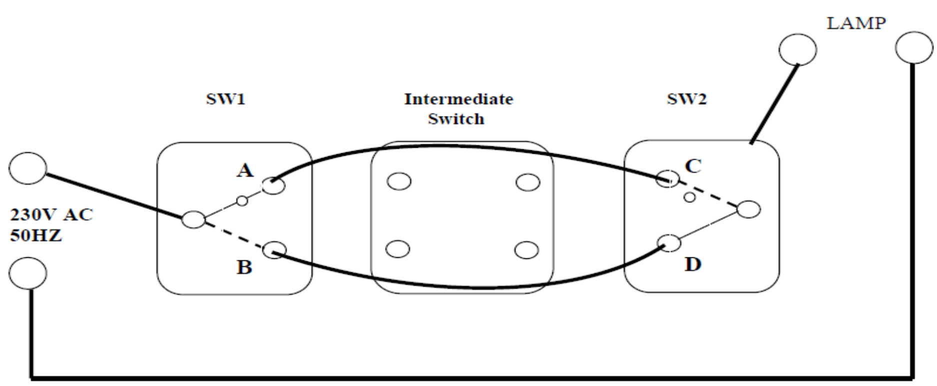



Fig 6.1

ii)Three way control:

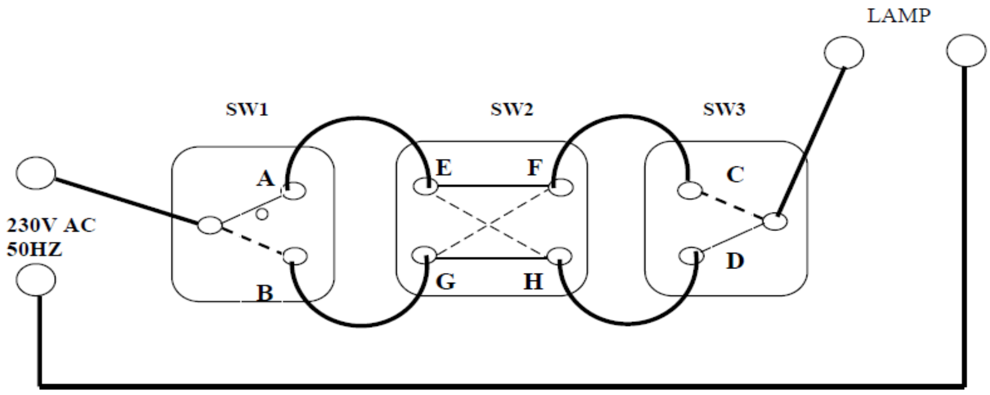



Fig 6.2

9. TRUTH TABLE:

I) Two way control:

| Sl.No | $SW_1$ | $SW_2$ | Lamp |
|---|---|---|---|
| 1 | A | C | ON |
| 2 | A | D | OFF |
| 3 | B | C | OFF |
| 4 | B | D | ON |

II) Three way control

| Sl.No | $SW_1$ | $SW_2$ | $SW_3$ | Lamp |
|---|---|---|---|---|
| 1 | A | Straight connection EFGH | C | ON |
| 2 | A | | D | OFF |
| 3 | B | | C | OFF |
| 4 | B | | D | ON |
| 5 | A | Cross Straight connection EFGH | C | OFF |
| 6 | A | | D | ON |
| 7 | B | | C | ON |
| 8 | B | | D | OFF |

10. RESULTS & CONCLUSIONS:

- The two way and three way control of lamp connected using switch and verified the truth table.

11. LEARNING OUTCOMES:

- Truth table of two way and three way control of lamp formulated and understood the concept.

12. APPLICATION AREAS:

- In stair case wiring.
- Circuit protection equipment.

- A big room having two entry/exit gate.
- To control any AC appliances like fan or light from two places like entry and exit.

13. REMARKS:

- -

1.EXPERIMENT NO :7

2. TITLE: MEASUREMENT OF EARTH RESISTANCE

3. LEARNING OBJECTIVES: Measurement of Earth resistance of Campus premises.

4. AIM: To measure the earth resistance

5. MATERIAL / EQUIPMENT REQUIRED:

- Digital earth resistance tester
- Earthing rods
- Cables associated with tester
- Measuring tape

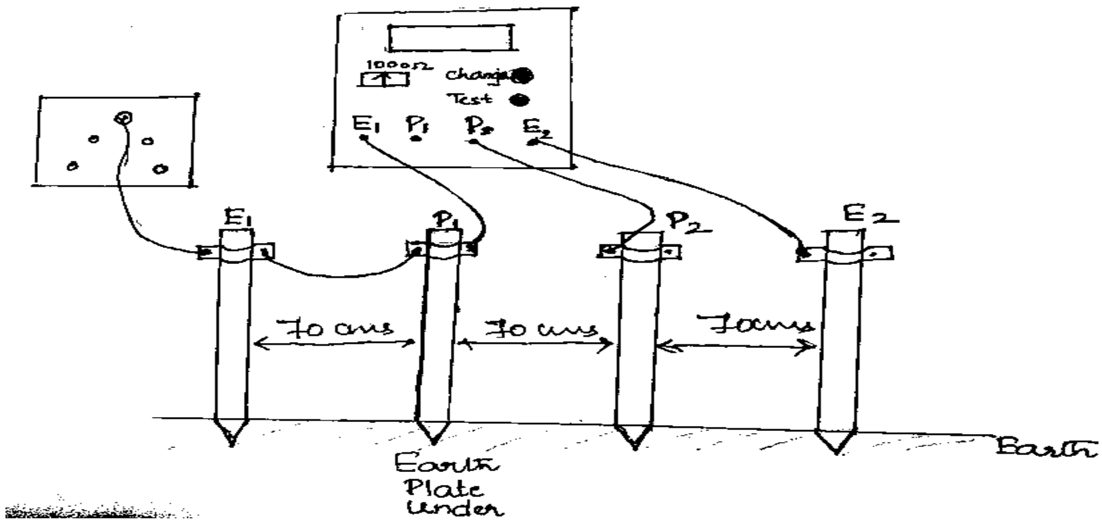
6. THEORY :

The process of electrically connecting to the earth itself is often called "earthing". The main reason for doing earthing in electrical network is for the safety. When all metallic parts in electrical equipments are grounded then if the insulation inside the equipments fails there are no dangerous voltages present in the equipment case. If the live wire touches the grounded case then the circuit is effectively shorted and fuse will immediately blow. When the fuse is blown then the dangerous voltages are away. The main reason for doing earthing in electrical network is for the safety. When all metallic parts in electrical equipments are grounded then if the insulation inside the equipments fails there are no dangerous voltages present in the equipment case. If the live wire touches the grounded case then the circuit is effectively shorted and fuse will immediately blow. When the fuse is blown then the dangerous voltages are away. Connection to earth is achieved by embedding a metal plate or rod or conductor in earth. This metal plate or rod or conductor is called as "Earth electrode". Effectiveness of the earthing connection made by embedding a metal plate in earth is quantified as "Earth Resistance". This earth resistance is measured in ohms.

7. PROCEDURE :

1.Connect the wire as shown in the figure.
2. Press test button keeping the resistance knob in 1000Ω
3. Note down the reading shown.
4. The reading of the meter indicated earth resistance

8. BLOCK DIAGRAM :




9. RESULTS & CONCLUSIONS:

The earth resistance measured was around 5 Ohms to 8 Ohms. The value of earth resistance should be very low.

10. LEARNING OUTCOMES :

1. The importance of earthing can be understood.
2. The Value of the earth resistance at different earth points can be measured

11.APPLICATION AREAS:

1. Earthing in Houses and industries.
2. Protection of electrical equipments from Lighting and fault conditions

13. REMARKS:

- -

1. EXPERIMENT NO:8

2.TITLE:Study of effect of Open and Short Circuit

3. LEARNING OBJECTIVES:

- To learn about open circuit effects
- To learn about short circuit effects

4. AIM: To study the effect of open and short circuit in simple dc Circuits

5. MATERIAL / EQUIPMENT REQUIRED:

- Voltmeter
- Ammeter
- Resistors
- Regulated DC Power Supply
- Connecting wires

6. THEORY / HYPOTHESIS:

- Open-circuit voltage(abbreviated as OCV or VOC) is the difference of electrical potential between two terminals of a device when disconnected from any circuit.
- There is no external load connected. No electric current flows between the terminals.
- Alternatively, the open-circuit voltage may be thought of as the voltage that must be applied to a solar cell or a battery to stop the current. It is sometimes given the symbol Voc.
- In network analysis this voltage is also known as the Thévenin voltage.

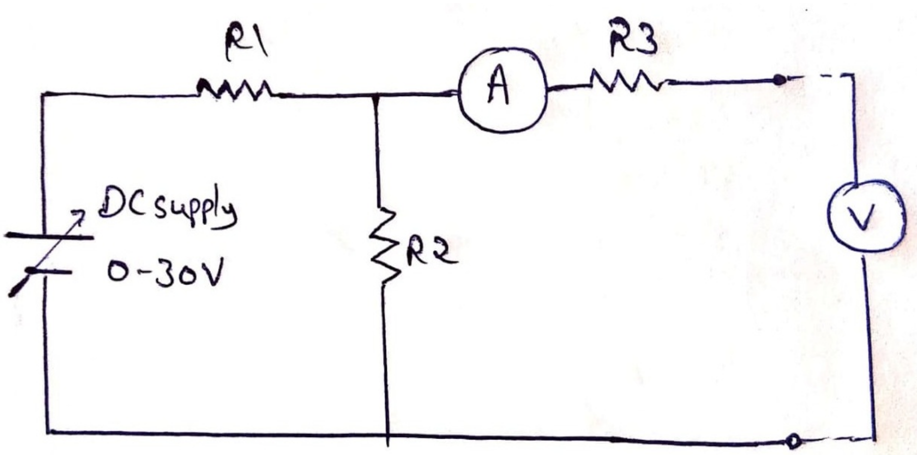
- The open-circuit voltages of batteries and solar cells are often quoted under particular conditions (state-of-charge, illumination, temperature, etc.).
- A short circuit(sometimes abbreviated to short or s/c) is an electrical circuit that allows a current to travel along an unintended path with no or a very low electrical impedance.
- This results in an excessive amount of current flowing into the circuit.
- The electrical opposite of a short circuit is an "open circuit", which is an infinite resistance between two nodes. It is common to misuse "short circuit" to describe any electrical malfunction, regardless of the actual problem.

7. PROCEDURE:

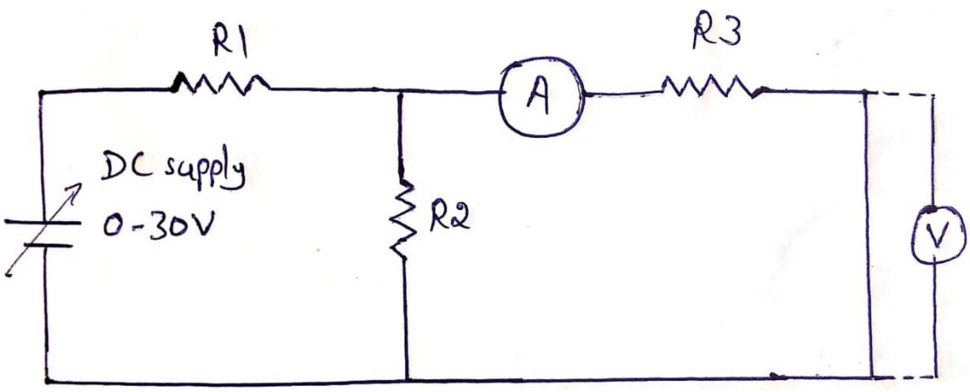
- Connect the circuit as per figure.
- Switch on the Mains power.
- Now increase the dc supply and note down current and voltage
- It can be observed that in open circuit, current will be zero and voltage will be maximum.
- It can be observed that in short circuit, current will be maximum and voltage will be zero.

8.BLOCK / CIRCUIT / MODEL DIAGRAM / REACTION EQUATION:

**Open Circuit**




**Short Circuit**



9. OBSERVATION TABLE :

| Sl.No | Vin Volts | Short Circuit Current (A) | Open Circuit Voltage (V) |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |

10. RESULTS & CONCLUSIONS:
- The effect of open and short circuit in simple dc Circuits is studied.

11. LEARNING OUTCOMES :
- Behavior of circuit under open circuit condition
- Behavior of circuit under short circuit condition

12. APPLICATION AREAS:
- Electronic Switches
- Relays

13. REMARKS:
- -

1. DEMONSTRATION EXPERIMENT NO:1

2. TITLE: Study of faults in fuse and MCB

3. LEARNING OBJECTIVES:
- To understand the working of MCB
- To learn about the working of fuses

4. AIM: Study of Faults in FUSE and MCB

5. MATERIAL / EQUIPMENT REQUIRED:
- MCB - 1 no.
- HRC FUSE - 1 no
- Lamp - 1 no
- Connecting wires

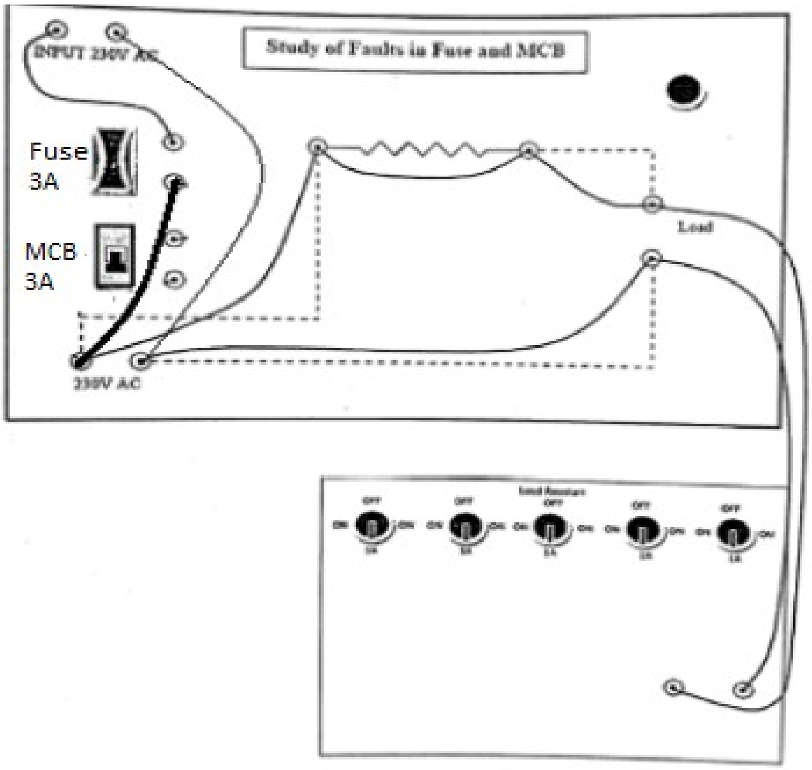
6. THEORY / HYPOTHESIS:
- In electronics and electrical engineering, a fuse is an electrical safety device that operates to provide over current protection of an electrical circuit.
- Its essential component is a metal wire or strip that melts when too much current flows through it, thereby interrupting the current.
- It is a sacrificial device; once a fuse has operated it is an open circuit, and it must be replaced or rewired, depending on type.
- A miniature circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current from an overload or short circuit.
- Its basic function is to interrupt current flow after a fault is detected.
- Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.

7. PROCEDURE:
- Connect the circuit as per figure

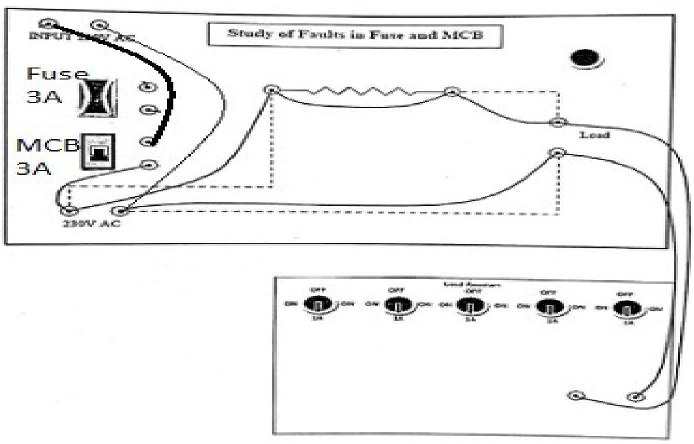
- Switch on the Mains power
- Now check Fuse, MCB
- Now create a fault in Fuse and MCB and Rectify that fault.
- Now increase the load and note down Fuse and MCB Tripping Current.
-

8. BLOCK / CIRCUIT / MODEL DIAGRAM :

A) Study of Fuse:




**B) Study of MCB**




9. RESULTS & CONCLUSIONS:

- Study of MCB and fault detection in fuses is verified.

10. LEARNING OUTCOMES :

- Response of MCB for high voltage is verified

- Detection of faults in fuses are verified.

11. APPLICATION AREAS:
- Domestic power supply
- Electric transmission and distribution system

12. REMARKS:
- -

1. DEMONSTRATION EXPERIMENT NO:2

2. TITLE: Cut-off section non working model a) DC shunt motor b) Induction motor c) Synchronous motor

3. LEARNING OBJECTIVES:
- To understand the working of DC Shunt Motor
- To understand the working of Induction Motor
- To understand the working of Synchronous Motor

4. AIM: To study working of dc shunt,induction and synchronous motor

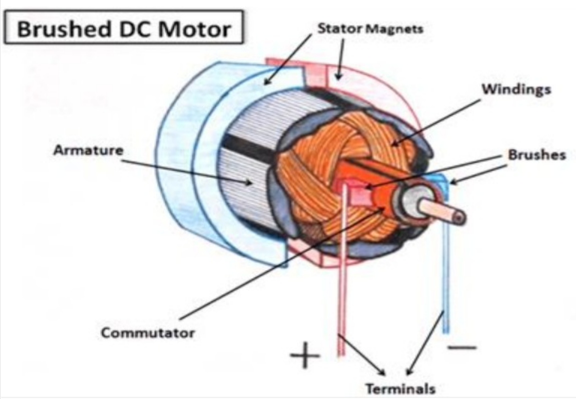
5. MATERIAL / EQUIPMENT REQUIRED:
- Non working model of DC Shunt Motor
- Non working model of Induction Motor
- Non working model of Synchronous Motor

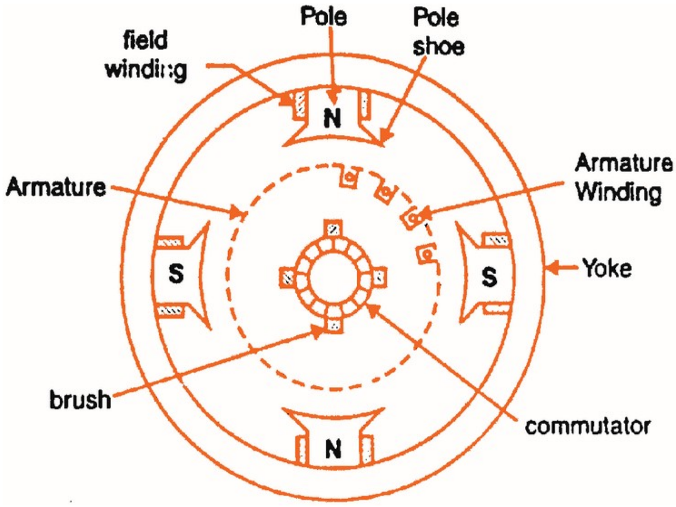
6.THEORY/HYPOTHESIS:
- In a DC shunt motor, the armature and field (shunt) windings are connected in parallel. A parallel circuit is also known as a shunt circuit thus, the term, “shunt motor” is used.
- The variations in construction between series-wound DC motors and DC shunt motors result in some differences in operation between the two types, but the most significant difference lies in their speed characteristics
- Where a series-wound DC motor exhibits a direct, inverse relationship between load and speed, a DC shunt motor is able to maintain a constant speed, regardless of the load on the motor.
- An induction motor or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding.
- An induction motor can therefore be made without electrical connections to the rotor. An induction motor's rotor can be either wound type or squirrel-cage type.
- Three-phase squirrel-cage induction motors are widely used as industrial drives because they are rugged, reliable and economical. Single-phase induction motors are used extensively for smaller loads, such as household appliances like fans.
- The motor which runs at synchronous speed is known as the synchronous motor. The synchronous speed is the constant speed at which motor generates the electromotive force. The synchronous motor is used for converting the electrical energy into mechanical energy.
- The stator and the rotor are the two main parts of the synchronous motor. The stator becomes stationary, and it carries the armature winding of the motor. The armature winding is the main winding because of which the EMF induces in the motor.

- The rotor carry the field windings. The main field flux induces in the rotor. The rotor is designed in two ways, that is the salient pole rotor and the non-salient pole rotor.
- The synchronous motor uses the salient pole rotor.

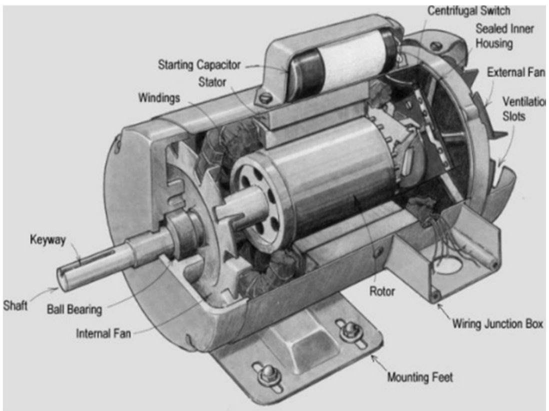
7. MODEL DIAGRAM :

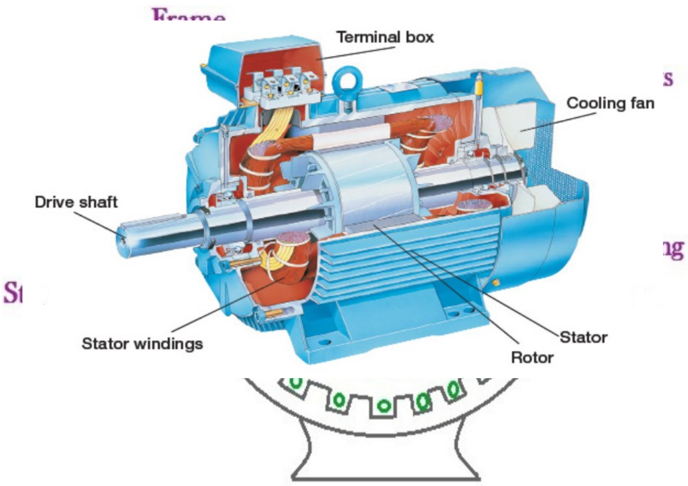
A) DC Shunt Motor



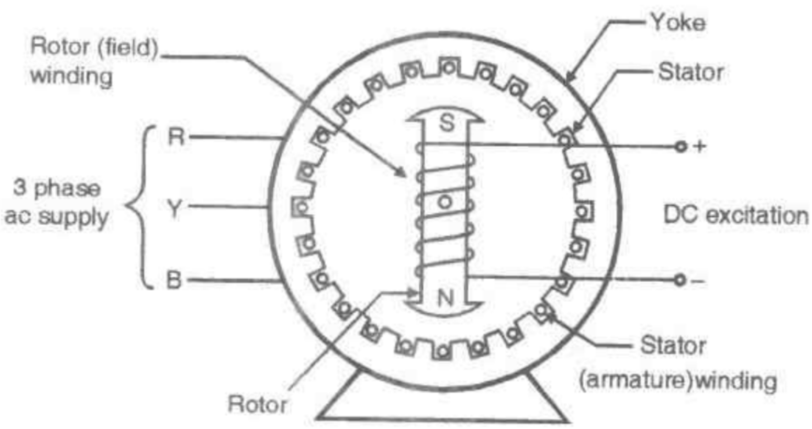




B) Induction Motor




C)Synchronous Motor



8. RESULTS & CONCLUSIONS:
- Non-working model of different motors like DC shunt,induction and Synchronous are studied.

9. LEARNING OUTCOMES :
Students have understood working and were able to explain the working of DC Shunt motor, Induction motor, Synchronous motor.

10. APPLICATION AREAS:
- Pumps,fans,lifts,weaving machine,spinning machines etc.

11. REMARKS:
- -

1. DEMONSTRATION NO: 3

2. TITLE: Understanding of AC and DC supply using Tester and Test Lamp

3. LEARNING OBJECTIVES:
- Study of AC and DC supply.
- To identify and the fault using Test lamp.

4. AIM: To Study AC and DC Supply Using Tester and Test Lamp

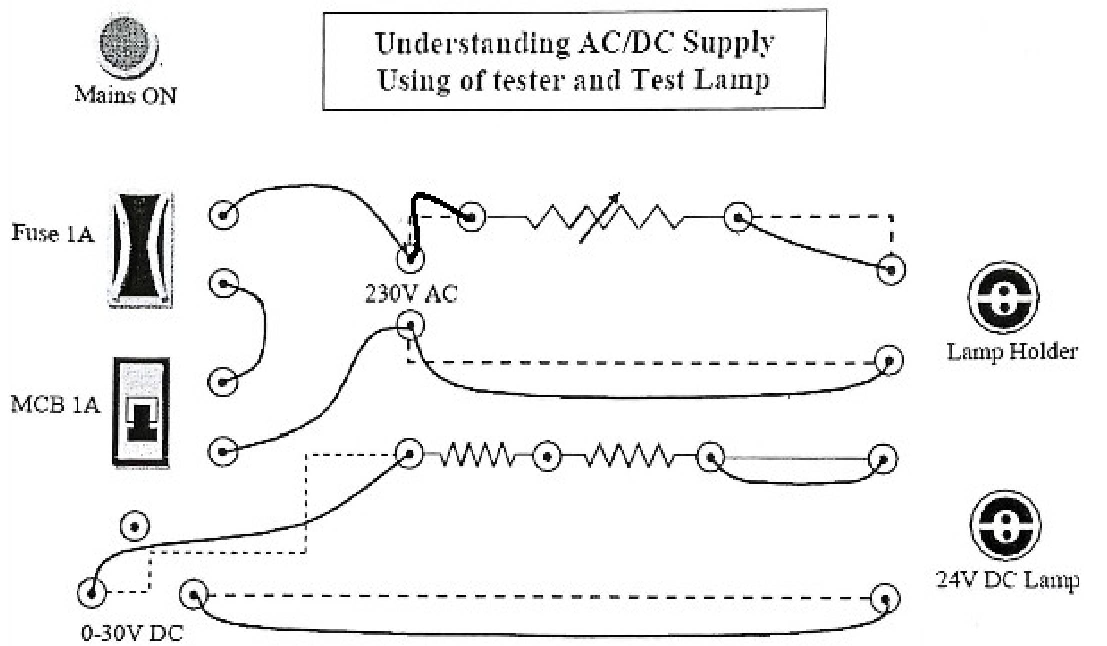
5. MATERIAL / EQUIPMENT REQUIRED:
- MCB - 1 no
- HRC FUSE - 1 no
- Lamp - 1 no
- AC/ DC Power Supply - 1 no
- Connecting wires

6. THEORY / HYPOTHESIS:
A test light, sometimes called a test lamp or voltage tester, is a simple but extremely useful electronic tool to check circuit. That is,the presence or absence of electricity to a certain component or piece of equipment can be checked using this circuit. If you are trying to diagnose and troubleshoot an electrical problem, sometimes a test light can help you rule out

7. FORMULA / CALCULATIONS:

8. PROCEDURE:
- Connect the circuit as per figure.
- Switch on the Mains power.
- Now Check Fuse, MCB and Lamp.
- Now Create a fault in Fuse, MCB & Lamp and Rectify that Fault using Test lamp

9.BLOCK / CIRCUIT / MODEL DIAGRAM :




10. RESULTS & CONCLUSIONS:
Fault was studied for AC and DC supply and was rectified using Test lamp.

11. LEARNING OUTCOMES :
Students have understood Detecting and Rectifying of fault using Testing lamp.

12. APPLICATION AREAS:
- Fault detection and rectifying

13. REMARKS:
- -

1.DEMONSTRATION NO: 4

2. TITLE: Understanding of UPS

3. LEARNING OBJECTIVES
- To understand the overall functioning of UPS.
- Study of charging and discharging of UPS Battery.
- To study the UPS circuit in load condition

4. AIM:
To Understand the overall functioning of UPS using Trainer Kit

5. MATERIAL / EQUIPMENT REQUIRED:
- UPS Trainer Kit
- Battery
- Connecting Wires

**TECHNICAL SPECIFICATIONS:**

Capacity: 150VA

Input Voltage Range: 190 to 260 V

Input Frequency: 50 Hz

Output: 220 V ±10%

Output Frequency: 50 Hz ± 5%

Back up Time: 100W Bulb 20 -30mts minutes

AC Fuse: 2A

Battery Low cut off: 10V

**Transformer specifications**

Input: 12 - 0 - 12 V

Outputs : 0, 160, 270 V, 0-18V for battery charging

6. THEORY :

**UNINTERRUPTIBLE POWER SUPPLY:**

All UPS include core circuitry that manipulates electricity, converting it from the AC power produced by the utility company to DC power stored in the battery, and back again for use by your equipment via an inverter. The exact type, nature, size and quality of this circuitry depend on the type of UPS, and more specifically the make and model you have chosen. Most modern UPS are microprocessor-controlled. There is actually a small computer embedded within the UPS itself that controls the key functions of the UPS. This includes detecting AC power failures, handling switching between power sources, monitoring the status of the battery, controlling the status indicators and so on. There are 3 basic topologies of the UPS

1) Offline UPS
2) Line Interactive UPS
3) Online UPS

**DESCRIPTION:**

ADD Trainer is a versatile training system to study the principal and working of an Uninterrupted Power Supply (UPS). It is housed in an elegant cabinet with test points provided to monitor voltage/ waveforms. A detailed instruction manual is provided. The product is designed keeping in mind that a student can understand each block of UPS in a very easy way. Various test points have been provided so that one can check inputs and outputs of each block contained. Being different from a conventional block diagram internal structure of blocks is also shown. Since UPS is different from an inverter because its switching changeover time is less than 3ms which is very less so a computer system doesn't get reboot.

In depth explanation of PWM switching technology, which is one of the most important feature of UPS

Low cost product demonstrating all basic concepts of UPS

Various test points are provided so that one can easily measures the voltages of different sections

Designed considering all safety standards

**WORKING:**

The push-pull circuit operation is carried out using bi-directional current carrying switches. It may be noted that mosfet, when bypassed by anti-parallel diode, qualify as bi-directional current carrying switches. In the circuit mosfet (Q1) together with diode (D1) constitutes the upper switch

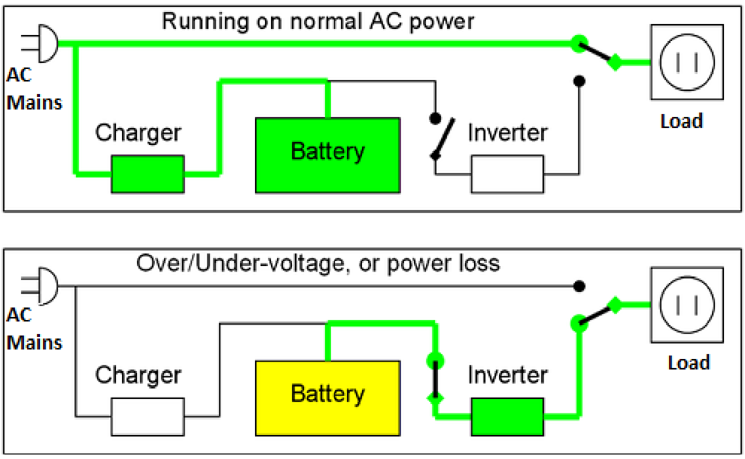
(SW1). Similarly lower switch (SW2) consists of MOSFET (Q2) in anti-parallel with diode (D2). During the positive half cycle of the input AC, the upper MOSFET(Q1) is turned ON by applying the positive gate pulse and the current flows through the MOSFET(Q1). Once the upper switch ‘Q1’ is conducting, the diode ‘D2’ of lower switch gets reverse biased. MOSFET ‘Q2’ is also reverse biased due to the elimination of gate pulse to the MOSFET(Q2). Thus while switch ‘SW1’is conducting current, switch ‘SW2’ is off and is blocking voltage and the battery gets start charging through MOSFET Q1. Similarly during the negative half cycle of the input AC, the lower MOSFET Q2 is turned ON by applying the positive gate pulse, ‘Q1’ is reverse biased and ‘Q2’ is forward biased. This results in ‘SW1’ turning off and ‘SW2’ turning on and the battery gets charged.

7. PROCEDURE :

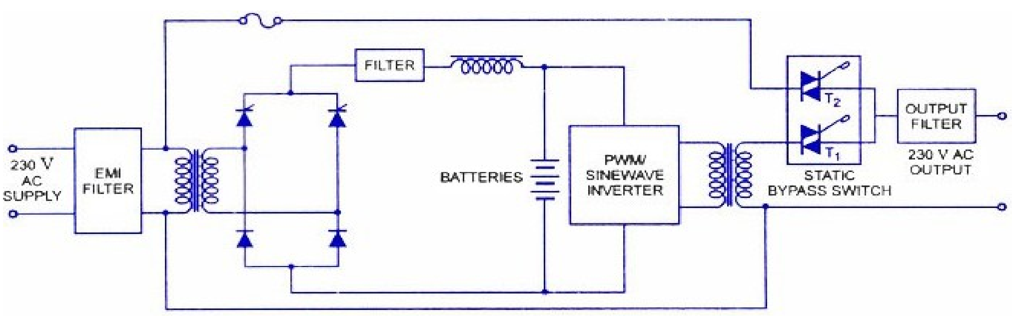
- Connect the load lamp and the battery to the UPS trainer kit.
- Switch on the Mains and observe the charging voltage across the battery.
- Switch on the UPS.
- Switch off the Mains and observe the discharging voltage of the battery.

8. BLOCK DIAGRAM :
DIFFERENT UPS BLOCK DIAGRAM

**OFF LINE UPS**

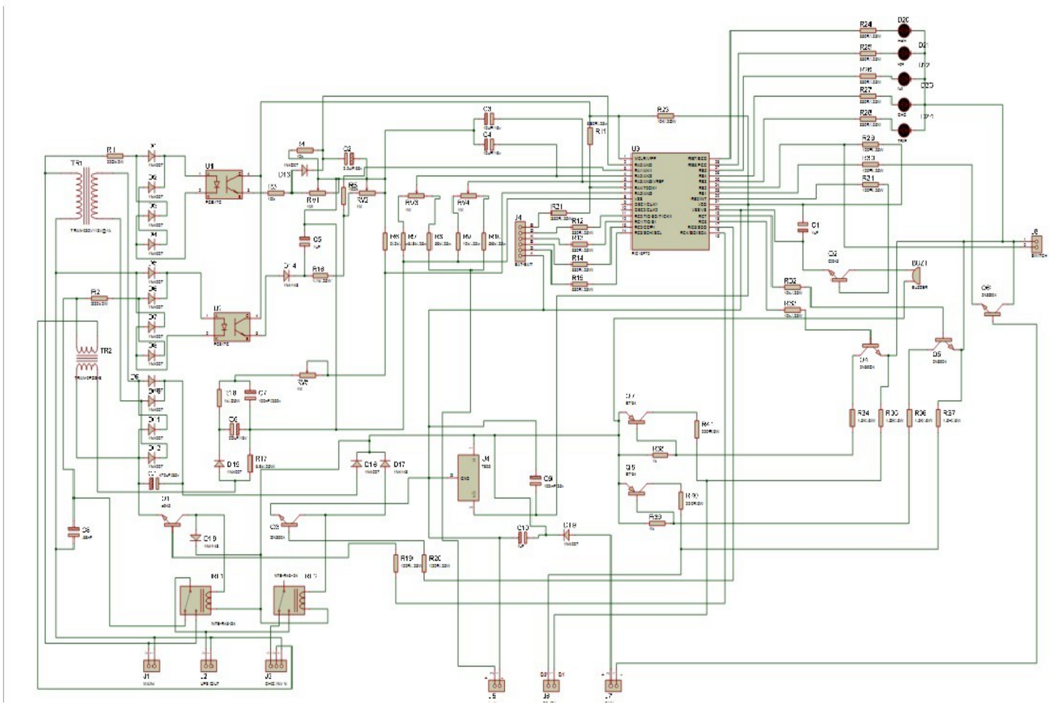



**ONLINE UPS**




*Block Diagram of On-Line UPS*

**COURSE LABORATORY MANUAL**



**MICROCONTROLLER CIRCUIT FOR UPS**

9. RESULTS & CONCLUSIONS:

Functioning of UPS is studied using UPS Trainer Kit.

10. LEARNING OUTCOMES :

- Understood the functioning of UPS.
- Understood the charging and discharging behavior of the battery.

11. APPLICATION AREAS:

- Domestic use, Emergency lighting equipments
- Medical equipment systems
- Computer systems
- Machine control systems.

Open ended 1

2. TITLE: Power factor improvement by using capacitor in parallel with inductive load

3. LEARNING OBJECTIVES:

- To compare the power consumed by Inductive and Capacitive load
- To Study the power factor due to each of these loads

4. AIM: To introduce the concept of power factor and method of improving power factor in load.

5. MATERIAL / EQUIPMENT REQUIRED:

| Sl No | Components | Range | No of Components |
|---|---|---|---|
| 1 | Motor | 55W | 1 |
| 2 | Capacitor | 8μF | 2 |
| 3 | | 3.3μF | 1 |

6. THEORY / HYPOTHESIS:

Power factor is the relationship (phase) of current and voltage in AC electrical systems. Under ideal conditions current and voltage are "in phase" and the power factor is unity If inductive loads (motors) are present, power factors less than unity(1). Low power factor, causes heavier current to flow in power distribution lines in order to deliver a given number of kilowatts to an electrical load. The power distribution system in the building, or between buildings, can be overloaded by excess current. Electrical costs are increased, generated power will also increase. Low power factor overloads generating, distribution, and networks with excess KVA. If there is a large building, there should be considering correcting poor power factor for either or both of these reasons: To reduce additional power factor charges and to restore the (KVA) capacity of overloaded feeders within the building or building complex. Capacitors Power factor correction capacitors are the most common method of correcting power factor .

Advantages of improving the power factors are:

- Size of the conductors to supply the same power reduces.
- Due to reduction in current, losses in power system reduces.
- Size of transformer, alternator transmission structure reduces.
- Over all cost of the system reduces.

7. FORMULA / CALCULATIONS:

$P = VI\ Cos\phi$

$Q = VI\ Sin\phi$

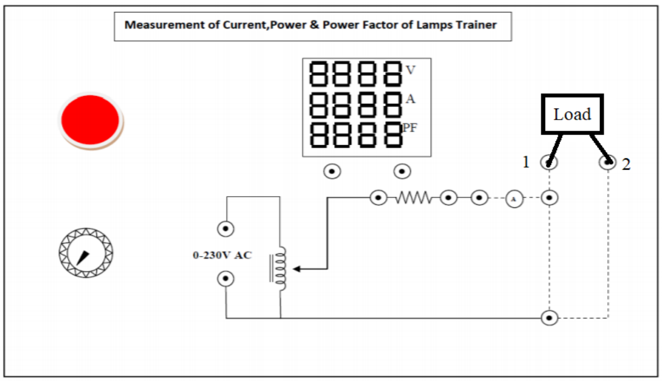
$$\tan\phi_2 = \tan\phi_1 - [\frac{C 2\pi f V^2}{P}]$$

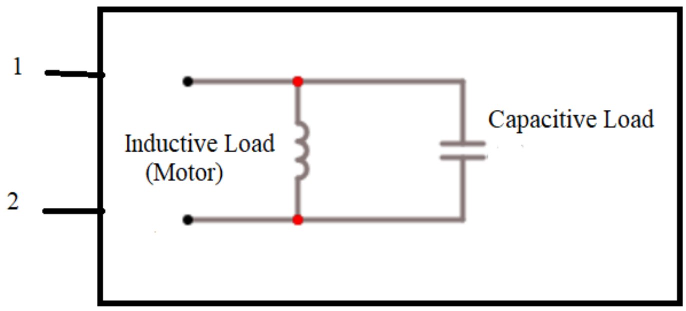
$$p.f = \cos\phi_2$$

8. PROCEDURE:

1. Connect the circuit as shown in the diagram
2. Switch on A.C supply, and observe the voltage, current and Power factor values in meter.
3. Repeat the same for different loading conditions
4. Now compare power factor , active, reactive and apparent Power of all the used.

9. BLOCK / CIRCUIT



10. OBSERVATION TABLE / LOOKUP TABLE / TRUTH TABLE:

| | Lamp | Voltage (V) | Current (A) | Cosϕ | P= VI Cosϕ (W) | Q= VI Sinϕ (VAR) | S=VI (VA) |
|---|---|---|---|---|---|---|---|
| 1 | Motor | | | | | | |
| 2 | Motor+ 8μ Capacitor | | | | | | |
| | Motor+ 16μ Capacitor | | | | | | |
| 4 | Motor+ 3.22μ Capacitor | | | | | | |

11. RESULTS & CONCLUSIONS:
Therefore it is observed that by using a capacitor of 3.22μF the power factor of the circuit improved and the current reduced.

12. LEARNING OUTCOMES :
Low power factor increase energy losses in AC circuits. However high power factor decreases losses in AC circuits

13. APPLICATION AREAS:
Domestic the Industrial application.

14. REMARKS:
- -

Open ended 2

2. TITLE: Demonstration of Noload and full Load current in a induction motor.

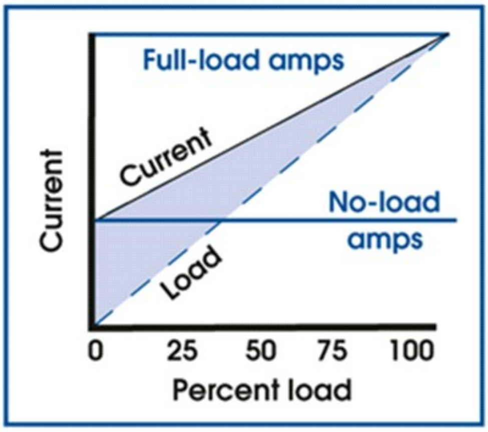
3. LEARNING OBJECTIVES:
- Observing the variation in the motor current when the load on the motor varies

4. AIM: To demonstrate No load and full Load current in a induction motor.

5. MATERIAL / EQUIPMENT REQUIRED:

| Sl No | Components | Range | No of Components |
|---|---|---|---|
| 1 | Motor | 55W | 1 |
| 2 | Tachometer | | 1 |
| 3 | Transformer | 110V-0-110V | 1 |

6. THEORY / HYPOTHESIS:
The Figure illustrates the relationship between load and current in the motor. The motor current is decided by the mechanical load present on the shaft. As more mechanical load is applied, the motor slows, and more current is drawn. The no-load current is the current required just to turn the motor shaft with nothing connected. No load is the current required to overcome the bearing and other friction losses in the motor. Typically a stall current is very high and will quickly overheat and damaging the motor.

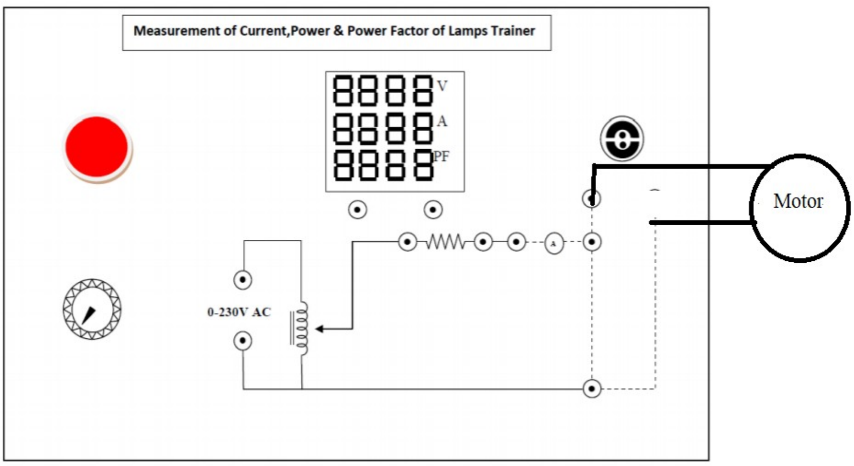



7. FORMULA / CALCULATIONS:

8. PROCEDURE:

1. Connect the circuit as shown in the diagram with Motor.
2. Switch on Supply
3. Note down the current for No load and full load conditions

9. BLOCK / CIRCUIT




10. OBSERVATION TABLE / LOOKUP TABLE / TRUTH TABLE:

| | Motor | Current (A) |
|---|---|---|
| 1 | No load | |
| 2 | Full Load | |

11. RESULTS & CONCLUSIONS:

Observer

1. No load Current=_____(A)
2. Full load current = _____(A)

| |
|---|
| 12. LEARNING OUTCOMES :<br>As the load on the motor increases the current drawn by the motor depends upon the loading conditions of the motor. |
| 13. APPLICATION AREAS:<br>Domestic the Industrial application. |
| 14. REMARKS:<br>• - |