UG- SKILL DEVELOPMENT COURSE
ELECTRICAL APPLIANCES
(w.e.f. 2020-2021 A.Y.)

Semester	Course Code (SD)	Course Title	Hrs/SEM	Hrs/wk	Credits	Sem End Exam (1.30hrs)
I	Skill Development Course	Electrical Appliances	30	2	2	50 Marks

Learning Outcomes: By successful completion of the course, students will be able to:

- Acquire necessary skills/hand on experience/ working knowledge on multimeters, galvanometers, ammeters, voltmeters, ac/dc generators, motors, transformers, single phase and three phase connections, basics of electrical wiring with electrical protection devices.
- Understand the working principles of different household domestic appliances.
- Check the electrical connections at house-hold but will also learn the skill to repair the electrical appliances for the general troubleshoots and wiring faults.

SYLLABUS: UNIT-I (6 hrs): Voltage, Current, Resistance, Capacitance, Inductance, Electrical conductors and Insulators, Ohm's law, Series and parallel combinations of resistors, Galvanometer, Ammeter, Voltmeter, Multimeter, Transformers, Electrical energy, Power, Kilowatt hour (kWh), consumption of electrical power

UNIT-II (10 hrs): Direct current and alternating current, RMS and peak values, Power factor, Single phase and three phase connections, Basics of House wiring, Star and delta connection, Electric shock, First aid for electric shock, Overloading, Earthing and its necessity, Short circuiting, Fuses, MCB, ELCB, Insulation, Inverter, UPS

UNIT-III (10 hrs): Principles of working, parts and servicing of Electric fan, Electric Iron box, Water heater; Induction heater, Microwave oven; Refrigerator, Concept of illumination, Electric bulbs, CFL, LED lights, Energy efficiency in electrical appliances, IS codes & IE codes.

Co-curricular Activities (Hands on Exercises): (04 hrs)

[Any four of the following may be taken up]

1. Studying the electrical performance and power consumption of a given number of bulbs connected in series and parallel circuits.
2. Measuring parameters in combinational DC circuits by applying Ohm's Law for different resistor values and voltage sources
3. Awareness of electrical safety tools and rescue of person in contact with live wire.
4. Checking the specific gravity of lead acid batteries in home UPS and topping-up with distilled water.
5. Identifying Phase, Neutral and Earth on power sockets.
6. Identifying primary and secondary windings and measuring primary and secondary voltages in various types of transformers.
7. Observing the working of transformer under no-load and full load conditions.
8. Observing the response of inductor and capacitor with DC and AC sources.
9. Observing the connections of elements and identify current flow and voltage drops.
10. Studying electrical circuit protection using MCBs, ELCBs
11. Assignments, Model exam etc.

Reference Books:

1. A Text book on Electrical Technology, B.L.Theraja, S.Chand& Co.,
2. A Text book on Electrical Technology, A.K.Theraja.
3. Performance and design of AC machines, M.G.Say, ELBSEdn.,
4. Handbook of Repair & Maintenance of domestic electronics appliances; BPB Publications
5. Consumer Electronics, S.P.Bali, Pearson
6. Domestic Appliances Servicing, K.P.Anwer, Scholar Institute Publications

2. Model Question papers for Life skill/Skill Development courses

MODEL QUESTION PAPER
All UG Life/Skill development courses
Semester:
Paper:…..,Title of the paper

Time: 2Hrs. Max Marks: 50

SECTION – A

Answer any 4 questions. Each question carries 5 marks (4 X 5M = 20M)
(Total 8 questions and at least two questions should be given from each unit)

1.
2.
3.
4.
5.
6.
7.
8.

SECTION – B

Answer all the questions. Each question carries 10 marks (3 X 10 = 30M)

9. from Unit I
(OR)
10. from Unit I

11. from Unit II
(OR)
12. from Unit II

13. from Unit III
(OR)
14. from Unit III

UNIT-I

Voltage

- Voltage is defined as the potential difference between two points in a conductor.
- Greater the Voltage, greater will the electric current.
- Voltage is similar to Pressure in the flow of water.
- According to Ohm's law

$$V = IR$$

- Where 'V' is the Voltage, 'I' is the Electric Current and 'R' is the Resistance.
- S.I.unit of Voltage is 'volt'.
- Voltage is measured with 'Voltmeter' or 'Mutimeter'
- Voltage is of two types; Direct Voltage and Alternating Voltage.
- In Direct Voltage, polarity of current remains the same.
- In Alternating Voltage, polarity of current reverses continuously.
- In a series circuit, voltage across a circuit is shared by all the components.
- In a parallel circuit, voltage is the same across each component.

Current

- Electric current is defined as the rate of flow of electrons in a conductor.
- Greater the Voltage, greater will the electric current.
- According to Ohm's law

$$I = \frac{V}{R}$$

- Where 'V' is the Voltage, 'I' is the Electric Current and 'R' is the Resistance.
- S.I.unit of Electric Current is "ampere'.
- Electric current is measured with an instrument called 'Ammeter'
- Electric current is of two types; Direct Current or Alternating Current.
- In Direct current, polarity of current remains the same.
- In Alternating current, the polarity reverses continuously.
- In a series circuit, current across a circuit is the same across each component.
- In a parallel circuit, voltage is shared by all the components.

Resistance

- Resistance is the opposition to the flow of electrical current in a circuit.
- Greater the Resistance, smaller will be the Electric Current.
- S.I. Unit of Resistance is 'Ohm'.
- According to Ohm's law

$$R = \frac{V}{I}$$

- Where 'V' is the Voltage, 'I' is the Electric Current and 'R' is the Resistance.

- ❖ Resistance per unit cross section and per unit length is called Resistivity and it depends on the nature of the material.
- ❖ Resistivity of conductors is very small while the resistivity of insulators is very large.
- ❖ Resistance can be measured with a Multimeter.
- ❖ Resistors can be connected in series or in parallel.
- ❖ When two or more resistors are connected in series the resultant resistance is the sum of all the resistances.

  If four resistors of resistances R_1, R_2, R_3, R_4 are connected in series, then the resultant resistance R is given by

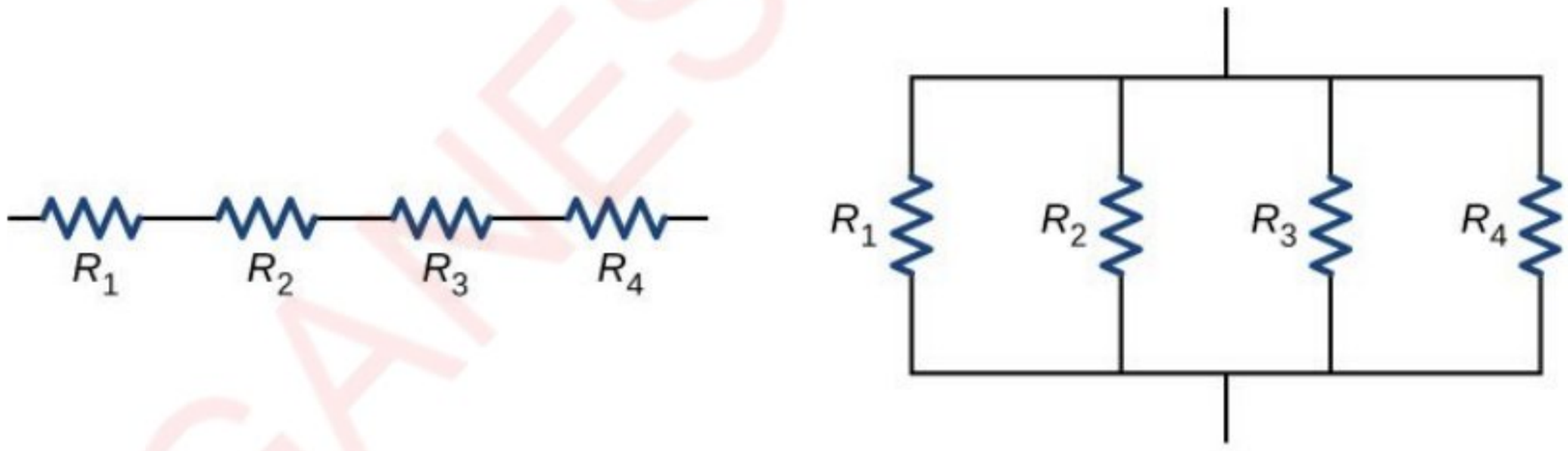
$$R = R_1 + R_2 + R_3 + R_4 + \ldots\ldots\ldots$$

When Resistors are connected in series, current is the same for all resistors connected in series.

- ❖ When two or more resistors are connected in parallel the resultant resistance is given by the following formula.

  If four resistors of resistances R_1, R_2, R_3, R_4 are connected in parallel, then the resultant resistance R is given by

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \ldots\ldots\ldots\ldots$$

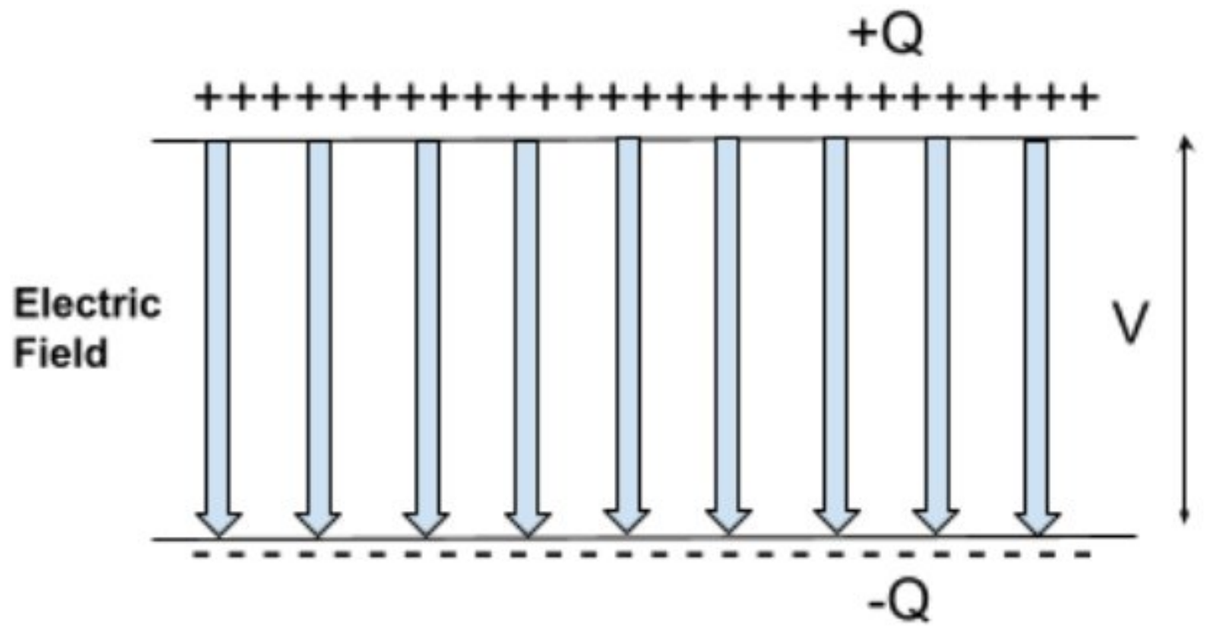


(a) Resistors connected in series (b) Resistors connected in parallel

When resistors are connected in parallel, voltage is the same for all resistors connected in parallel.

Capacitance

- ❖ Capacitor is a device to store energy through an electric field.
- ❖ It contains two oppositely charged conducting plates separated by an insulator. An electric field is formed between the two charged plates which stores the electrical energy.
- ❖ The Capacitance of a Capacitor is defined as the ratio of charge on the conducting plates to the potential difference between them.



Consider a parallel plate capacitor as shown in figure. Let 'Q' be the electric charge on the plates and 'V' be the potential difference between the two plates. Then Capacitance 'C' is given by

$$C = \frac{Q}{V}$$

- Capacitance of a capacitor can be increased by placing a dielectric between its plates. If 'k' is the dielectric constant of the material placed between the plates, then the Capacitance is given by

$$C' = k\,C$$

- S.I. unit of Capacitance is 'farad'
- Energy stored in a capacitor is given by

$$E = \tfrac{1}{2}CV^2$$

- When two or more capacitors of capacitances $C_1, C_2, C_3 \ldots\ldots$ are connected in series, the resultant capacitance C is given by

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots..$$

- When two or more capacitors of capacitances $C_1, C_2, C_3 \ldots\ldots$ are connected in parallel, the resultant capacitance C is given by

$$C = C_1 + C_2 + C_3 + \ldots....$$

Inductance

- Inductor is a device to store energy through a magnetic field.
- Inductor opposes the change in electric current due to electromagnetic induction.
- When alternating current is passed through an Inductor, it produces an induced e.m.f which opposes the change in current.If 'e' is the induced e.m.f and i is the current passing through the coil then Inductance 'L' is given by

$$L = -\frac{e}{\frac{di}{dt}}$$

- The direction of induced e.m.f always opposes the change in current.
- S.I. unit of Inductance is 'henry'
- Energy stored in an Inductor is given by

$$E = \frac{1}{2}Li^2$$

- When two or more inductors of inductances $L_1, L_2, L_3 \ldots\ldots\ldots\ldots$ are connected in series, the resultant capacitance L is given by

$$L = L_1 + L_2 + L_3 + \ldots\ldots$$

- When two or more capacitors of capacitances $L_1, L_2, L_3 \ldots\ldots\ldots\ldots$ are connected in parallel, the resultant capacitance L is given by

$$\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \ldots\ldots$$

- Inductance is of two types.
  1. Self Inductance
  2. Mutual Inductance
- If the induced e.m.f in a coil due to the change in current affects the same coil, it is called elf inductance.
- If the induced e.m.f in a coil due to the change in current affects a secondary coil, it is called mutual inductance.

Ohm's Law

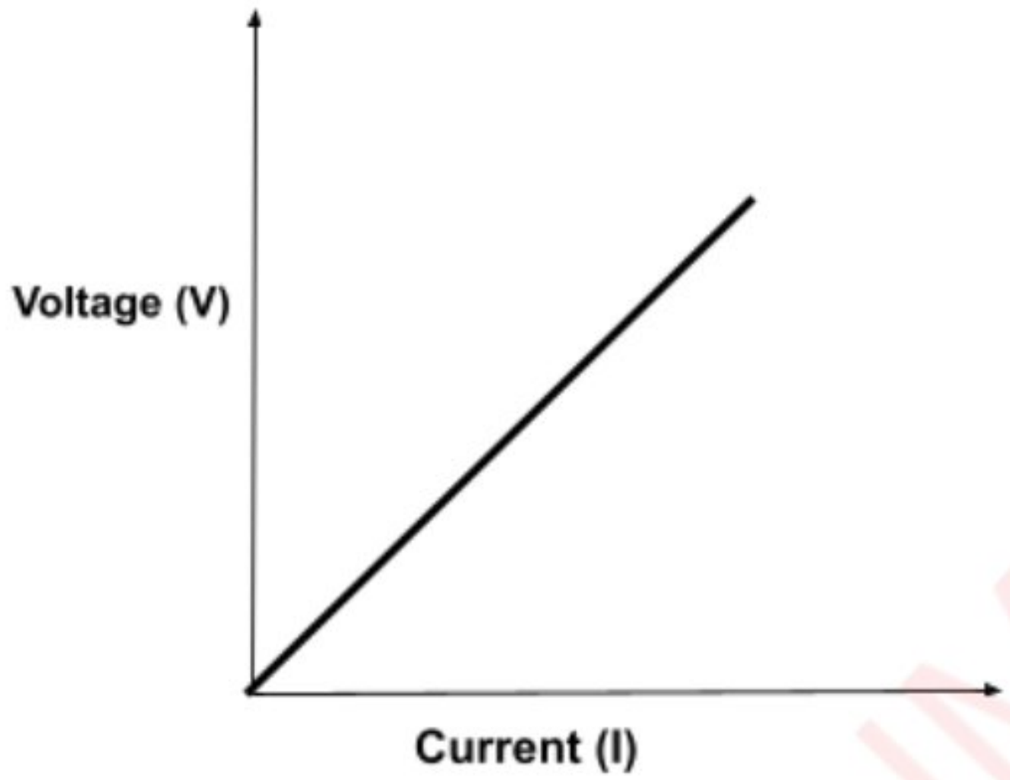
- Ohm's law is one of the most fundamental laws in electronic and electrical circuits.
- It states that current passing through a coil is directly proportional to the electric current and inversely proportional to the resistance.
- According to Ohm's law

$$I = \frac{V}{R}$$

Where 'V' is the Voltage, 'I' is the Electric Current and 'R' is the Resistance.

- Hence according to Ohm's law there is a linear relationship between Voltage and Current when the resistance is constant as shown in figure.
- Ohm's law is valid for metallic conductors.
- Conductors which obey Ohm's law are known as ohmic conductors and conductors which do not obey Ohm's law are called non-ohmic conductors.

- Ohm's law is not applicable for unilateral circuits also where the current flows in only one direction. Hence circuits containing diodes and transistors do not obey Ohm's law.
- Ohm's law is applicable for A.C.Circuits also. In A.C Circuits, Impedances of Capacitors and Inductors should be considered in addition to the Resistance.



Electrical Conductors and Insulators

Conductors:

- A material which allows electric current to flow through it is called an electrical conductor.
- Examples of conductors are Silver, Copper, Iron, Gold etc
- Electrical resistivity of conductors is extremely small.
- The resistivity of conductors is of the order of $10^{-8} ohm-m$
- According to Band theory, valence band overlaps with conduction band in conductors. Hence conductors have a large number of free electrons.
- Resistivity of conductors increases with increase in temperature.
- Conductors which obey Ohm's law are known as ohmic conductors and conductors which do not obey Ohm's law are called non-ohmic conductors.

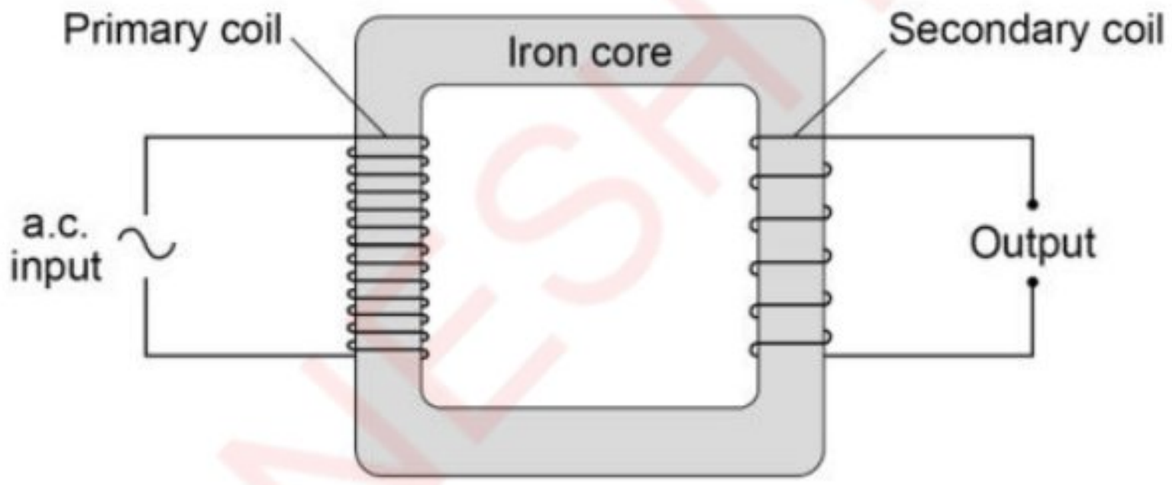
Insulators:

- A material which does not allow electrical current to flow through it is called an electrical insulator.
- Examples of Insulators are Rubber, Glass, Dry wood etc,.
- Electrical resistivity of Insulators is very large of the order of $10^{16} ohm-m$
- According to Band theory, there exists an energy gap between valence band and conduction band in Insulators. Hence Insulators have a very small number of free electrons.
- Resistivity of Insulators decreases with increase in temperature.
- Insulators do not obey Ohm's law.

Galvanometer vs Ammeter

Galvanometer	Ammeter
Instrument used for detecting the strength and direction of small current	Instrument used for measuring the magnitude of current in a circuit
Galvanometer shows the direction of current	Ammeter does not show the direction of current
Sensitivity of Galvanometer is high	Sensitivity of Ammeter is low
Accuracy of Galvanometer is low	Accuracy of Galvanometer is high
Galvanometer measures Direct Current only	Ammeter measures both Direct and Alternating Currents
Galvanometer is generally used in bridges and potentiometer circuits	Ammeter is is used in electrical circuits
Galvanometer requires magnetic field	Ammeter may or may not require magnetic field

Transformer



Transformer is a device which transfers electrical energy from one circuit to another through electromagnetic induction.It is used to increase or decrease the voltage in A.C. circuits.

Principle:

Transformer is based on the principle of mutual induction. According to the principle of mutual induction, when the magnetic flux linked with a circuit changes, it produces an induced e.m.f of the same frequency.

Working:

A Transformer mainly contains the following components.

- Primary coil
- Secondary coil
- Iron core

The primary and secondary coils are wrapped around the common soft iron core. The primary coil is connected to the A.C.power source while the secondary coil is connected to load.

When alternating current of voltage V_1 or E.M.F E_1 is passed through the primary coil, the magnetic flux linked with the secondary coil changes.

Due to the change in magnetic flux an induced e.m.f. E_2 of the same frequency is produced in the secondary coil due to electromagnetic induction. Let N_1 and N_2 be the number of turns of primary and secondary coils. If V_2 and E_2 are the output voltage and e.m.f then

$$\frac{E_1}{E_2} = \frac{N_1}{N_2} = a$$

The above equation is known as the e.m.f equation of the Transformer. It is clear from the above equation that the ratio of input and output voltages depends on the ratio of the number of turns of primary and secondary coils.

- If $N_2 > N_1$, then $E_2 > E_1$ .Hence Voltage increases. In this case, the transformer is called a step-up transformer.
- If $N_2 < N_1$, then $E_2 < E_1$ .Hence voltage decreases. In this case, the transformer is called a step-down transformer.

The efficiency of a transformer is defined as the ratio of output power to input power

$$\eta = \frac{Outpot\ power}{Input\ power}$$

Voltmeter

- Voltmeter is a device used for measuring the potential difference between two points in a circuit.
- It is denoted by the symbol 

in circuits.
- Voltmeter is designed such that it has a very high resistance. Hence it must always be connected in parallel in which we want to measure the voltage. If it is connected in series, due to its high resistance, the current flow will be zero.
- Voltmeter can measure both direct voltage and alternating voltage.
- Based on the construction principle, Voltmeters are classified as follows.
    1. Permanent Magnet Moving Coil Voltmeter
    2. Moving Iron Voltmeter
    3. Electro Dynamo type Voltmeter
    4. Rectifier type Voltmeter
    5. Induction type Voltmeter
    6. Electrostatic type Voltmeter
    7. Digital Voltmeter

Multimeter

- ❖ Multimeter is a device to measure multiple parameters of an electrical circuit like Current, Voltage, Resistance, Capacitance etc.
- ❖ It is also used to test continuity between two points in an electrical circuit.
- ❖ Multimeters are divided into two types basing on their functioning
    - Analog Multimeter
    - Digital Multimeter
- ❖ Analog Multimeter is also called VOA meter for measuring Voltage in Volts, Resistance in Ohms and Current Amperes.
- ❖ Analog Multimeter is based on the principle of moving coil galvanometer and use a needle to show the reading
- ❖ Digital Multimeters are based on logic gates and the reading is displayed as a number on the digital screen.
- ❖ Digital multimeters are compact and more accurate than analog multimeters and hence they are widely used nowadays.

Electrical Energy-Power-Kilowatt Hour

- An Electrical Circuit transfers energy to Electrical Appliances due to the flow of electrons. The energy transfer depends on the current, voltage and resistance of the circuit.
- The amount of energy transferred by an electrical circuit to the load is called Electric Power.
- Electric Power is measured in 'Watt"
- Electric Power is defined as the product of Voltage and Electric Current.

If 'V' is the Voltage and 'I' is the Electric Current, then

Electric Power $P = VI$

According to Ohm's law $I = \frac{V}{R}$

Hence $P = \frac{V^2}{R}$

- The value of Electric Power
    - ➢ Directly proportional to the square of electric current
    - ➢ Inversely proportional to the resistance
- Kilowatt Hour: Kilowatt Hour is a unit of energy consumed.
    - ➢ The energy consumed by an electrical appliance of one kilowatt power in one hour duration is called Kilowatt Hour

$$1\ kWh = 36 \times 10^5 Joules$$

UNIT-II

Principle of working, parts and servicing of Electric fan

Principle:

★ Principle of Electric Fan is "Electromagnetic Induction"

When electric current is passed through a coil placed in a magnetic field, it produces a torque to rotate the coil. This is called electromagnetic induction.

Electric fan is an example of a Single Phase Induction Motor.

Parts of an Electric Fan:

1. **Capacitor:** The Rotor of a fan initially requires a large torque to start rotating. Hence a Capacitor of the order of 2.2 μF is used to maximize the initial torque acting on the rotor.
2. **Electric Motor:** The Electric Motor has two parts, Stator and Rotor.
   a. **Stator**: Stator has two coils called Start winding and Running winding. Start winding is needed to start the motor rotation while Running winding is needed to maintain the rotation.
   b. **Rotor**: Rotor is a ring shaped metal placed outside the stator which rotates.
3. **Axle**: Axle is a hollow metallic rod made of steel which connects the electric motor to the ceiling.
4. **Blades**: Electric fan generally has 3 or 4 rotating blades connected to the motor with aerodynamic design to produce air flow.

Working:

- When power is switched on, alternating current passes through the capacitor until it is fully charged.
- The capacitor then discharges and the current passes through Start winding and Running Winding in the Stator.
- The two windings produce a rotating magnetic field which produces a current in the rotor due to electromagnetic induction.
- A torque is produced on the rotor due to the induced current which rotates the rotor and the attached blades with high speed.

Principle of working, parts and servicing of Electric Iron

Principle:

★ Principle of Electric Iron is "Conversion of Electrical Energy into Heat Energy".

When electric current is passed through a wire of high resistance, heat is produced.

$$Q = i^2 Rt$$

Where $Q = Heat\ produced$

$i = Current$

$R = Resistance$

$t = Duration\ of\ current\ flow$

Parts:

1. **High Resistance Wire:**
   A high resistance wire like Nichrome is used to convert the electrical energy into heat energy. It is covered with an insulator like Mica to avoid leakage of current.
2. **Thermostat:** Thermostat is an arrangement to control the amount of heat produced. It contains a bimetallic strip of two metals of different coefficients of thermal expansions.
3. **Iron Soleplate**: Soleplate is a flat polished sheet of metal made of a good heat conductor like stainless steel which moves on the clothes.The heat and pressure of the soleplate removes the wrinkles on the clothes.

Working:

- When power is switched on, electric current passes through the nichrome wire and it gets heated.
- The heat produced in the wire is transferred to the soleplate through conduction.
- Thermostat of the Iron controls the heating process using a bimetallic strip.
- When the iron gets sufficiently hot the bimetallic strip bends and the circuit becomes open. Hence the heating stops automatically.
- When the iron gets cool, the strip becomes normal and the circuit is closed again, Now the heating starts again.

Principle of working, parts and servicing of Electric Heater

Principle:

★ **Principle of Electric Heater is "Conversion of Electrical Energy into Heat Energy".**

When electric current is passed through a material of high resistance, heat is produced.

$$Q = i^2 Rt$$

Where $Q = Heat\ produced$

$i = Current$

$R = Resistance$

$t = Duration\ of\ current\ flow$

Parts:

1. **High Resistance Wire:**
   A high resistance wire like Nichrome is used to convert the electrical energy into heat energy. It is covered with an insulator like Mica to avoid leakage of current.
2. **Thermostat:** Thermostat is an arrangement to control the amount of heat produced. It contains a bimetallic strip of two metals of different coefficients of thermal expansions.
3. **Hot Water and Cold Water Pipes**: The Water Heater has two pipes. The cold water pipe draws cold water into the tank and the hot water pipe delivers the heated water.

4. **Tank**: A cylindrical tank made of copper or stainless steel is used to store the heated water. The inner surface of the tank is coated with enamel to minimize corrosion.

Working:

- ❖ When power is switched on, electric current passes through the nichrome wire and it gets heated.
- ❖ The heat produced in the wire is transferred to the cold water through conduction.
- ❖ Thermostat of the Iron controls the heating process using a bimetallic strip.
- ❖ When the iron gets sufficiently hot, the bimetallic strip bends and the circuit becomes open. Hence the heating stops automatically.
- ❖ When the iron gets cool, the strip becomes normal and the circuit is closed again, Now the heating starts again.
- ❖ The heated water is delivered through the hot pipe.

Principle of working, parts and servicing of Microwave Oven

Principle:

★ **Principle of Microwave oven is "Dielectric Heating"**

When high frequency microwaves of the order of 2.5 GHz are passed through food, the water molecules in the food absorb energy and vibrate. The vibration of molecules produces heat which cooks the food quickly and homogeneously. This is called dielectric heating.

Parts:

1. **Magnetron**: Magnetron is a device which generates high frequency microwaves. It contains a high power vacuum tube with multiple cavities.The electrons interact with electric and magnetic fields in the cavities to produce microwaves.
2. **High voltage Transformer**: A high voltage transformer is used to provide a voltage of around 2100 Volts required for the Magnetron.
3. **High Voltage Capacitor**: A capacitor of $1\ \mu F$ and a diode are used to convert the AC to DC at a voltage of 2100 Volts.
4. **Wave Guide**: Waveguide is a device to focus or direct the microwaves on to the food.
5. **Cooking Chamber:**Cooking chamber is a cavity for heating the food. It has metallic walls and acts like a faraday cage.The microwaves are continuously reflected from the walls until they are fully absorbed by the food.

Working:

- ❖ When power is switched on, electric current passes through the transformer which raises the voltage to 2100 Volts.
- ❖ The high voltage AC is converted to DC after passing through a circuit containing capacitor and diode.
- ❖ The high voltage DC passes through the Magnetron to produce high frequency microwaves.

- ❖ The microwaves are directed on to the food in the cooking chamber using the waveguide.
- ❖ The water molecules in the food absorb the microwaves and the food is heated due to dielectric heating.
- ❖ When the food is heated to a desired temperature, the control unit automatically switches off the magnetron to stop cooking.

Principle of working, parts and servicing of Induction Heater

Principle:

★ **Basic principles involved in Induction Heater are "Electromagnetic Induction and Joule Heating"**

When a conductor is placed inside a coil carrying Radio Frequency Alternating Current, induced current is produced in the conductor due to electromagnetic induction. The conductor will be heated due to the induced current. This is called Joule Heating. This non contact process of heating a conductor is called induction Heating.

Parts:

1. **RF Power Supply:** Induction Heater contains a Radio Frequency Power Supply. It contains an electromagnet and an electronic oscillator with variable capacitors and Inductors to produce the desired RF alternating current.
2. **Induction Coil:** Induction coil is the most important of an Induction Heater. It converts the electrical energy into magnetic energy.

Working:

- ❖ When power is switched on, RF current passes through the Induction coil.
- ❖ The Induction coil converts the alternating current into an alternating magnetic field.
- ❖ Now the Conductor which is to be heated is placed inside the coil.
- ❖ Due to the alternating magnetic field of the coil, induced current is produced in the conductor. This is called electromagnetic induction.
- ❖ The induced current heats the conductor due to Joule Heating.
- ❖ When the conductor is heated to a desired temperature the power supply is automatically switched off.

Electric Bulbs-CFL

CFL means Compact Fluorescent Lamp. CFL bulbs are 75 % more energy efficient than incandescent bulbs.

Principle:

★ **Principle of CFL bulb is fluorescence.**

➔ When ultraviolet light is incident on a fluorescent material like Phosphor, it is converted into visible light. This is called fluorescence.

Parts:

1. **Vacuum Pipe**: CFL bulb contains a spiral shaped vacuum pipe which has electrodes on both ends.
2. **Mercury:** A small amount of mercury vapour of the order of 4 mg per bulb is sealed in the vacuum pipe.
3. **Phosphor**: The inner walls of the vacuum pipe are coated with fluorescent material like Phosphor.

Working:

- ❖ When electric current passes through the bulb, electrons are emitted from the cathode.
- ❖ These electrons pass through the vacuum tube and strike the mercury atoms to produce ultraviolet light.
- ❖ The ultraviolet light is absorbed by the phosphor on the inner walls of the vacuum pipe which converts the ultraviolet into visible light.
- ❖ This conversion of ultraviolet light into visible light is called fluorescence. Hence the lamp is called fluorescent lamp.

LED

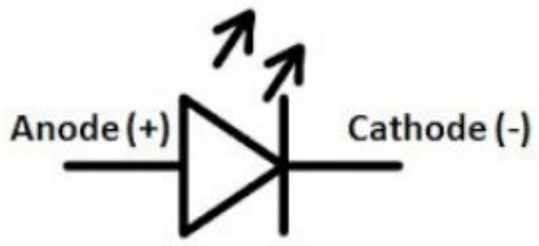
LED means Light Emitting Diode. LED bulbs are more energy efficient than incandescent and CFL bulbs.

Principle and Working :

★ **Principle of LED bulbs is conversion of electrical energy into light energy using a P-N junction diode.**

- ❖ Consider a heavily doped P-N junction diode connected in forward bias.
- ❖ Since the diode is heavily doped, the width of the depletion layer is less.
- ❖ Hence the electrons and holes recombine at the depletion layer and produce photons of specific energy.
- ❖ The colour of the emitted light depends on the energy gap of the semiconducting material.
- ❖ Only those semiconductors which have a direct band gap emit light.
- ❖ Materials with indirect band gap do not emit light.
- ❖ LEDs are widely used in TV, Mobile Displays, Remote Controls etc.
- ❖ Commonly used materials for LED bulbs:
  - ❖ Aluminium Gallium Arsenide(AlGaAs) – infrared.
  - ❖ Gallium Arsenic Phosphide(GaAsP) – red, orange, yellow.
  - ❖ Aluminium Gallium Phosphide(AlGaP) – green.
  - ❖ Indium gallium nitride (InGaN) – blue, blue-green, near UV.
  - ❖ Zinc Selenide(ZnSe) – blue

Symbol:



Refrigerator

Refrigerator is a device used to produce and maintain low temperatures of the order of 4^0C to 5^0C in an enclosure relative to the surroundings.

Principle:

- **When a liquid with low boiling point is made to evaporate, it extracts heat from the surrounding objects and cools them. This is the basic principle of refrigerator.**

Parts:

1. Compressor
2. Evaporator:
3. Condenser
4. Refrigerant
5. Expansion valve
6. Thermostat

Working:

- The liquid refrigerant passes through the expansion valve and is cooled due to expansion.
- The cooled refrigerant which has a low boiling point flows through evaporator coils to extract heat from the food items and evaporates.Hence cooling is produced due to the evaporation of the refrigerant.
- The evaporated gas refrigerant which has a low pressure then enters the compressor and becomes a hot high pressure gas.
- The high pressure gas then passes through the condenser coils and condenses into liquid by losing heat to the surroundings.
- The cooled refrigerant again passes through the expansion value and the cycle repeats.

Inverter

- Inverter is a device to convert direct current into alternating current.
- Frequency, Voltage and Electric Current of AC can also be controlled using Inverter.
- Power produced from Solar Cells and Batteries is DC. But most of the electrical appliances operate with AC. Hence Inverter is an important component of electrical appliances.
- Transistor is the key component of an Inverter.
- Transistor acts like a switch and converts the steady unidirectional DC to constantly

changing AC.

- Two types of transistors are used in Inverters.
  - ➔ Bipolar Junction Transistor (BJT)
  - ➔ Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
- Inverters are classified into three types based on the output waveform.
  - ➔ Square Wave Inverter
  - ➔ Modified Sine Wave Inverter
  - ➔ Sine Wave Inverter
- Inverters are classified into two types based on the load.
  - ➔ Single Phase Inverter
  - ➔ Three Phase Inverter
- Inverters are used in UPS systems.

UPS

- UPS means Uninterrupted Power Supply.
- UPS is an electrical system used to supply uninterrupted alternating current to the electrical appliances when the mains supply is off.
- UPS mainly has three parts.
  - ★ **Rectifier**: Rectifier converts the alternating current from the mains supply into direct current to charge the battery.
  - ★ **Battery**: UPS has a battery to store energy when the mains supply is 'ON'. The battery is charged with direct current from the DC output of the rectifier.
  - ★ **Inverter:** Inverter converts the direct current from the battery into alternating current.
- When the Mains Supply is 'ON', the battery is gradually charged and stores electrical energy.
- When the supply is 'OFF" battery discharges and supplies power to the circuit.
- Hence uninterrupted power is supplied to the electrical appliances.
- In addition to providing uninterrupted power supply, UPS also protects the appliances from voltage fluctuations.

UNIT-III

Direct Current and Alternating Current

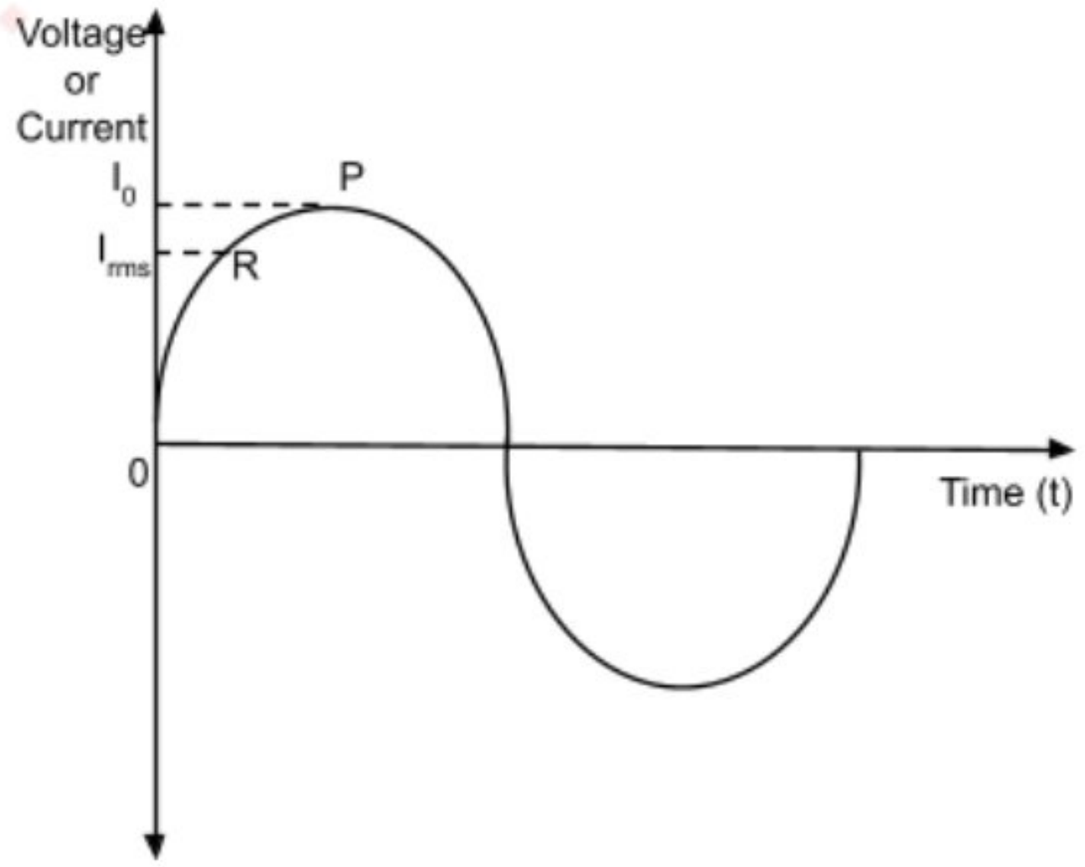
S.No	Direct Current	Alternating Current
1	Magnitude and Polarity of electric current is constant in Direct Current	Magnitude and Polarity of electric current changes periodically in Alternating Current
2	Flow of electrons is unidirectional in D.C	Flow of electrons is bidirectional in A.C
3	D.C Current is produced from batteries, generators, solar cells etc	A.C.Current is produced from Alternators.
4	Examples of electrical appliances which operate with DC are Mobiles, Computers,TVs, Audio Systems etc	Examples of electrical appliances which operate with ac are Refrigerator, Electric Motor,Electric Fan, Dishwashers etc
5	Difficult to transmit over long distances	Easy to transmit over long distances
6	Device which converts DC to AC is called Inverter	Device which converts AC to DC is called Rectifier

Alternating Current-RMS and Peak Values

If the Magnitude and Polarity of electric current changes periodically, it is called Alternating Current (A.C).

- ❖ Flow of electrons is bidirectional in A.C
- ❖ Examples of electrical appliances which operate with AC are Refrigerator, Electric Motor,Electric Fan, Dishwashers etc
- ❖ It is easy to transmit A.C over long distances with minimum energy losses.Hence electricity supplied by grid for domestic use is A.C
- ❖ Frequency of domestic AC supply in India is 50 HZ

Graphical representation of AC Current is shown in the figure.



It is clear from the graph that the magnitude and polarity of A.C current changes periodically.

At any time 't' A.C Current is given by the expression

$$I = I_0 \, Sin \, \omega t = I_0 \, Sin \, 2\pi f t$$

Here 'f' is the frequency

- ➔ The maximum value of current I_0 denoted by the point 'P' is known as the Peak Value of AC Current.
- ➔ Root Mean Square(R.M.S) value of A.C current is the square root of mean of squares of instantaneous currents denoted by the point 'R' in the figure.

RMS Current is given by

$$I_{rms} = \frac{I_0}{\sqrt{2}} = 0.707 \, I_0$$

The reason why RMS Value of current is used instead of peak value and average value is that an AC Current of RMS value would deliver the same power as that of Direct Current of the same value.In other words,the RMS value is the equivalent measure of DC Current. Hence RMS current is also called effective current.

Power Factor of an AC Circuit

In AC Circuits, some amount of power is lost due to reactances of Capacitors and Inductors also in addition to the power losses due to resistances. This loss of power due to reactances is called Reactive Power. The Reactive Power Loss is due to the phase difference between Voltage and Current produced due to the reactances of Capacitors and Inductors. Hence in AC Circuits, the True Power is less than the Apparent Power.

- ➔ Power Factor of an AC Circuit is defined as the ratio of True Power (In Watts) to Apparent Power (In Volt-Amp).

If ϕ is the phase difference between Voltage and Current, then Power Factor is given by

$$\text{Power Factor } Cos\phi = \frac{True \, Power \, (In \, Watts)}{Apparent \, Power \, (In \, Volt\text{-}Amp)}$$

Depending on the Phase difference ϕ between Voltage and Current, the value of Power Factor ranges between 0 and 1.

Case (i): If the Voltage and Current are in phase, then $\phi = 0$,

then Power Factor $Cos\phi = 1$

Hence in DC Circuits power factor is always unity..

Case(ii): If the phase difference between and Voltage and Current is 90^0,

then $\phi = 90^0$,

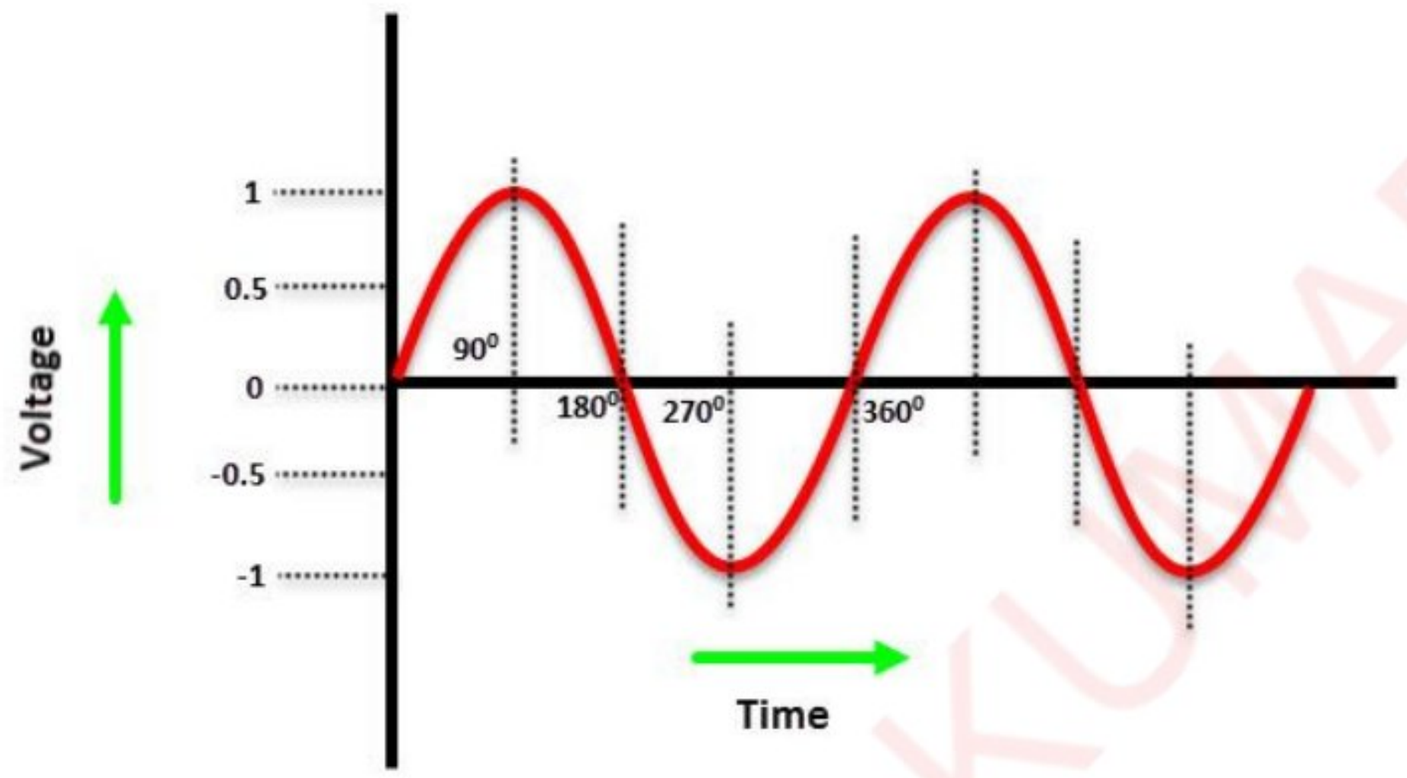
Then Power Factor $Cos\phi = 0$

Single phase and three phase connections

Depending on the load, supply of electrical power is done in two ways. Single Phase Power Supply or Three Phase Power supply.

Single Phase Power Supply:

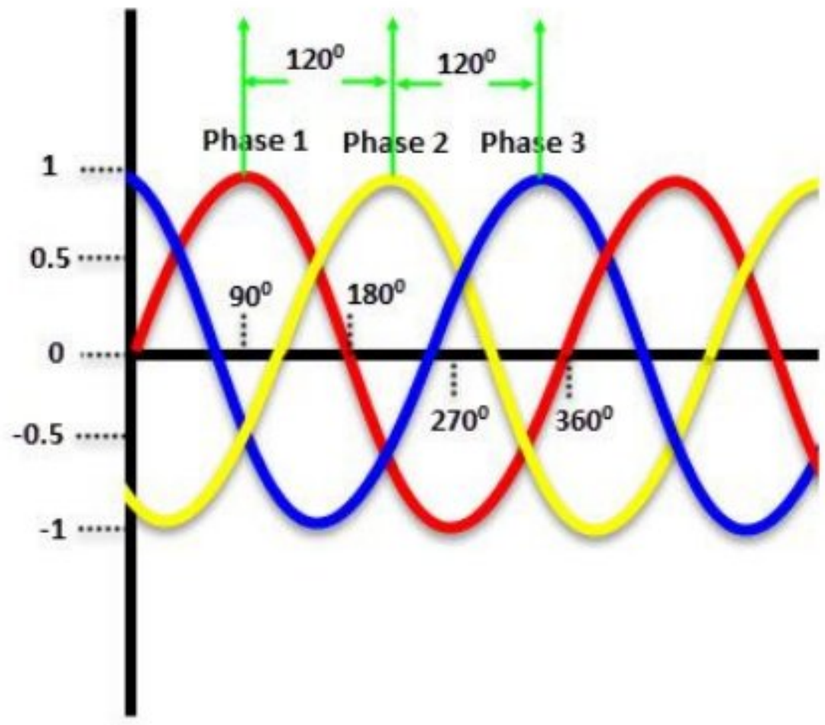
In Single Phase Power Supply, the AC power is distributed using two wires known as Phase and Neutral. Since it has only one phase, it is called a Single Phase Power Supply. Single Phase waveform is shown in figure.



- It is clear from the figure that the voltage of a Single phase System changes continuously and becomes zero two times in a cycle. Hence constant power cannot be delivered to the load.
- Most of the residential homes use Single Phase Power Supply since the load is small. Hence Single Phase is sometimes called “Residential Voltage”.
- In India, the Single Phase Voltage is 230 V and Frequency is 50 Hz.
- Design and Operation is simple.
- Sufficient for loads upto 2500 Watts.
- Efficiency is less.

Three Phase Power Supply:

In Three Phase Power Supply, the AC power is distributed using three power wires each carrying an AC Current with a phase difference of 120^0. In Some cases, a neutral wire is also used. Since it has 3 Phases, it is called a Three Phase Power Supply. The 3 phases are called Red, Yellow and Blue (R, Y, B). Three Phase waveform is shown in figure.



- It is clear from the figure that the voltage of a three phase system is approximately constant and does not become zero. Hence constant power can be delivered to the load.
- Most of the Industrial and business connections use three phase power supply since the load is high.
- In India, the Three Phase Voltage is 415 V and Frequency is 50 Hz.
- Design and operation is complex.
- Requires less wire than a SIngle Phase Power Supply.
- Efficiency is more.

Star and Delta connection

In Three Phase Power Supply, the AC power is distributed using three power wires each carrying an AC Current with a phase difference of 120^0. In Some cases, a neutral wire is also used. Since it has 3 Phases, it is called a Three Phase Power Supply.

The 3 phases are called Red, Yellow and Blue (R, Y, B). They can be connected in two ways; Star connection and Delta connection

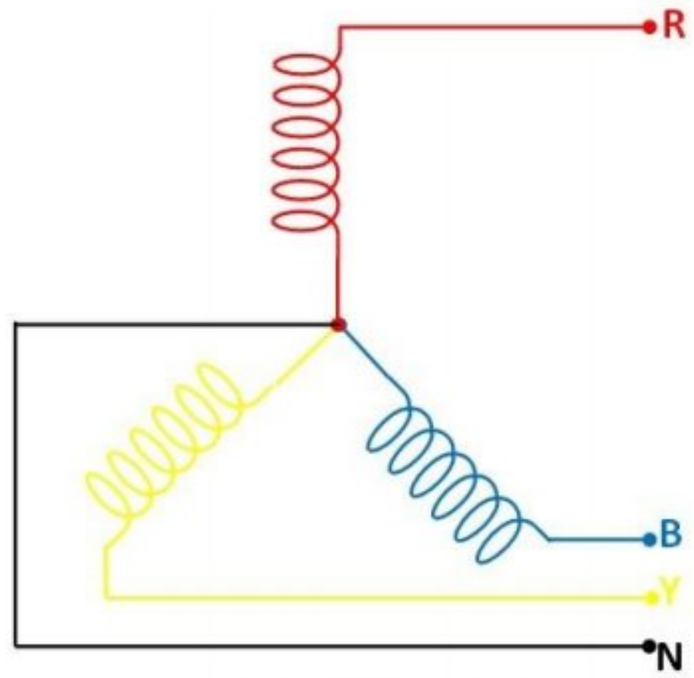
1. **Star Connection:** Star Connection has three phase wires and one neutral wire. In Star Connection, one end of all the three phase wires are connected to a common point to form a 'Y' shaped arrangement. The common point is connected to the neutral and is called Star Point.
   - ➔ In a Star Connection, the voltage between phase and neutral is 230 V while the voltage between any two phases is 415 V. Hence a Star Connection can provide three single phase connections also.
   - ➔ It has two voltage levels.
   - ➔ In Star Connection, Line Voltage and Phase Voltage are different.

$$V_L = \sqrt{3} V_P$$

   - ➔ In Star Connection, Line Current and Phase Current are equal since the phase wires are connected in series.

$$I_L = I_P$$

➔ Star Connections can be used for long distances.



STAR Connection

2. **Delta Connection**: Delta connection has three phase wires only with no neutral. In Delta Connection every phase wire is connected to the other two phase wires in the shape of a triangle. The three common points act as three phases.

➔ In Delta Connection the Voltage between any two phases is 415 V.

➔ It has only one voltage level.

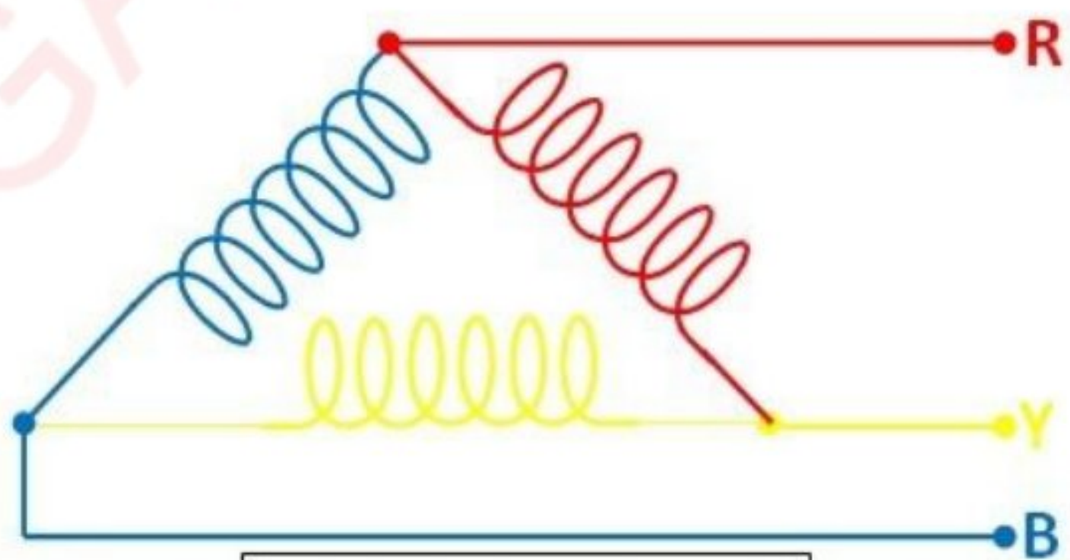
➔ In Delta Connection, Line Voltage and Phase Voltage are the same since the phase wires are connected in parallel.

$$V_L = V_P$$

➔ In Delta Connection, Line Current and Phase current are different.

$$I_L = \sqrt{3}\, I_P$$

➔ Delta Connections are used for short distances only.



DELTA Connection

Electric Shock and First Aid

Human body is a conductor of electricity. So when electric current accidentally passes through the human body it can cause external and internal injuries. This is called electric shock or electrocution.

Causes of Electric Shock:

- ❖ Power Lines
- ❖ Household Apliances
- ❖ Electric Machinery
- ❖ Lightning

Factors affecting the injury of an electric shock:

- ❑ **Voltage Level:** Voltage level determines the severity of injury. Voltage of less than 500 Volts does not cause severe injuries except minor burns. But high voltage electricity can cause serious internal injuries to Heart, Brain, Muscles etc.
- ❑ **Duration of current flow**: Longer is the current flow through the body, more severe are the injuries.
- ❑ **Type of Current**:Alternating Current is more dangerous than D.C of the same voltage because of the alternating nature of A.C.
- ❑ **Path of electricity**: If most of the electricity passes through the clothing or the outer parts of the body, injuries will be less.

First Aid:

- ➔ If a person is being electrocuted, the first thing to be done is to switch off the power supply or disconnect the source using an insulator like wood, cardboard or plastic to prevent further damage.
- ➔ When the power is switched off, the person may fall down due to jerks and have secondary injury. It should be avoided with proper support.
- ➔ If the person loses consciousness, he/she should be laid down with legs elevated relative to head.
- ➔ CPR should be done if the person has cardiac arrest.
- ➔ In case of burns, rinse the injury with cool water and apply antibiotic ointment to avoid infection.

Earthing and its Necessity

Earthing means to connect an electrical system to earth through a conducting material like Iron, Copper , Aluminium etc. Earthing provides a low resistance path to the circuit if there is a leakage of current.It is an important safety mechanism of any electrical system.

Necessity of Earthing:

- ➔ Earthing provides an alternative path for the accidental leakage of current to flow towards earth.
- ➔ It protects humans from electric shock.
- ➔ It protects the electrical equipment from damage due to short circuits or high voltage.
- ➔ It protects tall buildings from lightning strikes.
- ➔ Earthing also provides voltage stabilization in sensitive electronic equipment.

MCB

MCB means Miniature Circuit Breaker.It is used to protect an electrical system incase of Overload and Short circuit by switching off or tripping the circuit automatically. It is a modern alternative to fuse.

Main components of MCB:

- ➔ Bimetallic Strip
- ➔ Solenoid
- ➔ Mechanical Latch
- ➔ Actuator Knob

Principle and Working:

Overload Protection: When an electrical circuit is overloaded, excessive current passes through the circuit. It causes the Bimetallic strip in the MCB to bend which releases a mechanical latch and trips the circuit.

Short Circuit Protection: When an electrical circuit is short circuited or has a faulty connection, a large amount of current suddenly passes through the circuit. It causes the Solenoid in the MCB to produce a magnetic field which releases a mechanical latch and trips the circuit within milliseconds.

Types of MCBs :

There are 6 different types of MCBs which are A,B,C,D, K and Z depending on the range of tripping current.

S.No	Type	Tripping Current	Operating Time
1	Type A	2 to 3 times the rated current	0.04 to 13 Sec
2	Type B	3 to 5 times the rated current	0.04 to 13 Sec
3	Type C	5 to 10 times the rated current	0.04 to 5 Sec
4	Type D	10 to 20 times the rated current	0.04 to 3 Sec
5	Type K	8 to 12 times the rated current	<0.1 Sec
6	Type Z	3 to 5 times the rated current	<0.1 Sec

ELCB

ELCB means Earth Leakage Circuit Breaker. It detects the earth leakage current and switches off or trips the circuit to prevent electric shock to humans.

Sometimes electric current may pass through the metal enclosures of an electrical system due to

insulation failure or faulty connection. This is called earth leakage current. If the earth leakage current is above the permissible limit of 1 mA or 50 V, it can cause electric shock to humans.

ELCBs are of two types.

- ➔ Voltage Earth Leakage Circuit Breaker
- ➔ Current Earth Leakage Circuit Breaker

Current Earth Leakage Circuit Breakers also known as Residual Current Circuit Breakers (RCCB) are widely used nowadays

Principle and Working:

- ➔ ELCB contains a relay coil or sensing coil.
- ➔ When Supply and Return currents pass through the relay coil, two magnetic fields are produced.
- ➔ When there is no earth leakage current, the two magnetic fields cancel each other since the supply and return currents are balanced.
- ➔ But When excessive earth leakage current passes through the relay coil, there will be an imbalance of currents and hence the magnetic fields do not cancel each other. The residual magnetic field releases a latch to trip the circuit preventing electric shock.

IS & IE Codes

IS and IE Codes in Electrical Engineering:

- ★ **IS Code**: Indian Standard Code
- ★ **IEC Code**: International Electrotechnical Commission Standards Code

- ➔ Electrical Codes are a set of regulations for the design and installation of electrical wiring in a building.
- ➔ Electrical Codes are very important to maintain the standards of electrical wiring systems.
- ➔ They are also intended to ensure the safety of people in case of accidents in electrical systems due to short circuits, overloading and faulty connections.
- ➔ The Electrical Codes are imposed by the Government considering the following factors.
    - Operating Voltage and Electric Current
    - Ambient Temperature
    - Moisture Levels
    - Exposure to Sunlight and Chemicals
- ➔ Hence Electrical Codes are different for different countries.
- ➔ IS Code is the Electrical Code in India.
- ➔ There are more than 1600 IS Codes
- ➔ IEC Code is an international code developed by engineering experts of all countries.
- ➔ IEC Code aims to provide uniform electrical standards for all countries.

Model Question Paper-1

I Semester-Skill Development Course

Electrical Appliances

(w.e.f 2020-21 batch)

Time: 90 Min. **Max Marks: 50**

Section-A

➔ **Answer any 4 questions. Each question carries 5 marks**

1. Write a short note on Voltage and Current?
2. What is Ohm's law? Is it applicable to AC Circuits?
3. Differentiate between Direct Current & Alternating Current?
4. Describe the first aid for electric shock?
5. Write a short note on CFL?
6. What are IS Codes and IE Codes?
7. Define Electric Power? What is Kilowatt hour?
8. What is the significance of earthing?

➔ **Answer all the questions. Each question carries 10 marks.**

9. Explain the principle and working of a Transformer?

(or)

10. Explain Conductors and Insulators?
11. Explain Single phase and Three phase connections?

(or)

12. What is MCB? Explain its principle and working?
13. Explain the principle, parts and working of Electric Iron?

(or)

14. Explain the principle, parts and working of Induction Heater?

Model Question Paper-2

I Semester-Skill Development Course

Electrical Appliances

(w.e.f 2020-21 batch)

Time: 90 Min. **Max Marks: 50**

Section-A

➔ Answer any 4 questions. Each question carries 5 marks

1. Write a short note on Resistance?
2. Differentiate between Ammeter and Voltmeter?
3. What is electric shock? What is the first aid for electric shock?
4. Write a short note on UPS?
5. What is the principle of Electric Fan?
6. Write a short note on LED bulbs?
7. Explain the working of Multimeter?
8. What are Star and Delta Connections?

➔ Answer all the questions. Each question carries 10 marks.

9. What is Capacitance? Explain?

(or)

10. Explain the principle and working of a Transformer?
11. Explain the principle and working of ELCB?

(or)

12. Explain the principle and working of an Inverter?
13. What is a Refrigerator? Explain its principle and working?

(or)

14. Explain the principle, parts and working of an Electric Oven??