ATOMIC ENERGY EDUCATION SOCIETY

DISTANCE TEACHING PROGRAMME

CLASS X SCIENCE

CHAPTER: MAGNETIC EFFECT OF CURRENT (MODULE 3/3)

Topics covered: (1. Fleming right hand rule 2. DC & AC 3. Electric generator 4. Domestic electric circuit.)

Fleming Right hand rule:

This rule gives direction of induced current due to phenomenon of electromagnetic induction.

- **Statement:** Stretch the thumb, forefinger and middle finger of right hand so that they are mutually perpendicular to each other, as shown in Fig. F. If the forefinger indicates the direction of the magnetic field and the thumb shows the direction of motion of conductor, then the middle finger will show the direction of induced current. This simple rule is called Fleming's right-hand rule.

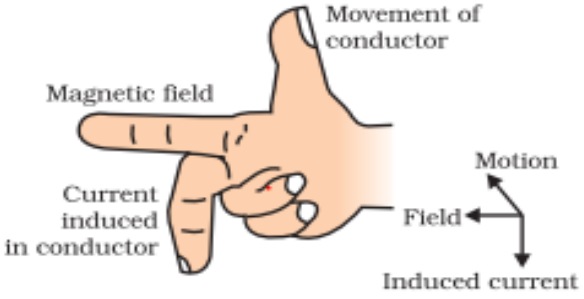

Figure F (Fleming Right hand rule)

Direct Current: When the current flows in the same direction with constant magnitude, it is called 'direct current' or DC. The current derived from a cell or battery is unidirectional. So it is a DC source. In this source the +ve and -ve terminals are fixed.

It is represented in an electrical circuit as in figure G

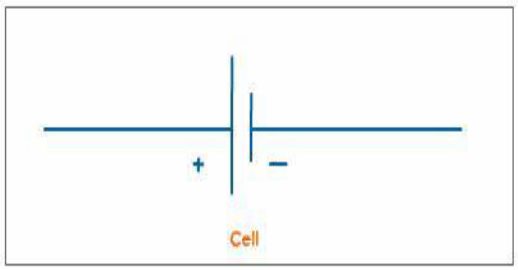

Figure G

The voltage V/s time graph for a DC source is represented as follows in figure H:

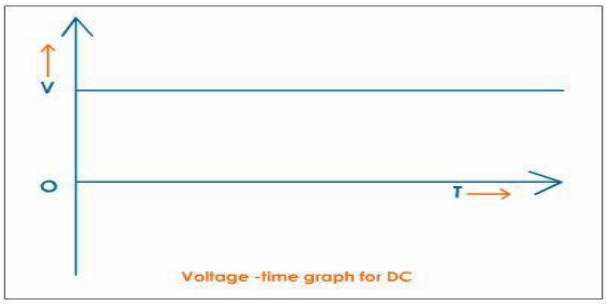

Figure H

Alternating Current: The current that changes its magnitude and direction after equal intervals of time, it is called alternating current.
It is represented in an electrical circuit as in figure I. It has no fixed terminals as the current changes its direction after every half cycle.

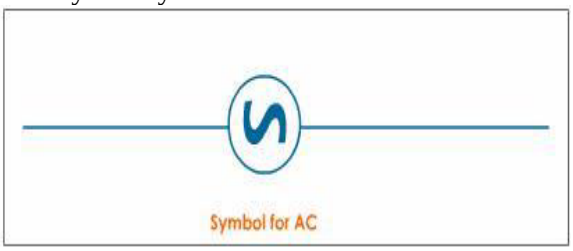

Figure I

The voltage V/s time graph for an AC source is represented as follows in fig. J

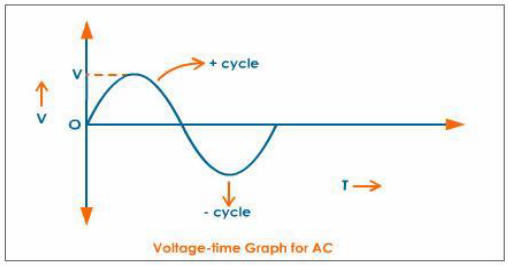

Figure J (One cycle of AC)

Frequency of alternating current: Number of cycles completed by alternating current or voltage in one second is called its frequency. In India frequency of AC is 50 Hertz (Hz). It means that AC changes direction after every 1/100 second.

Advantages of Alternating Current (AC) over Direct Current (DC)

Electric power can be transmitted to longer distances without much loss of energy. Therefore Cost of transmission is low.

Electric Generator: It is the machine which converts mechanical energy into electrical energy.

Principal: its principal is based on phenomenon of electromagnetic induction, in which the

potential difference or current is induced in a conductor due to a change in the magnetic field associated with conductor.

AC generator: It converts mechanical energy into alternating current (AC).
DC generator: It converts mechanical energy into direct current (DC).

AC generator: Construction:

- An electric generator, as shown in Fig. K, consists of a rotating rectangular coil ABCD placed between the two poles of a permanent magnet.
- The two ends of this coil are connected to the two rings R_1 and R_2. The inner sides of these rings are insulated.
- The two conducting stationary carbon brushes B_1 and B_2 are kept pressed separately on the rings R_1 and R_2, respectively.
- The two rings R_1 and R_2 are internally attached to an axle. The axle may be mechanically rotated from outside to rotate the coil inside the magnetic field.
- Outer ends of the two brushes are connected to the galvanometer.
- Galvanometer shows flow of current in the given external circuit.

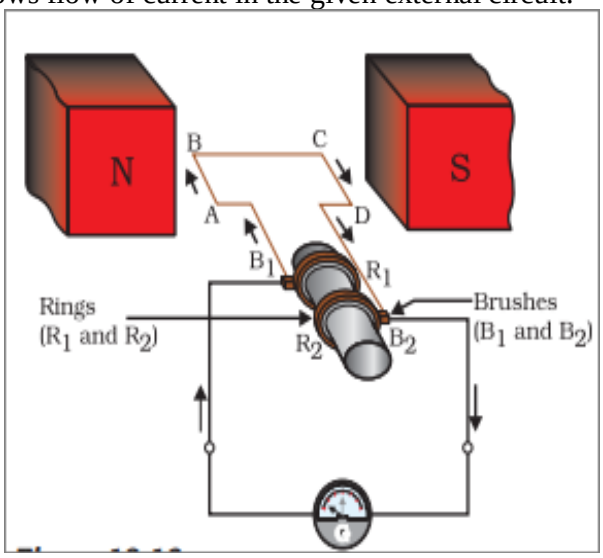

Figure K

Working:
When the axle attached to the two rings is rotated then the arm AB moves up and the arm CD moves down in the magnetic field produced by the permanent magnet. Let us say the coil ABCD is rotated clockwise in the arrangement shown in Fig. K

- By applying Fleming's right-hand rule, the induced currents are set up in these arms along the directions AB and CD. Thus an induced current flows in the direction ABCD. If there are larger numbers of turns in the coil, the current generated in each turn adds up to give a large current through the coil.
- This means that the current in the external circuit flows from B_2 to B_1.
- After half a rotation, arm CD starts moving up and AB moves down. As a result, the directions of the induced currents in both the arms changes, giving rise to the net induced current in the direction DCBA. The current in the external circuit now flows

from B_1 to B_2. Thus after every half rotation the polarity of the current in the respective arms changes.

- Such a current, which changes direction after equal intervals of time, is called an alternating current (abbreviated as AC). This device is called an AC generator.

DC generator:

- The output produced here is unidirectional. The slip rings are replaced with split rings to achieve this.
- To get a direct current (DC) generator a split-ring type commutator must be used. In this arrangement, one brush is at all times in contact with the arm moving up in the field while the other is in contact with the arm moving down. Thus a unidirectional current is produced in such a generator. (Fig. L)

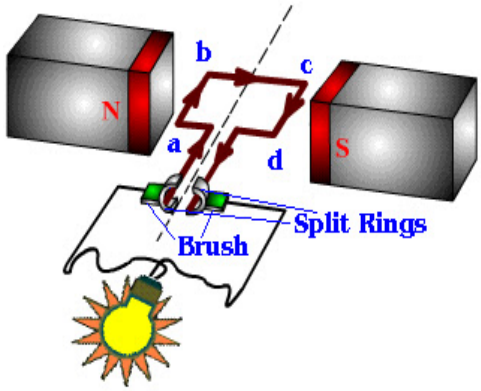

Figure L (DC generator)

Problem: Choose the correct option.
A rectangular coil of copper wires is rotated in a magnetic field. The direction of the induced current changes once in each:
(a) two revolutions (b) one revolution (c) half revolution (d) one-fourth revolution
Sol. Right option is (c): half rotation

DOMESTIC ELECTRIC CIRCUITS:

- In our homes, the electric power supplied is of potential difference V = 220V and frequency 50Hz.
- It consist of three wires :– (1) Wire with red insulation cover – LIVE WIRE (POSITIVE). Live wire is at high potential of 220V
- (2) Wire with black insulation cover – NEUTRAL WIRE (NEGATIVE) .Neutral wire is at zero potential, therefore the potential difference between these two wires two is 220V.
- (3) Wire with Green insulation cover – EARTH WIRE. It is connected to a copper plate deep in the earth near house.
- The metallic body of the appliances is connected with the earth wire as a safety measure. Earth wire provides a low resistance to the current hence any leakage of current to the metallic body of the appliances keep its potential equal to that of earth. That means zero potential and the user is saved from severe electric shock.

Points to be noted in Domestic Circuit:

- Each appliance has a separate switch of ON/OFF
- In order to provide equal potential difference to each appliance, they should be connected parallel to each other. So that they can be operated at any time.

- In parallel combination if any one appliance stops working .even then other appliances will continue to work.
- There are two separate circuits in a house namely lighting circuit and power circuit. The lighting circuit with a 5 A fuse is used for running electric bulbs, fan, radio, TV, tube lights etc. and the power circuit with a 15 A fuse is used for running electric heater, electric iron, geyser, refrigerator etc as it draws more current.

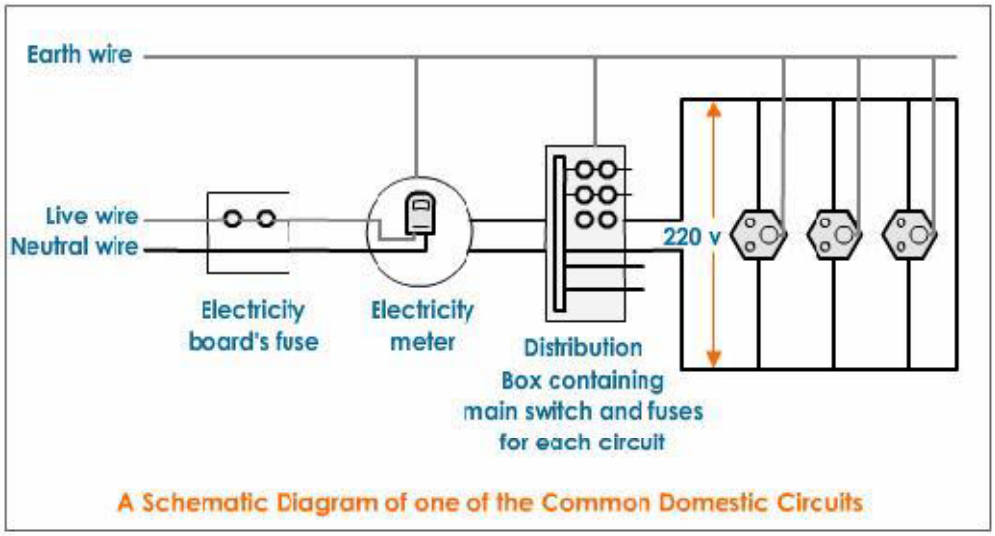

Figure M

Causes of Damage to Domestic Electric Circuits:

- **Short Circuiting:** Due to fault in the appliances or damage in the insulation of two wires, the circuit will offer zero or negligible resistance to the flow of current. Due to low resistance, large amount of current will flow. It is called as short circuiting. According to Joule's law of heating effect, heat is produced in live wire and produces spark, damaging the device and wiring.
- **Overloading:** Overloading can be caused by (a) Connecting too many appliances to a single socket or (b) accidental rise in supply voltage. If the total current drawn by the appliances at a particular time exceeds the bearing capacity of that wire, it will get heated up. This is known as overloading. Fuse a safety device can prevent the circuit from overloading and short circuiting.
- **Fuse wire:** It protects circuits and appliances by stopping the flow of any unduly high electric current or short-circuiting. The fuse is placed in series with the device. It consists of a piece of wire made of Lead Tin alloy having **low melting point and high resistivity** If a current larger than the specified value flows through the circuit, the temperature of the fuse wire increases. This melts the fuse wire and breaks the circuit. This prevents damage to the appliance.

Refernces : NCERT Science X class , Wikipedia, H C Verma Physics

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