CHAPTER 12: MAGNETIC EFFECTS OF ELECTRIC CURRENT

Introduction

In our daily life, electricity is used in many devices such as fans, lights, and motors. Earlier, we studied the heating effect of electric current. However, electric current also produces another important effect — the **magnetic effect**.

When electric current passes through a conductor, it creates a magnetic field around it. This shows that electricity and magnetism are closely related.

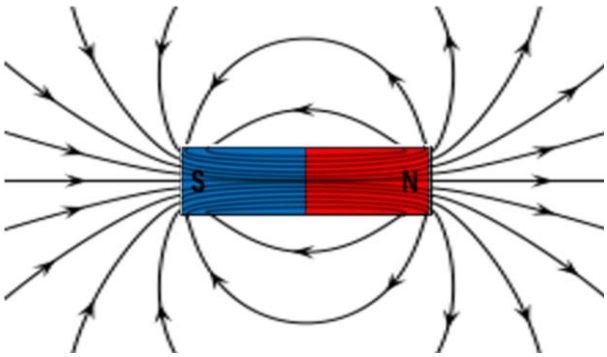
Magnetic Field

A magnetic field is the region around a magnet or a current-carrying conductor where its magnetic effect can be felt.

A compass needle placed in this region gets deflected, showing the presence of a magnetic field.

Magnetic field lines are imaginary lines used to represent the magnetic field around a magnet.

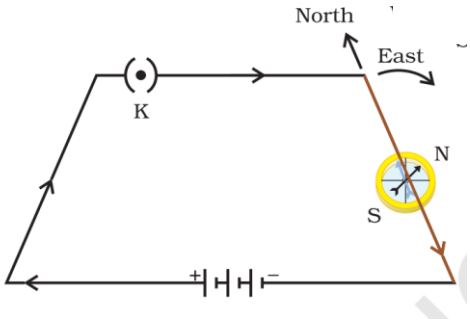
Properties of Magnetic Field Lines



1. They originate from the north pole and end at the south pole outside the magnet.
2. Inside the magnet, they move from south to north.
3. They form closed continuous curves.
4. The closeness of field lines indicates the strength of the magnetic field.
5. No two magnetic field lines intersect each other.

Magnetic Field due to Electric Current

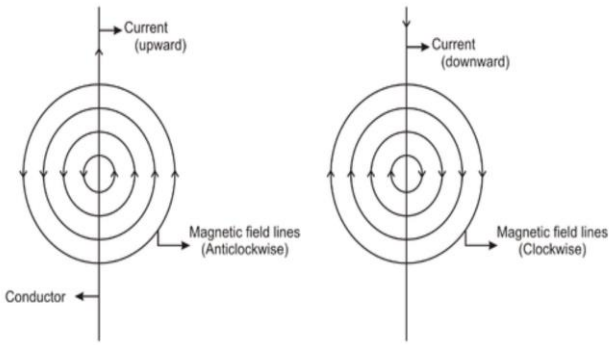
When current flows through a conductor, a magnetic field is produced around it.



Magnetic Field due to a Straight Conductor

When a straight wire carries current:

- Magnetic field lines form concentric circles around the wire
- Strength of field increases with increase in current
- Strength decreases as distance from wire increases

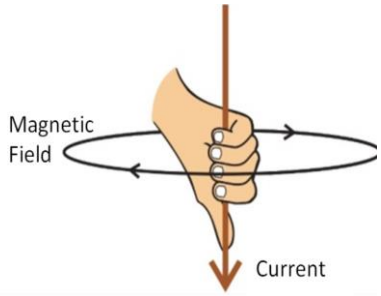


Right-Hand Thumb Rule

This rule helps to determine the direction of magnetic field.

If a conductor is held in the right hand such that:

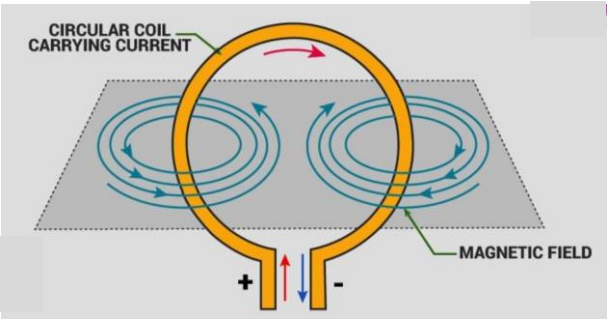
- Thumb points in the direction of current
- Then curled fingers give the direction of magnetic field



Magnetic Field due to Circular Loop

When a wire is bent into a circular loop and current is passed:

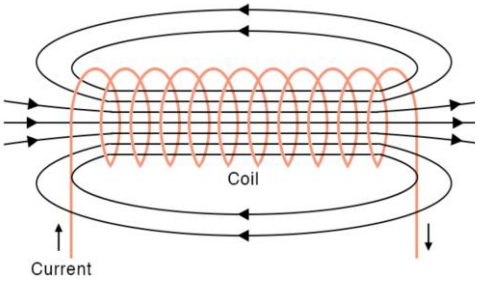
- Each part of the loop produces a magnetic field
- At the center, the fields combine to form a strong magnetic field
- Field lines near the center become almost straight



If the number of turns increases, the magnetic field becomes stronger.

Magnetic Field due to a Solenoid

A solenoid is a coil of many circular turns of insulated wire.



Characteristics:

- It behaves like a bar magnet
- One end acts as north pole, other as south pole
- Magnetic field inside the solenoid is uniform

Electromagnet

An electromagnet is formed when a soft iron core is placed inside a current-carrying solenoid.

- Strength depends on current
- Can be switched ON and OFF
- Temporary magnet

Uses:

- Electric bells
- Cranes

- Relays

Force on a Current-Carrying Conductor

When a current-carrying conductor is placed in a magnetic field, it experiences a force.

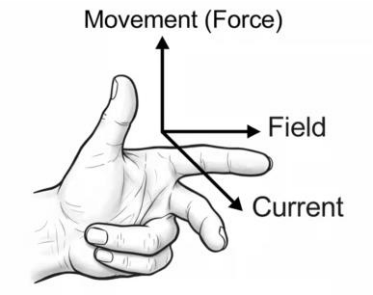
Factors affecting force:

- Magnitude of current
- Strength of magnetic field
- Length of conductor

Maximum force is experienced when the conductor is placed perpendicular to the magnetic field.

Fleming's Left-Hand Rule

This rule is used to determine the direction of force acting on a conductor.



- Forefinger → direction of magnetic field
- Middle finger → direction of current
- Thumb → direction of force (motion)

Direct Current (DC)

Direct current flows in only one direction.

Examples:

- Cells
- Batteries

Alternating Current (AC)

Alternating current changes its direction periodically.

Frequency:

The number of times current changes direction in one second is called frequency.

In India:
Frequency = 50 Hz

Advantages of AC over DC

- Easily transmitted over long distances
- Less power loss
- Can be stepped up or down using transformers

Domestic Electric Circuits

Electricity is supplied to homes through:

- Live wire (red)
- Neutral wire (black)
- Earth wire (green)

The potential difference between live and neutral wire is **220 V**.

Parallel Connection in Homes

All appliances are connected in parallel because:

- Each appliance gets the same voltage
- Appliances work independently

Earth Wire (Safety Measure)

The earth wire is connected to the metal body of appliances.

Purpose:

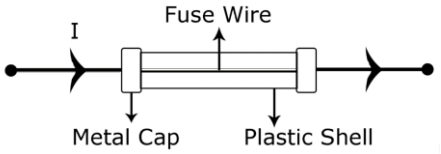
- Prevent electric shock
- Provides path for leakage current

Electric Fuse

A **fuse** is a safety device used in electrical circuits.

Working:

When current exceeds the safe limit:



- Fuse wire heats up
- Melts and breaks the circuit

Short Circuit

A **short circuit** occurs when live and neutral wires come in direct contact.

Effects:

- Sudden increase in current
- Can damage appliances or cause fire

Overloading

Overloading occurs when too many appliances are connected to a single socket.

Effects:

- Excess current flows
- Wires may overheat

Important Relationships

- Magnetic field ∝ Current
- Magnetic field ∝ 1 / Distance
- Magnetic field in coil ∝ Number of turns
- Force ∝ Current × Magnetic field × Length