

# 10<sup>th</sup> Class

## ➤ MAGNETIC FIELD DUE TO A CIRCULAR LOOP:

### 1. Ampere's Law:

- Ampere's law describes the relationship between the magnetic field ( $B$ ) around a closed loop and the electric current ( $I$ ) passing through that loop.
- For a circular loop, Ampere's law can be used to find the magnetic field at its center.

### 2. Formula for Magnetic Field:

- The magnetic field at the center of a circular loop is given by the formula:

$$B = \frac{\mu_0 \cdot I \cdot R^2}{2(R^2 + x^2)^{\frac{3}{2}}}$$

where:

- $B$  is the magnetic field strength,
- $I$  is the current flowing through the loop,
- $R$  is the radius of the loop, and
- $x$  is the distance from the center of the loop to the point where the magnetic field is being measured.

### 3. Direction of Magnetic Field:

- The magnetic field lines around a circular loop are concentric circles lying in planes perpendicular to the plane of the loop.
- At the center of the loop, the magnetic field lines are perpendicular to the plane of the loop and point outward (if the current is clockwise when viewed from above) or inward (if the current is counterclockwise when viewed from above).

### 4. Applications:

- Magnetic field due to circular loops is fundamental in the design and analysis of various electromagnetic devices, such as solenoids, transformers, and electric motors.
- It is used in the construction of electromagnets for lifting heavy objects in industries, magnetic resonance imaging (MRI) machines in medical diagnostics, and maglev trains for high-speed transportation.

### 5. Comparison with Other Geometries:

- The formula for the magnetic field at the center of a circular loop is specific to this geometry.
- Similar formulas can be derived for other geometries, such as straight wires, solenoids, and toroids, using Ampere's law and symmetry considerations.

## ➤ MAGNETIC FIELD STRENGTH AND CONTROL:

### 1. Strength Control:

- The strength of the magnetic field at the center of a circular loop depends on factors such as the current flowing through the loop and the radius of the loop.
- Increasing the current or the number of turns in the loop increases the magnetic field strength.

## 2. **Applications of Control:**

- This controllability is essential in various applications, such as in electromagnets used in scrap yards for lifting ferrous materials or in particle accelerators for scientific research.

Understanding the magnetic field due to a circular loop is crucial for understanding electromagnetism and its applications in technology and engineering. These principles are fundamental in the study of electricity and magnetism and have wide-ranging applications in various fields of science and technology.