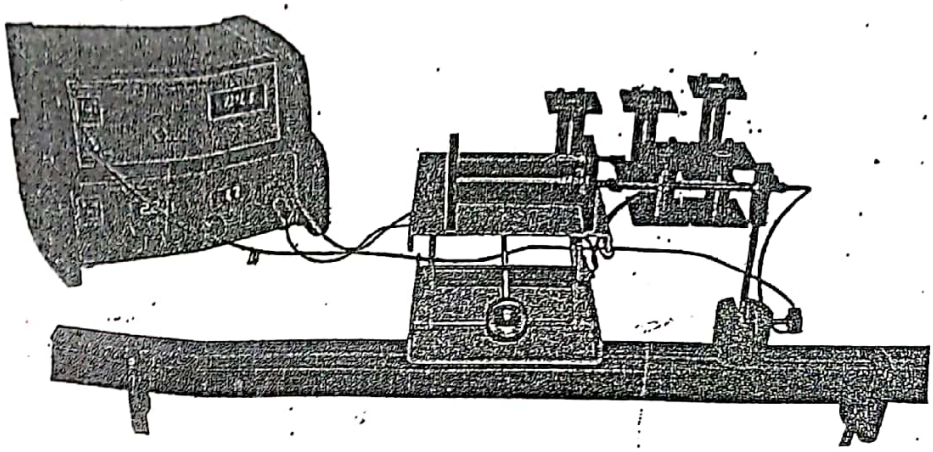
LABORATORY MANUAL FOR
MAGNETIC FIELD ALONG THE AXIS OF A COIL



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Aim: To study the variation of magnetic field with distance along the axis of a circular current carrying coil.

Apparatus: DC Power supply, Gauss meter with axial probe, probe holder, multimeter, connecting leads, coil, meter ruler, clamps and holders

Theory: The intensity of magnetic field at a point on the axis of a circular coil of radius a having n turns, at a distance x from the center of the coil is given by

$$B = \frac{\mu_0}{4\pi} \frac{2\pi n I a^2}{(a^2 + x^2)^{3/2}}$$

where I is the current in amperes flowing through the coil. For a solenoid of finite length, the magnetic field at the center of the coil is given by

$$B = \frac{\mu_0 n I}{2l}(\cos\alpha - \cos\beta),$$

where angles α and β are shown in fig. 1.

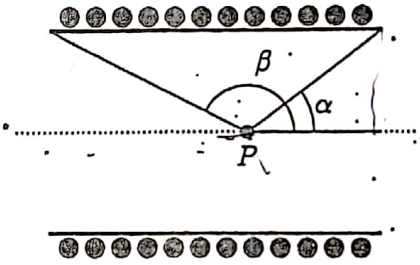

Figure 1: Magnetic field inside a solenoid.

Procedure: The experimental set-up used for the experiment is shown in fig. 2.

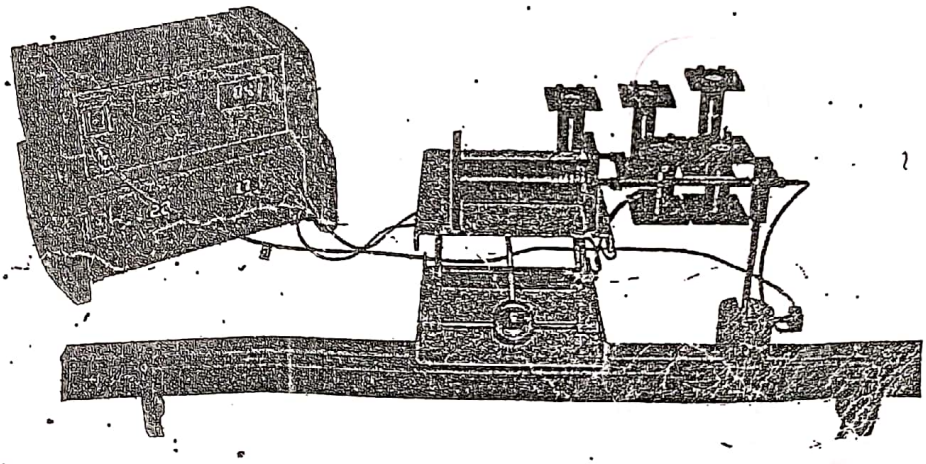

Figure 2: The experimental set-up used in the experiment.

1. Connect the power supply to the coil.
2. Set up the gaussmeter and the sensor.
3. Arrange the set-up as shown in fig. 2.
4. Place the coil on the laboratory jack at around the center of the wooden scale.
5. Insert the axial probe inside the coil.
6. Switch ON the power supply and set the current to an appropriate value ($\sim$ 1 A).
7. Measure the magnetic field at various positions of the axial probe.
8. To eliminate the asymmetry in the experimental set-up, reverse the current and again measure the magnetic field. The result is given by the average of the measured values.
9. Position of maximum magnetic field should be taken as the $x = 0$ position.
10. Repeat these steps by changing the coil with different length, diameter and turns.
11. Plot a graph between the position of the axial probe and the magnetic field for all the measurements; a sample graph is shown in fig. 3.

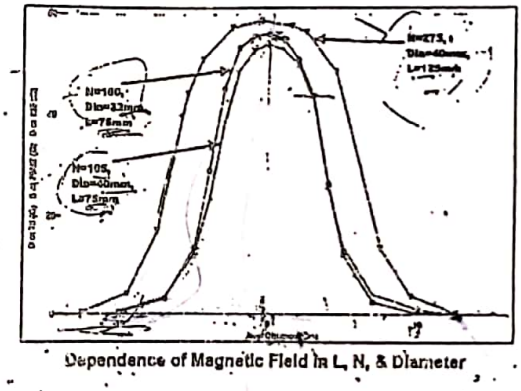

Figure 3: A graph between magnetic field and axial distance.

Observations:

Specifications of the coil:

1. Number of turns = ...
2. Length = ...

Current in the coil, I = ...

Axial probe reading for maximum magnetic field (x_0) = ...

S. No.	Position of axial probe x' (cm)	Magnetic field (Gauss)	$x = x' - x_0$ (cm)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

1. Repeat above measurements for different coils with different length, diameter and number of turns.

2. Draw graphs between x and magnetic field for various coils.

~~Results: From graph following changes are observed with change in~~

~~1. Length of the coil:~~ . . . . . .

~~2. Diameter of the coil:~~ . . . . . .

~~3. No. of turns in the coil:~~ . . . . . .

Precautions:

1. The current in the coil should not be increased beyond the maximum current ratings for the coil. It is safe not to increase the current beyond 1 A.

2. It should be ensured that the axial probe is along the axis of the of the coil while measuring magnetic field.

3. Readings around the maximum of magnetic field should be taken carefully to determine the center of the coil.

Result :- Mag. field is maximum at the center of coil & decreases as we move away from the center, towards the edges.