EXPERIMENT – 2

Stewart and Gee experiment

Aim of the experiment: To setup the Stewart and Gee arrangement and determine the profile of axial magnetic field due to a circular coil carrying current.

Equipment, apparatus, devices required: Stewart and Gee setup consisting of a circular coil mounted on a stand with a rail passing axially for a tangent magnetometer, DC power supply 6V 500mA, 50Ω 1A Rheostat, 1A Ammeter, connecting wires.

Principle: Using Biot-Savart's law the axial magnetic field due to a current carrying coil can be determined to be

$$B_x = \frac{\mu_0}{4\pi} \frac{Ia}{(x^2 + a^2)^{3/2}} 2\pi a$$

for a coil with N turns

$$B_x = \frac{\mu_0}{2} \frac{NIa^2}{(x^2 + a^2)^{3/2}}$$

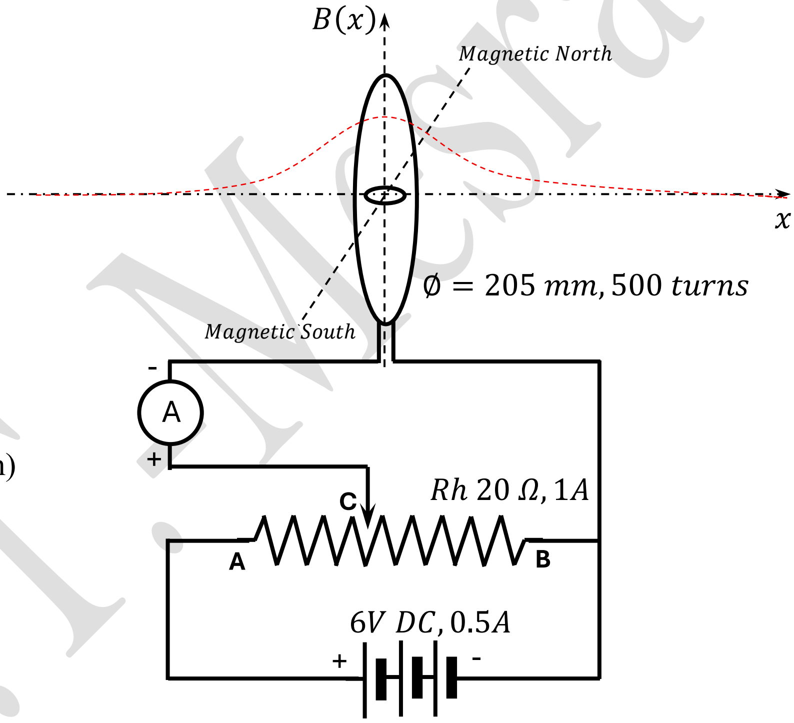
Magnetic field at the center of the coil is given by

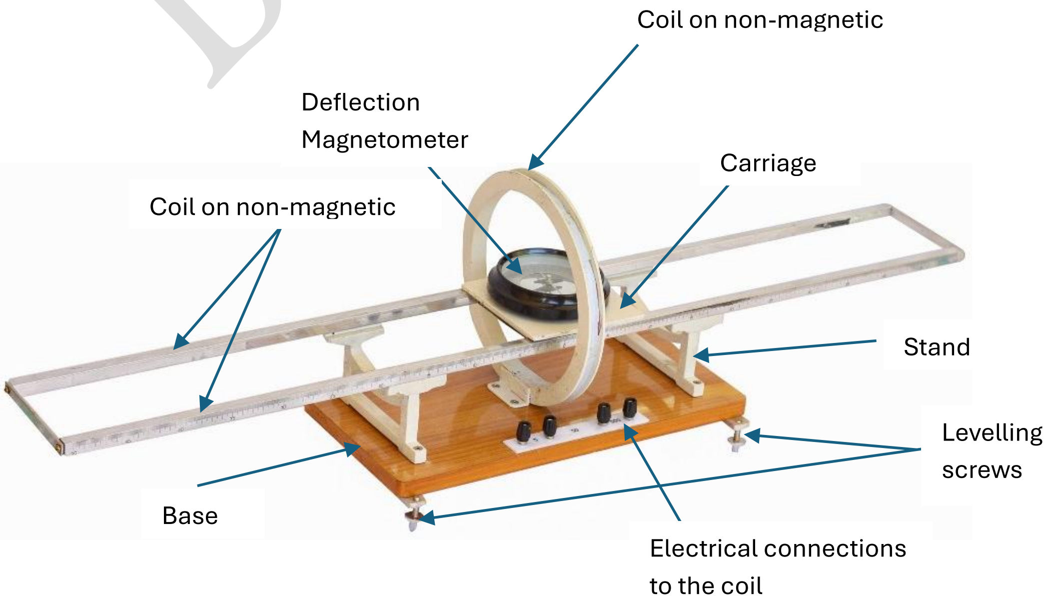
$$B_{x_0} = \frac{\mu_0}{2} \frac{NI}{a}$$

Using tangent law (in magnetism)

$B = B_H \tan\theta$

the axial component of the magnetic field can be experimentally determined.





Procedure and precautions:

1. Place the Stewart and Gee instrument at a location away from magnetic materials. Avoid having cell phones, keys, etc., in your pocket as they too may adversely affect your experiment.
2. Measure the radius of the coil using Vernier callipers.
3. Place the magnetometer on the carriage of the rails at the centre of the coil.
4. Rotate the instrument on the table surface to and align the plane of the coil with the magnetic meridian. This can be done with the help of magnetic needle of the magnetometer.
5. Ensure that the instrument is properly levelled in this position with the help of a spirit level. Also ensure that all its legs (adjustable or fixed) are firmly touch the table surface and the instrument does not shake.
6. Rotate the magnetometer dial such that the aluminum pointer reads 'zero'.
7. Wire a circuit according to the diagram in fig-1.
8. Adjust the current with the help of the rheostat to have a nominal deflection (≤65°) in the magnetometer. For this, barely 20 to 30 mA of current should be enough.
9. Gently push the magnetometer to one end of the rail and record the pointer deflection with the position of the magnetometer. Repeat this for all positions of magnetometer on the rails. Read both ends of the pointer from a position to avoid parallax and then take the mean.
10. Populate the observation table by recording and calculating relevant data and then plot $B(x)$ vs x.

Observations:

Absolute magnetic permeability of free space, $\mu_0 = 4\pi \times 10^{-7}\ Hm^{-1}$

The **horizontal component** B_H for **Ranchi** is about **37,000–38,000 nT**.

(1 Gauss = 10^5 nT)

Horizontal component of the earth's magnetic field = 370 to 380 mG

Total number of turns in the coil = 500

Radius of the coil = 205 mm

I = _________________ (mA)

Table-1: Readings for the deflection angle versus axial position

x (cm)	θ_1 (deg)	θ_2 (deg)	Mean θ (deg)	$tan\theta$	$B(x) = B_H\ tan\theta$ $(gauss)$
-50					
...					
...					
...					
+50					

Calculations:

$$B_{x_0} = B_H \, tan\theta$$

$$B_{x_0} = \frac{\mu_0}{2} \frac{NI}{a}$$

Results and Discussion:

A plot of B(x) against x may be plotted to show that the profile of axial magnetic field obtained experimentally using the Stewart and Gee setup is in fair agreement with the