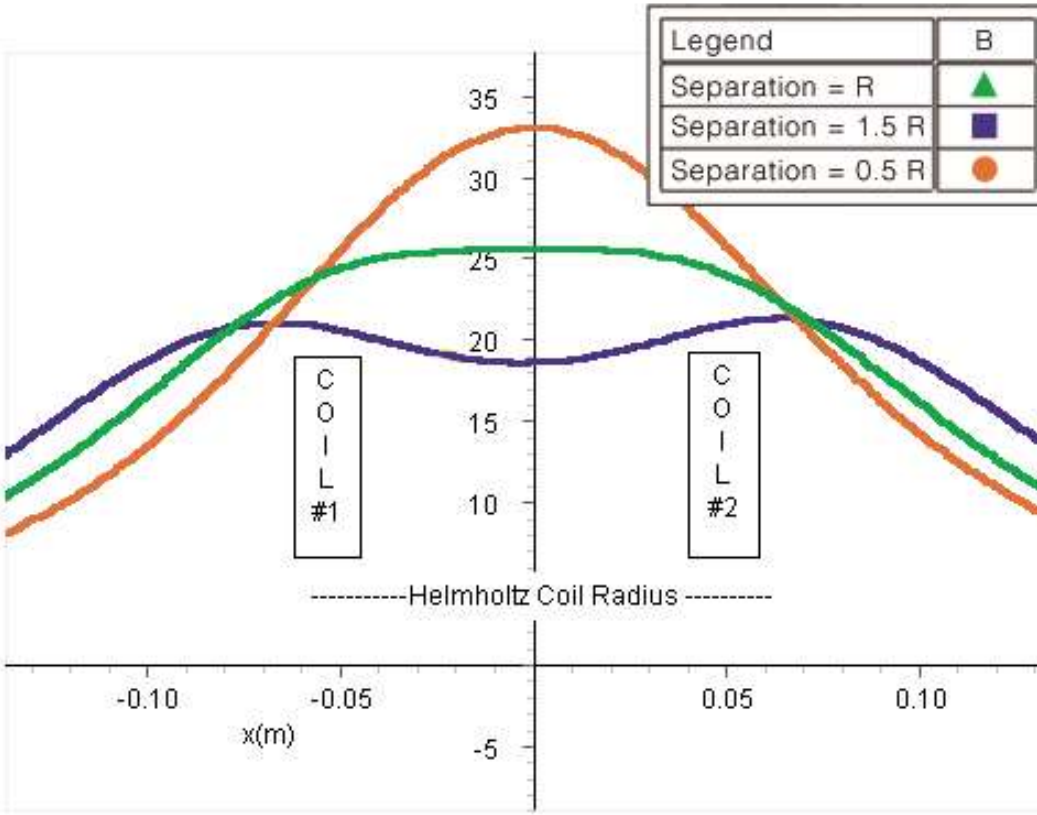
Engineering Physics, FIC 102

Helmholtz Coil



Aim:

To study

- the magnetic field variation along the axis of Helmholtz coil.
- magnetic field along the axis of the circular coils, when the distance between them $a = R$, $a=2R$, $a=R/2$ (R=radius of the coils).

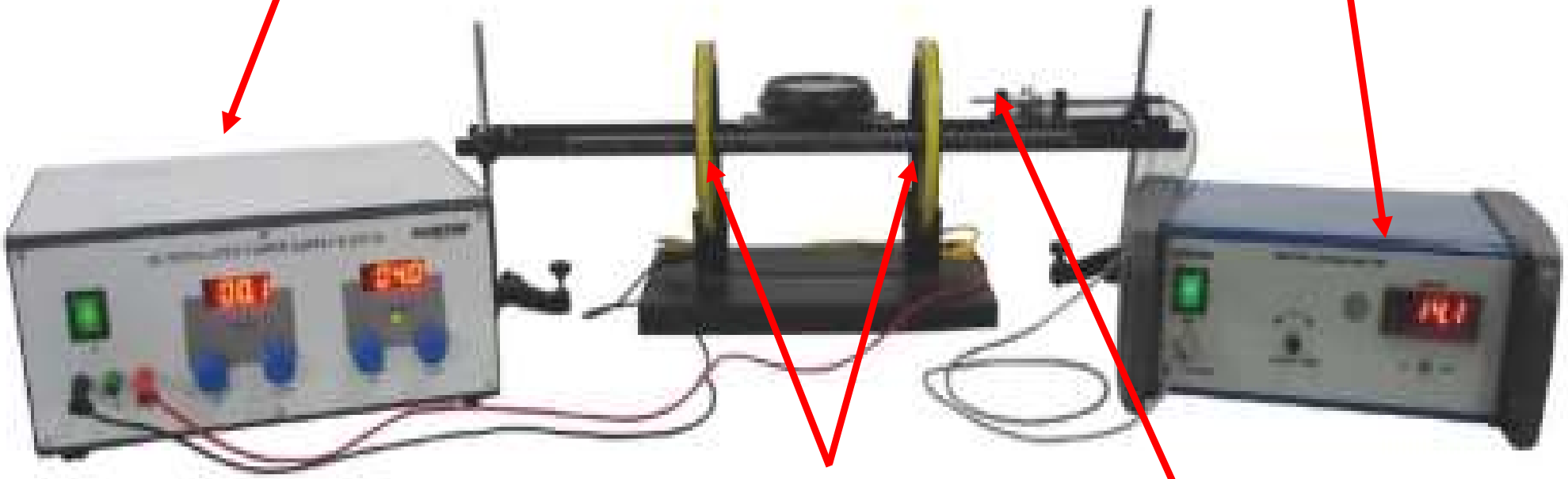
Apparatus:-

- Power supply DC 0-20v, (5Amp)
- Digital Gauss meter with Axial probe.
- Coils -2.
- Support base rod.
- Connecting wires.

Set-up

Gaussmeter
(measures Magnetic field, B)
B ~ 1500 Gauss

Digital power supply



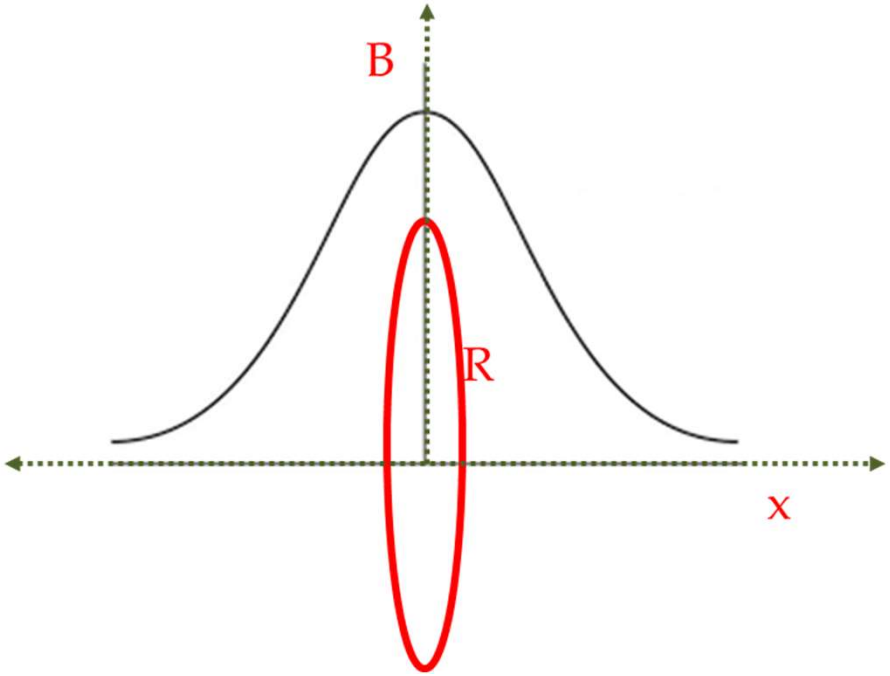
Helmholtz Coil

Axial Hall probe

Voltage

Theory

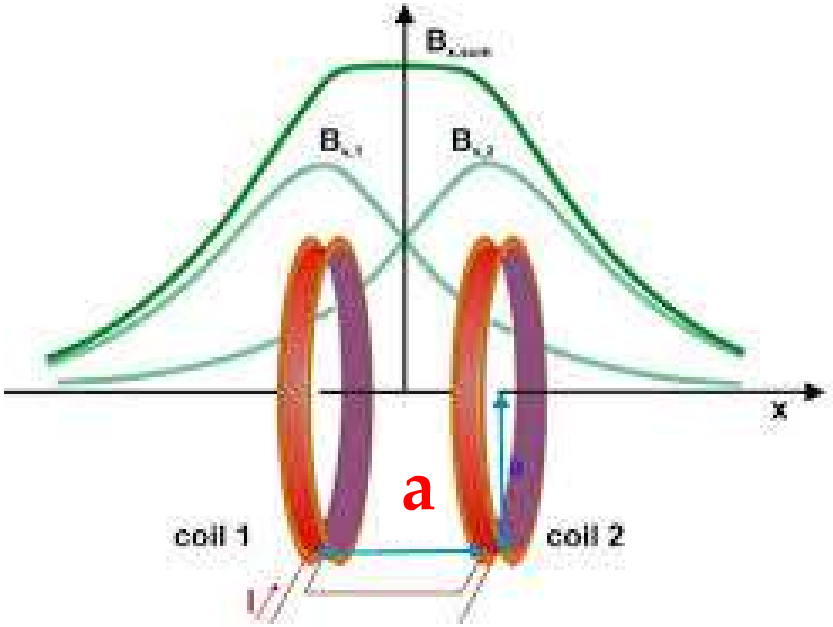
Biot-Savart Law exp



Single current carrying loop

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

Helmholtz Coil exp

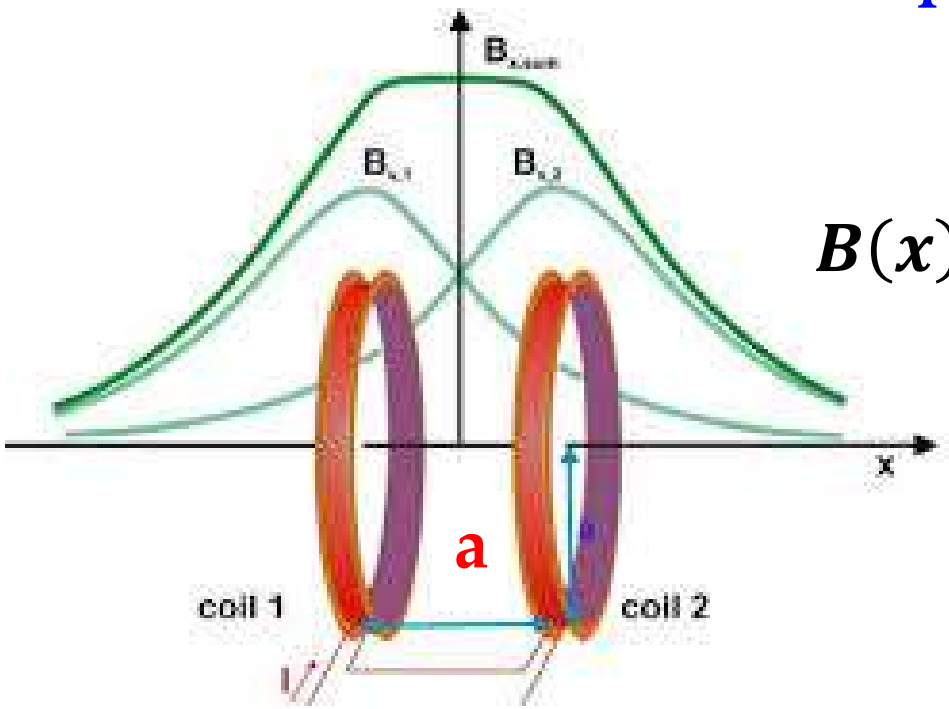


Two loops carrying current in the **same direction**

$$\boldsymbol{B(x) = \frac{\mu_0 NI}{2R} \cdot \left(\frac{1}{(1+A_1^2)^{3/2}} + \frac{1}{(1+A_2^2)^{3/2}} \right)}$$

$$A_1 = \frac{x + \frac{a}{2}}{R}, A_2 = \frac{x - \frac{a}{2}}{R}$$

Theory



$$\boldsymbol{B(x) = \frac{\mu_0 NI}{2R} \cdot \left(\frac{1}{(1+A_1^2)^{3/2}} + \frac{1}{(1+A_2^2)^{3/2}} \right)}$$

where, $A_1 = \frac{x+\frac{a}{2}}{R}$, $A_2 = \frac{x-\frac{a}{2}}{R}$

I= Current

N: No of turns

R: Radius of the coil

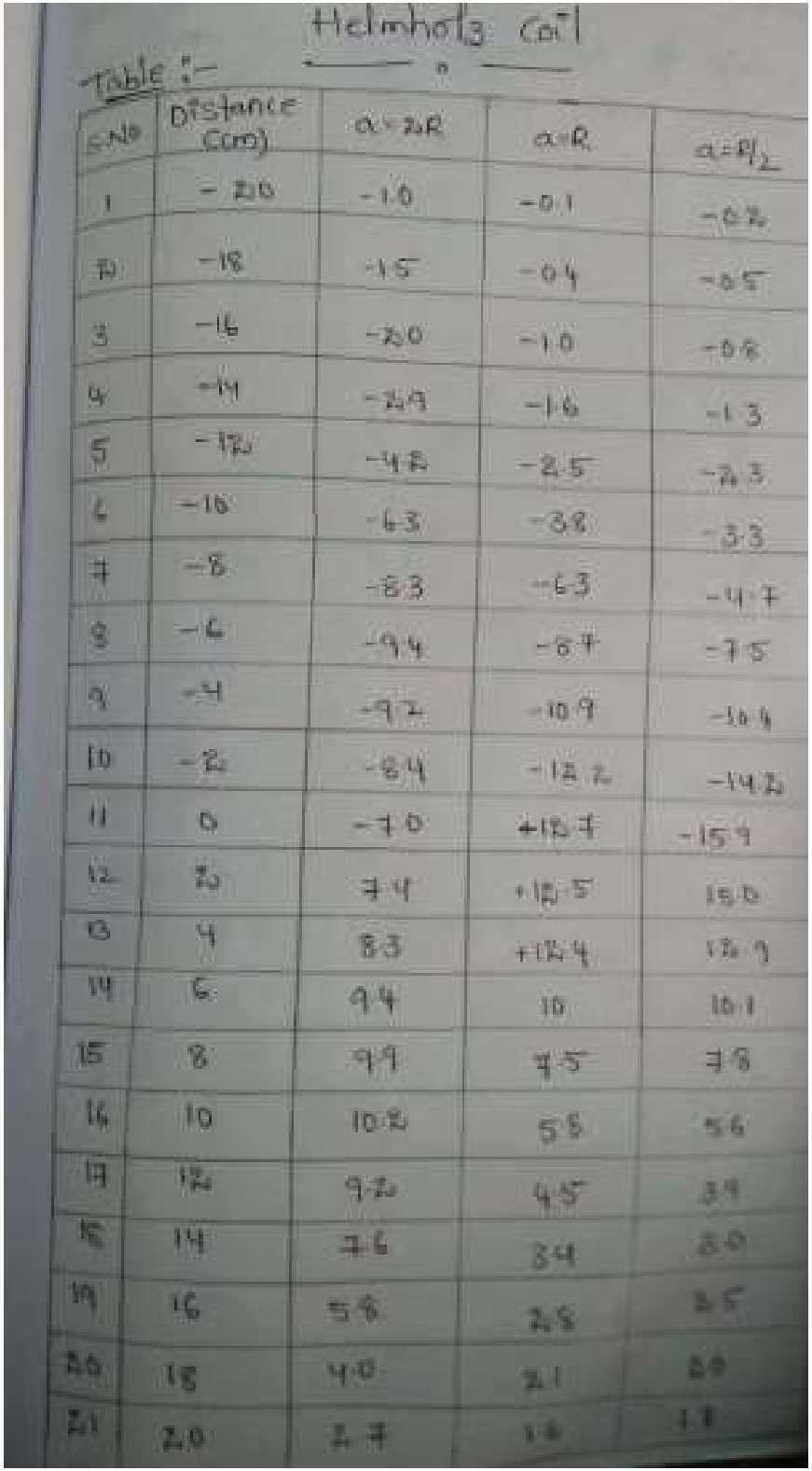
x: distance between the reference point from the centre between the coils

a: distance between the two coils

Experimental Data

Distance	x(cm)	B at $a=R/2$ (Gauss)	B at $a=R$ (Gauss)	B at $a=2R$ (Gauss)
0	-20			
2	-			
4	-2			
-	0			
-	2			
38	-			
40	20			

Experimental Data

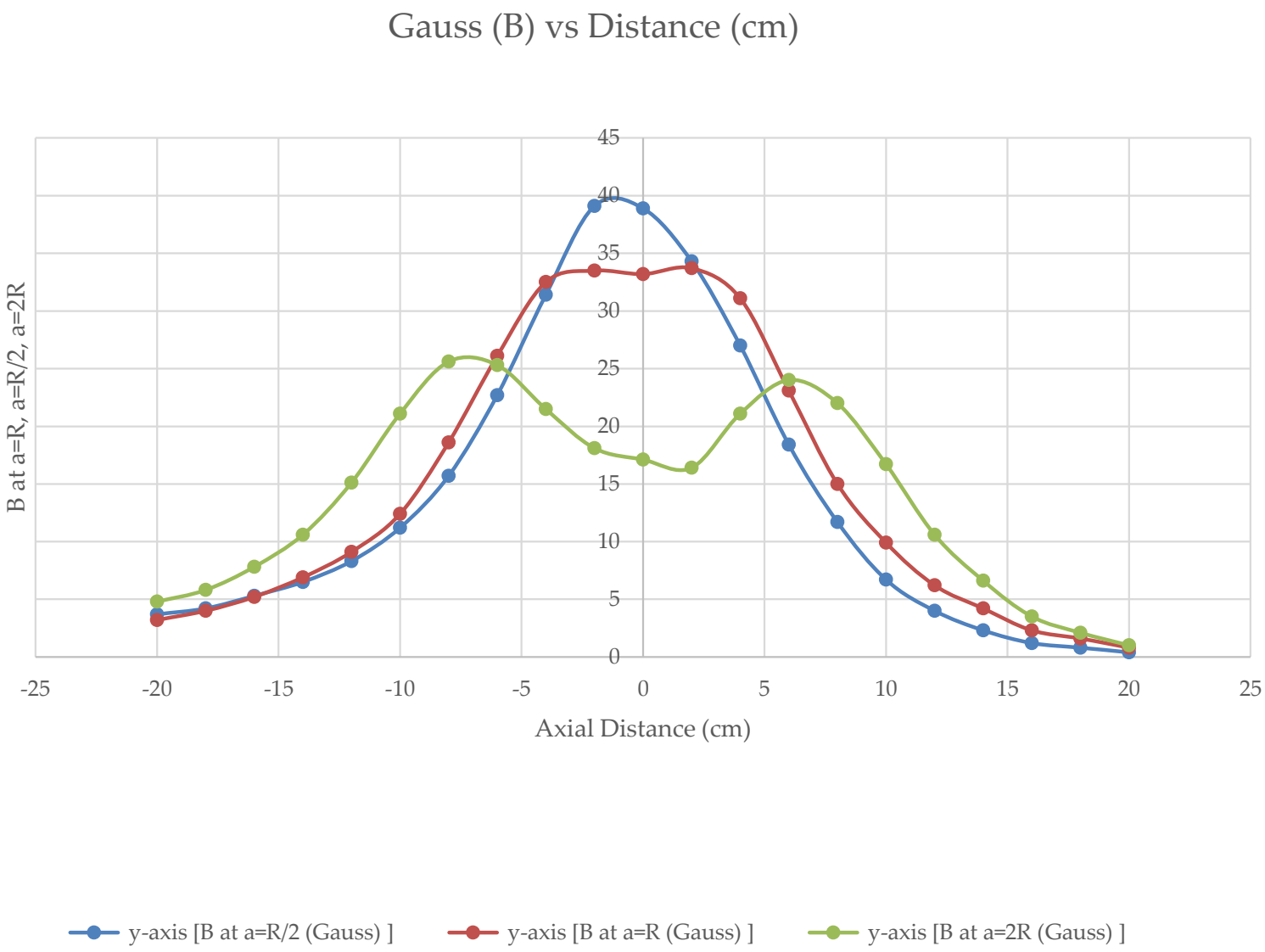


Helmholtz Coil

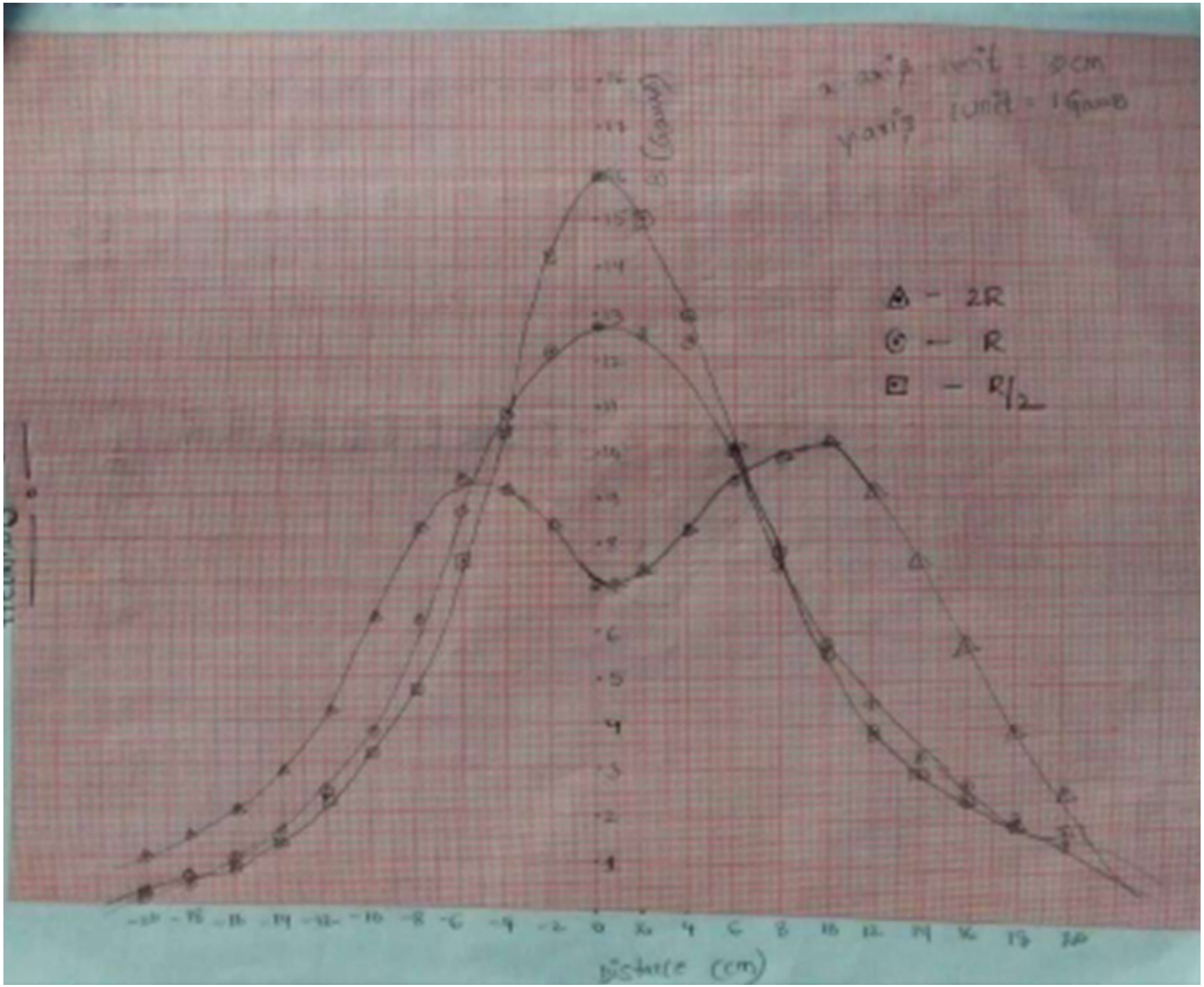
Table :-

S.No	Distance (cm)	a=2R	a=R	a=R/2
1	-20	-10	-0.1	-0.2
2	-18	-15	-0.4	-0.5
3	-16	-20	-1.0	-0.6
4	-14	-2.9	-1.6	-1.3
5	-12	-4.2	-2.5	-2.3
6	-10	-6.3	-3.8	-3.3
7	-8	-8.3	-6.3	-4.7
8	-6	-9.4	-8.7	-7.5
9	-4	-9.2	-10.9	-10.4
10	-2	-8.4	-12.2	-14.2
11	0	-7.0	+12.7	-15.9
12	2	7.4	+12.5	15.0
13	4	8.3	+12.4	12.9
14	6	9.4	10	10.1
15	8	9.9	7.5	7.8
16	10	10.2	5.8	5.6
17	12	9.2	4.5	3.9
18	14	7.6	3.4	3.0
19	16	5.8	2.8	2.5
20	18	4.0	2.1	2.0
21	20	2.7	1.6	1.8

Model graph


Gauss (B) vs Distance (cm)
B at a=R, a=R/2, a=2R
45
40
35
30
25
20
15
10
5
0
-25
-20
-15
-10
-5
0
5
10
15
20
25
Axial Distance (cm)
y-axis [B at a=R/2 (Gauss)]
y-axis [B at a=R (Gauss)]
y-axis [B at a=2R (Gauss)]

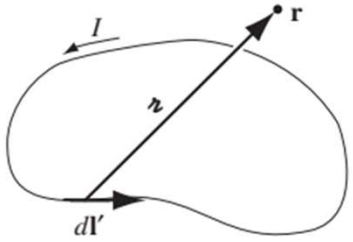
Graph



VIVA Questions

VIVA QUESTIONS:

1. What is Biot-Savart's law?



$$\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi} I \int \frac{d\vec{l'} \times \hat{\imath}}{\imath^2}$$

2. What do you mean by Helmholtz coil? Pair of two identical set of coils with current flowing in the same direction
3. How do you construct a Helmholtz coil? consists of two identical circular magnetic coils that are placed symmetrically.
4. What are the advantages of Helmholtz coil over the other coils in the experiments? In Biot-Savart law, the coil does not produce a uniform magnetic. Helmholtz coil is a device for producing a region of nearly uniform magnetic field.
5. How does the field along the axis of a coil vary? See model graph and exp data
6. Define the principle of superposition. In linear systems, the net response caused by two or more stimuli is the sum of the responses that would have been caused by each stimulus individually.

VIVA QUESTIONS:

7. What is the relation between Gauss and Tesla? 1 T = 10^4 Gauss
8. How does the region of uniform magnetic field vary with the radius of the Helmholtz coils? See the theory
9. What are the applications of Helmholtz coil?
    a. Creating a uniform magnetic field
    b. Measuring unknown field of a bar magnet