T.C.
GEBZE TECHNICAL UNIVERSITY
PHYSICS DEPARTMENT

PHYSICS LABORATORY II
EXPERIMENT REPORT

THE NAME OF THE EXPERIMENT

Magnetic Fields of Single Coils/Biot-Savart Law

PREPARED BY

NAME AND SURNAME :

STUDENT NUMBER :

DEPARTMENT :

GROUP NO :

TEACHING ASSISTANT :

DATE OF THE EXPERIMENT : ….. / ….. / ……….

DATE : ….. / ….. / ……….

Equipment:

- Vernier Magnetic Field Sensor
- TeslaMeter
- Optical Bench
- Circular Loop of Wires;

  - *N=1; Ø = 122 mm, 86 mm and 60 mm,*
  - *N=2; Ø = 122 mm, 86 mm and 60 mm,*
  - *N=3; Ø = 122 mm, 86 mm and 60 mm,*

where *N* is the number of turns and *Ø* is the diameter (=2r).

- Sensor Holder
- Loop holder
- DC power supply
- Connection cables

Experiment Set:

Before starting, please check the rings, power supply, magnetic field sensor, and connection cables with the help of Figure 1.

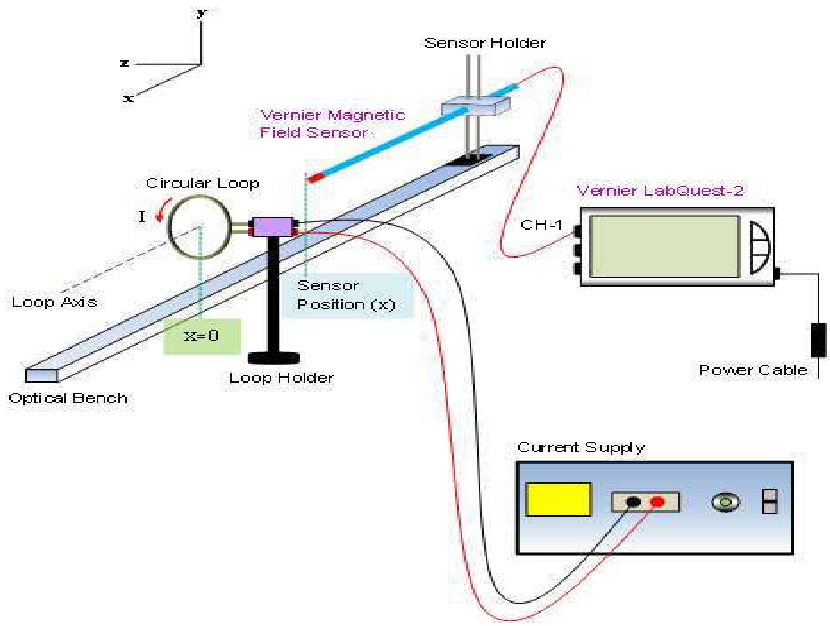

***Figure 1**. Experimental Set-up for current-carrying loops.*

Experimental Procedure:

A - For magnetic field *B* and radius r relationship:

1. Reset the Tesla meter after switching it on.
2. Hang the desired circular ring on the loop holder (according to Tables 1, 2, and 3).
3. Locate the magnetic field sensor at the center of the rings.
4. Set the measurement settings to reach the values of current in the table.
5. Measure the magnetic field and fill the Tables given below.

Please <u>turn off</u> the power supply when you make changes on the experimental set-up.

Table 1. *Magnetic field values for the rings with number of loops of 1.*

N = 1	***Ø (mm)***	***I (A)***	***B (mT)***
	60	2	
	86	2	
	122	2	

Table 2*. Magnetic field values for the rings with number of loops of 2.*

N = 2	***Ø (mm)***	***I (A)***	***B (mT)***
	60	2	
	86	2	
	122	2	

Table 3. *Magnetic field values for the rings with number of loops of 3.*

N = 3	***Ø (mm)***	***I (A)***	***B (mT)***
	60	2	
	86	2	
	122	2	

Plot magnetic field B (y-axis) vs. $\frac{1}{2r}$ (x-axis) graph for each N according to Table 1,2.,3
Indicate each N either with ***a different colored line or a distinct symbol***.

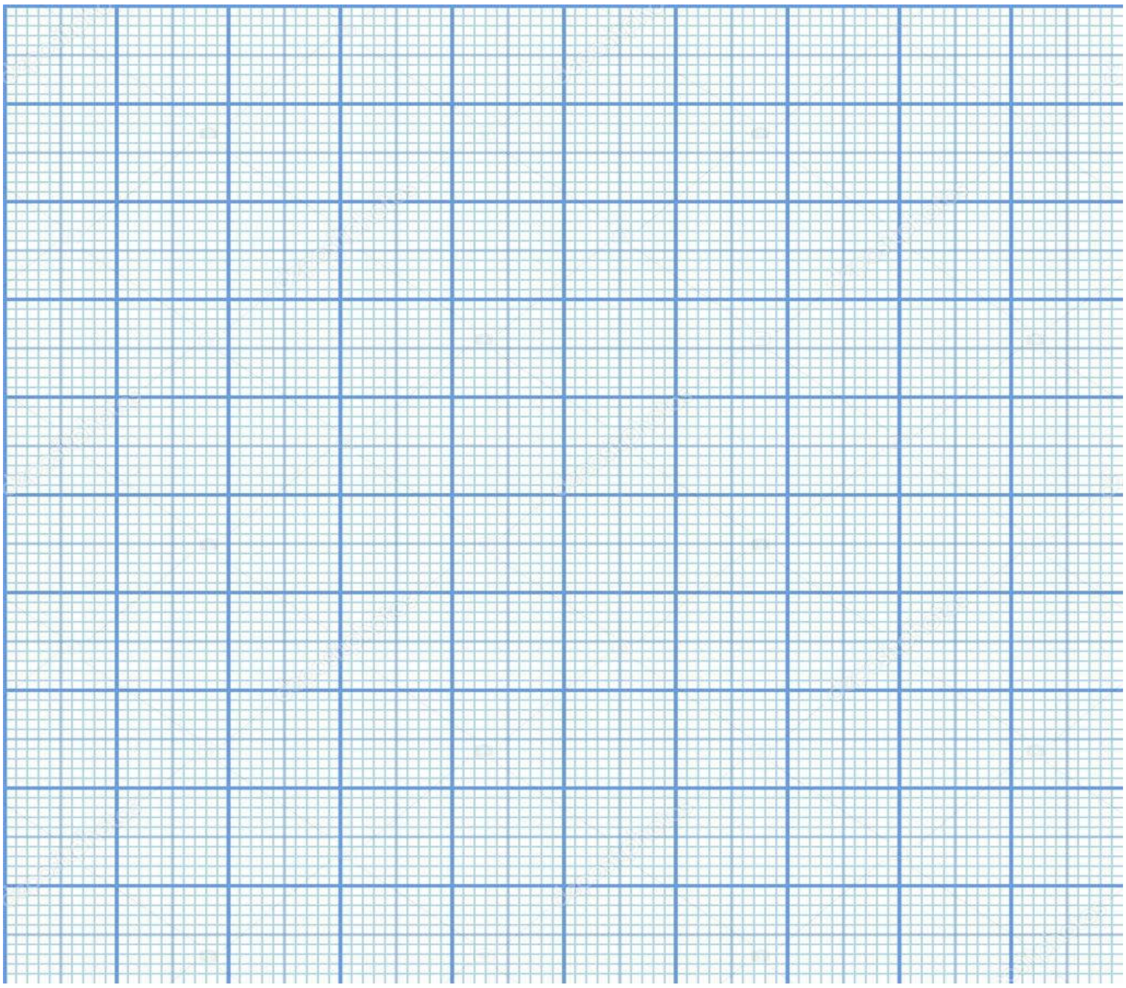

***Figure 2**. $B - \frac{1}{2r}$ graph.*

For Ø ($60\ mm$) $\frac{1}{2r} =$

For Ø ($86\ mm$) $\frac{1}{2r} =$

For Ø ($122\ mm$) $\frac{1}{2r} =$

Signature:

Calculate the slopes m of the lines that fit the data points on your B vs. $\frac{1}{2r}$ graphs, which are plotted in the previous step. In the following formulae, the x_i 's represent $\frac{1}{2r}$ while the y_i's represent the magnetic field B. n is the number of data used in calculations.

Write down the intermediate steps.

For $\mathrm{N} = 1$,

$$\sum_{i=1}^{n} x_i y_i =$$

$$m\ (\mathrm{N} = 1) = \frac{\sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2} =$$

$$\sum_{i=1}^{n} x_i^2 =$$

For $\mathrm{N} = 2$

$$\sum_{i=1}^{n} x_i y_i =$$

$$m\ (\mathrm{N} = 2) = \frac{\sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2} =$$

$$\sum_{i=1}^{n} x_i^2 =$$

For $\mathrm{N} = 3$,

$$\sum_{i=1}^{n} x_i y_i =$$

$$m\ (\mathrm{N} = 3) = \frac{\sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2} =$$

$$\sum_{i=1}^{n} x_i^2 =$$

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In Eq. (6), $B = \frac{\mu_0 I}{2r} N$ can write transformation $m = \frac{B}{\left(\frac{1}{2r}\right)} = \mu_0 IN$. The slope of the $B - \frac{1}{2r}$ graph gives $m = \mu_0 IN$.

Thus, please calculate the experimental μ_0 by using the equation $m = \mu_0 IN$ and find the percent errors. In theory, $\boldsymbol{\mu_0} \approx \boldsymbol{4.\pi\, 10^{-7} \frac{H}{m}} = \boldsymbol{4.\pi\, 10^{-7} \frac{(T.m^2)/A}{m}} = \boldsymbol{1.256\, 10^{-6} \frac{T.m}{A}}$ is the magnetic permeability of free space. Write down the intermediate steps.

μ_{exp} (N = 1) :

%error =

μ_{exp} (N = 2) :

%error =

μ_{exp} (N = 3) :

%error =

1) Please explain the theoretical background of the effect of the Loop's radius and the number of turns on the magnetic field.

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B -For magnetic field *B* and current *I* relationship:

1. Reset the Teslameter after switching on.
2. Hang the desired circular ring on the loop holder (according to Table 4).
3. Locate the magnetic field sensor at the center of the rings.
4. Turn on the power supply and set it to the current values given in Table 4).
5. Measure the magnetic field and fill Table 4.

Please <u>turn off</u> the power supply when you make changes on the experimental set-up.

Table 4. *Magnetic field values as a function of current change.*

N=1, Ø=86 mm	***I (A)***	***B (mT)***
	1	
	2	
	3	
	4	
N=2, Ø=86 mm	***I (A)***	***B (mT)***
	1	
	2	
	3	
	4	
N=3, Ø=86 mm	***I (A)***	***B (mT)***
	1	
	2	
	3	
	4	

Signature:

Plot magnetic field *B* (y-axis) vs. current *I* (x-axis) graph for each N according to Table4. Indicate each N either with *a different colored line or a distinct symbol*.

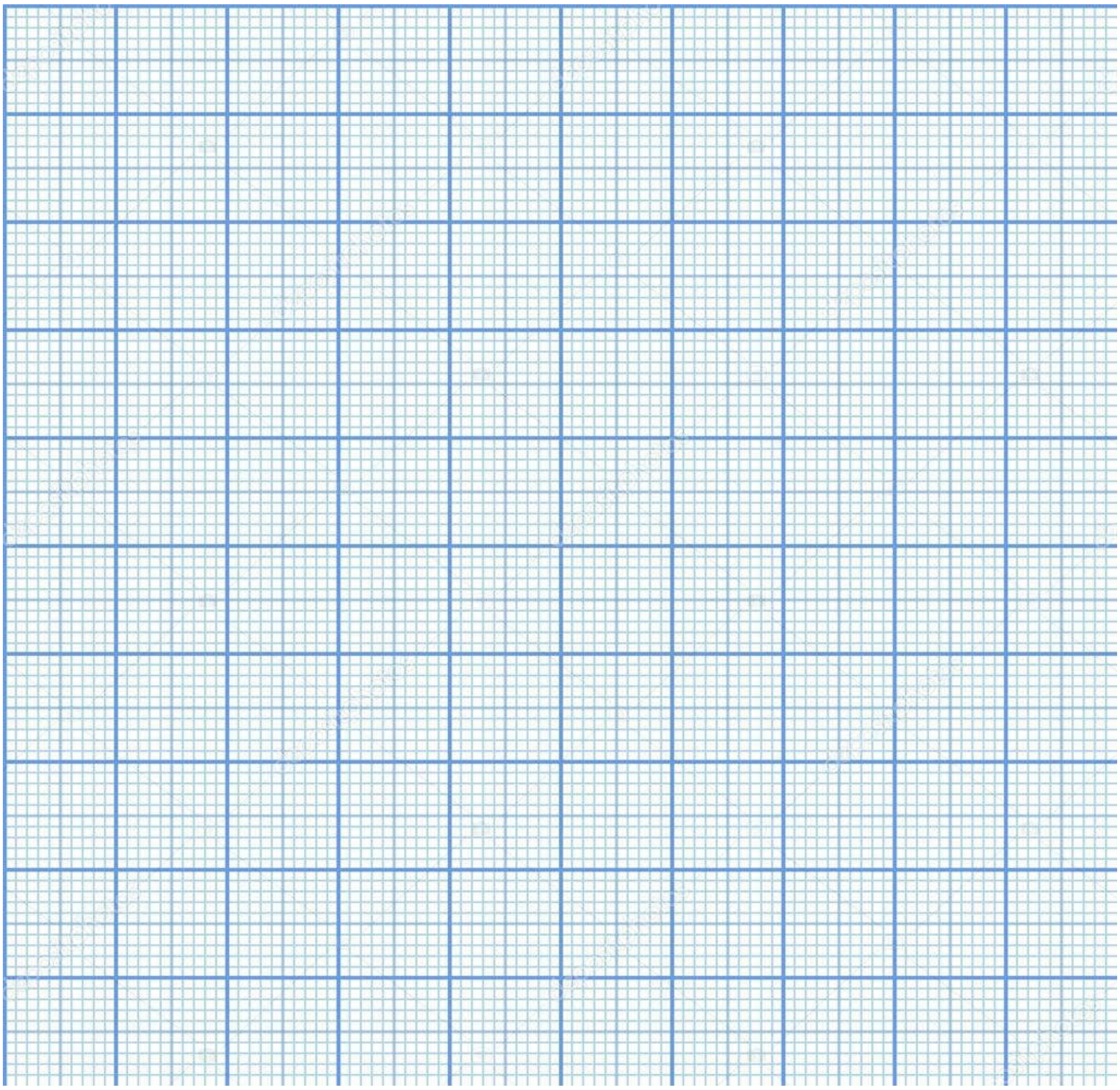

***Figure 3**. B vs. I graph.*

Equation $B = \frac{\mu_0 I}{2r} N$ can write transformation $\mathrm{m} = \frac{\mathrm{B}}{\mathrm{I}} = \frac{\mu_0 \mathrm{N}}{2\mathrm{r}}$.

The slope of the $B - I$ graph gives $m = \frac{\mu_0 \mathrm{N}}{2\mathrm{r}}$.

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Calculate the slopes m of the lines that fit the data points on your *B* vs. *I* graphs, which are plotted in the previous step. In the following formulae, the x_i 's represent the current *I* while the y_i's represent the magnetic field B. n is the number of data used in calculations.

Write down the <u>intermediate steps.</u>

For $\mathrm{N} = 1$,

$$\sum_{i=1}^{n} x_i y_i =$$

$$m\ (\mathrm{N} = 1) = \frac{\sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2} =$$

$$\sum_{i=1}^{n} x_i^2 =$$

For $\mathrm{N} = 2$

$$\sum_{i=1}^{n} x_i y_i =$$

$$m\ (\mathrm{N} = 2) = \frac{\sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2} =$$

$$\sum_{i=1}^{n} x_i^2 =$$

For $\mathrm{N} = 3$,

$$\sum_{i=1}^{n} x_i y_i =$$

$$m\ (\mathrm{N} = 3) = \frac{\sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2} =$$

$$\sum_{i=1}^{n} x_i^2 =$$

Signature:

Thus, please calculate the experimental μ_0 by using the $m = \frac{\mu_0 N}{2r}$ equation and find the percent errors. , $\boldsymbol{\mu_0} \approx \boldsymbol{4.\pi\ 10^{-7}\frac{H}{m}} = \boldsymbol{4.\pi\ 10^{-7}\frac{(T.m^2)/A}{m}} = \boldsymbol{1.256\ 10^{-6}\frac{T.m}{A}}$ is the magnetic permeability of free space. Write down the <u>intermediate steps.</u>

μ_{exp} (N = 1) : %error =

μ_{exp} (N = 2) : %error =

μ_{exp} (N = 3) : %error =

2) Are the calculated magnetic permeability μ_0 values equal? If not, explain why?

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Conclusion, Comment and Discussion:

(**Tips**: Give detail explanation about what you've learned in the experiment and also explain the possible errors and their reasons.)

-Give detail explanation about what you've learned in the experiment

-Explain the possible errors and their reasons in the experiment

Questions:

Q1. Write down the physical meaning of magnetic permeability μ_0, and find its derived units in terms of basic quantities of the SI system.

Signature:

Q2. Write down the definitions of magnetization (M), magnetic dipole moment (μ), magnetic flux (Φ), magnetic induction (magnetic flux density) (B) and magnetic field strength (H)?

Magnetization (*M*), …………………………………………………………………………………

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Magnetic dipole moment (*μ*), ………………………………………………………………………

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Magnetic Flux (*Φ*), …………………………………………………………………………………

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Magnetic induction (magnetic flux density) (*B*), ………………………………………………

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Magnetic field strength (*H*), ………………………………………………………………………

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Q3. Write down the units of the physical quantities that you defined in the previous question and find their derived units in terms of basic quantities of the SI system.

Magnetization (*M*), …………………………………………………………………………………

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Magnetic dipole moment (*μ*), ………………………………………………………………………

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Magnetic Flux (*Φ*), …………………………………………………………………………………

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Magnetic induction (magnetic flux density) (*B*), ………………………………………………

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Magnetic field strength (*H*), ………………………………………………………………………

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