MARMARA UNIVERSITY
FACULTY OF ENGINEERING

PHYS 1104

PHYSICS LABORATORY II

Magnetic Field Of Solenids

Section:
Group:
Instructure: Date:

	Department	Student Id Number	Name & Surname
1			
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1 Purpose

To measure the magnetic flux density along the axis of a solenoid with the Hall probe and to determine the magnetic permeability of the air μ_0 experimentally.

2 Theory

From Ampere's Law, the magnetic flux N turn solenoid in free space is

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 NI \tag{1}$$

$$B = \frac{\mu_0 NI}{L} \tag{2}$$

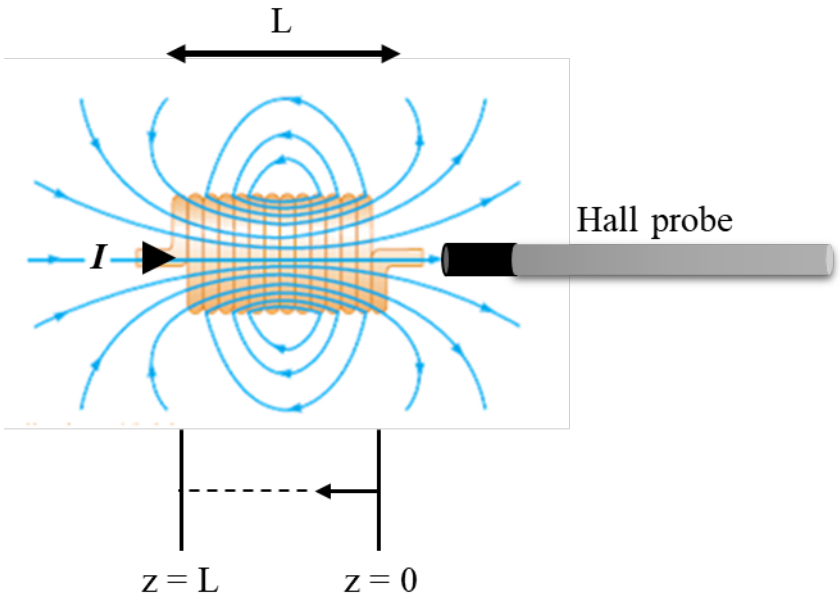

Figure 1: Magnetic field lines for a tightly wound solenoid of finite length with a Hall probe to measure the magnetic field intensity along the axis of z. The field in the interior space is strong and nearly uniform.

where L (m) is the length of a a solenoid, I (A) is the current flowing through the solenoid,, B (T) and μ_0 are the magnetic flux density and permeability of the free space respectively. The theoretical value of μ_0 is equal to 1.26x10^{-6} T.m/A.

Equation 2 is valid only for points near the center (that is far from the ends) of a very long solenoid. As a result, the magnetic field intensity is stable and higher at the center, smaller at the ends.

3 Experimental Setup

3.1 Equipment List

Equipments in order to use in this experiment:

1. circuit board x1
2. Digital Multi-Meter x1
3. Cables
4. Gaussmeter with DC Hall Probe x1
5. G-clamp x1
6. Right angle clamp x1
7. Support rod x1
8. Ruler x1
9. 100 turns solenoids (L=0,043m) x1
10. 200 turns solenoids (L=0,090m) x1
11. 200 turns solenoids (L=0,143m) x1

4 Procedure

PART 1

For N_1=100 turns solenoid

Set the experiment as shown in Figure 2a. Operate the power supply at 12 V as a constant current source of 0.5 A by adjusting the rheostat on the circuit board. Connect an ammeter in series to the circuit to see the value of current through the solenoid simultaneously.

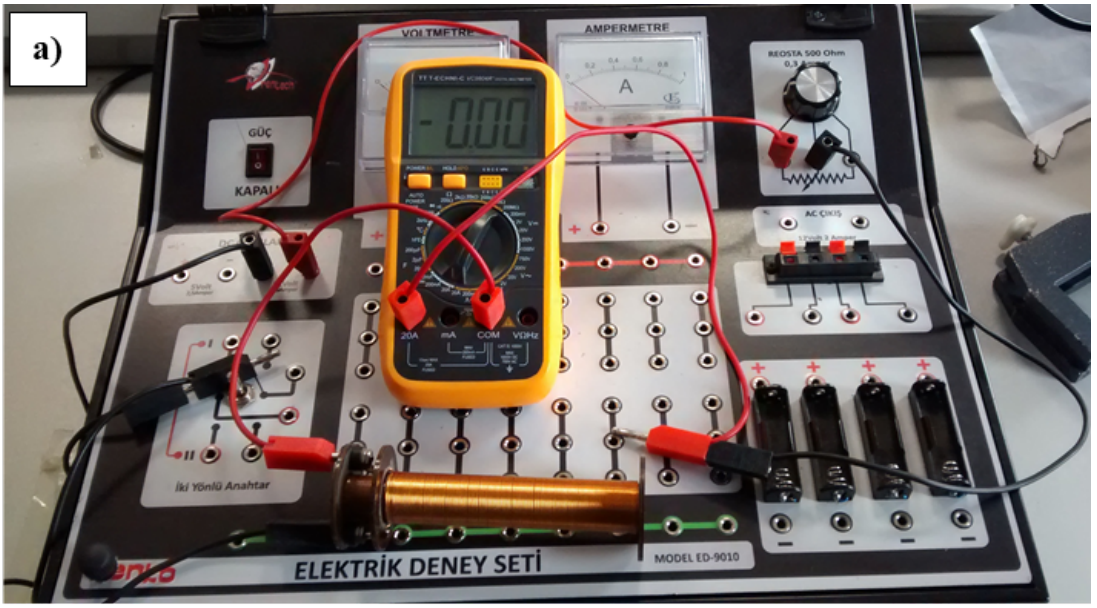

Figure 2: Setup for a) solenoid carrying the current of 0.5 A b) Hall probe.

Before the experiment, ***ensure that the ammeter is operated at 10A scale so plug the electrical cables in appropriate socket*** since the current flown through the circuit is 0.5 A. Support the Hall probe using the clamps, rod and ruler at the corner of the table as shown in Figure 2b. Before the measurement provide the digital display to show "0.00" mT by tuning the black button while the switch is at the position of 'SIFIRLAMA'. Then, change the switch into the position of

'ÖLÇME' to measure the magnetic field intensity along the axis of the solenoid.

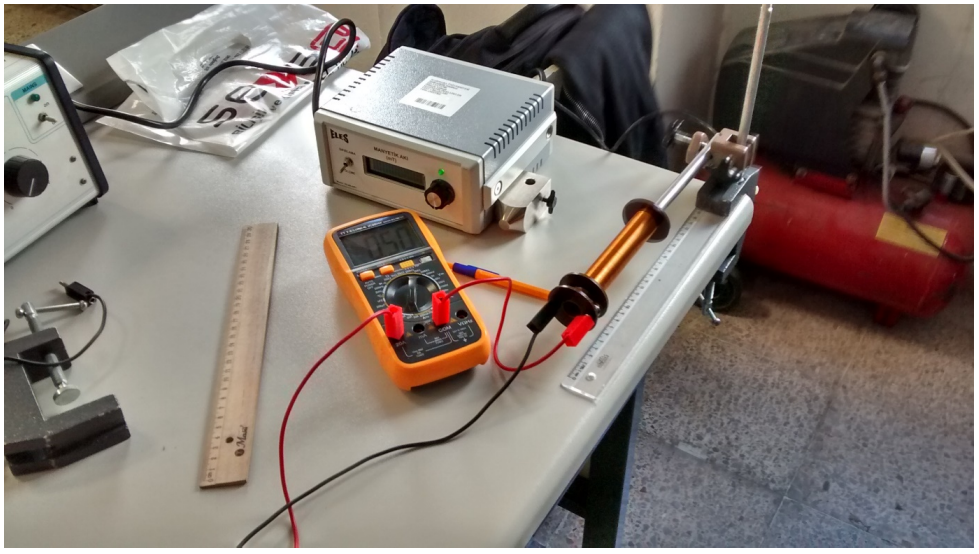

Figure 3: Setup for measurement of the magnetic field along the axis of the solenoid.

Before starting the measurement, make sure that the probe is aligned at the center of the cross section of the solenoid. Start the measurement at the entrance of the solenoid (z = 0, Figure 1) and move the solenoid to measure the magnetic field for each z values by the help of ruler.

Change the current to 1.0 A and measure the magnetic intensity

Record each measurement and fill in separate tables as seen in Table 1.

Table 1: B values along z-axis of the solenoid.

Z(cm)	B(z) mT
0	
1	
2	
3	
4	
.	
.	
N	

Plot z(cm) versus B(z) as listed in the Table 1.

After the measurement, get the value of B at the center of the solenoid which is the $z = \frac{L}{2}$ and calculate the experimental value of the μ_0 using Equation 2. Compare this result with the theoretical one with a percentage error analysis.

Experimental μ_0:.....T.m/A

Percentage error in μ_0:.....

Repeat the same procedure for solenoids of 200 and 300 turns respectively.

PART 2

At this part the relation between the current and the magnetic field intensity is investigated.

Built the experimental set up for 300 turns of solenoid same as the Part 1. Place the hall effect probe at the middle length of the solenoid. Adjust the current to 0A. The increase current value up to 1.0A in 10 steps. Record measured values to the Table 2.

Plot the current versus the magnetic intensity from Table 2. Obtain the equation of this plot using curve fitting to get the slop of the line. Calculate the magnetic permeability using the slop of the line and compare with the theoretical value.

Table 2: B values along current of the solenoid.

I(A)	B (mT)
0	
1	
2	
3	
4	
.	
.	
N	

Experimental μ_0:.....T.m/A

Percentage error in μ_0:.....