Date 6.7.21

Page

Home Assignment

1.) Ampere's Circuital law:

The line integral of magnetic field of induction $\vec{B}$ around any closed path is free space is equall to absolute permitibility of free space μ_0 times the total current flowing through area bounded by the path.

Mathematically, $\oint \vec{B} \cdot \vec{dl} = \mu_0 I$

Calculation of magnetic field inside a long straight solenoid:

According to Ampere's Circuital law,

$\int \vec{B} \cdot \vec{dl} = \mu_0 \times$ total current through the loop abcd

$$\int \vec{B} \cdot \vec{dl} = \int_a^b \vec{B} \cdot \vec{dl} + \int_c^d \vec{B} \cdot \vec{dl} + \int_d^a \vec{B} \cdot \vec{dl}$$

But $\int_b^c \vec{B} \cdot \vec{dl} = \int_b^c B\,dl \cos 90° = 0$

$\int_c^d \vec{B} \cdot \vec{dl} = 0$ as $B = 0$ for points outside the solenoid.

$$\therefore \int \vec{B} \cdot \vec{dl} = \int_a^b \vec{B} \cdot \vec{dl}$$

$$= \int_a^b B\,dl \cos 0° = B \int_a^b dl = Bl$$

Where,

l = length, $n = \frac{N}{l}$ (No. of turns per unit length)

$N = nl$ (Total no. of turns in length l)

Date
Page

Total current flowing = nl

Now, $\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{net} = \mu_0 n l I$

$\Rightarrow Bl = \mu_0 n l I$

$\Rightarrow B = \mu_0 n I$

2.) a) Same as 1) 2nd part.

b)
=> In a toroid, magnetic lines do not exist outside the body.
=> Toroid is lose whereas the solenoid is open on both side
=> Magnetic field is uniform inside a toroid, whereas for solenoid, it is different at the two ends and the center.

c) The magnetic field lines inside a given solenoid is made strong by:
=> Increasing the current.
=> using a soft ~~iron~~ iron
=> Increasing the no. of coils in the solenoid.

Q3) $n = 300$ turns/m $\quad I = 5A$, $l = 0.5m$

$B = \mu_0 n I$

$= 4\pi \times 10^{-7} \times 300 \times 5$

$= 18840 \times 10^{-6}$

$= 1.884 \times 10^{-2}$ T

Q.4 $l = 0.5\,m$

$N = 500$

Flux density $= 2.52 \times 10^{-3}\,T$

Find the current in the solenoid.

Given, $\mu_0 = 4\pi \times 10^{-7}\,Hm^{-1}$

$$B = \mu_0 n \cdot I$$

$$B = \frac{\mu_0 N I}{l}$$

$$2.25 \times 10^{-3} = \frac{4\pi \times 10^{-7} \times 500 \times I}{0.5}$$

$$I = \frac{0.5 \times 2.25 \times 10^{-3}}{4\pi \times 10^{-7} \times 500}$$

$$\therefore I = 1.79 \approx 1.8A.$$