Home Assignment

1. State Ampere's circuital law. Show through an example, how this law enables an easy evaluation of the magnetic field inside a very long solenoid having n turns per unit length carrying a current I.
2. Answer the following:
   a) Using Ampere's circuital law, obtain the expression for the magnetic field due to a long solenoid on its axis.
   b) In what respect, is a toroid different from a solenoid? Draw and compare the pattern of the magnetic field lines in the two cases.
   c) How is the magnetic field inside a given solenoid made strong?

Question 3 : A solenoid coil of 300 turns/m is carrying a current of 5A. The length of the solenoid is 0.5 m and has a radius of 1cm. Find the magnitude of the magnetic field inside the solenoid.

Question 4 : A 0.5 m long solenoid has 500 turns and has a flux density of $2.52 \times 10^{-3} T$ at the center. Find the current in the solenoid. Given $\mu_0 = 4\pi \times 10^{-7} Hm^{-1}$.

classmate

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1 The line Integral $\oint \vec{B} \cdot \vec{dl}$ for a closed curve is equal to μ_0 times the net current I threading through the area bounded by the curve.

let n be the no. of turns per unit length.
Total no. of turns = nh
Enclosed current (I_e) = I (nh)
From Amper's Circuit law
$BL = \mu_0 I_e$, $Bh = \mu_0 I(nh)$ $B = \mu_0 n I$

2 $n = 300$ turns/m
$I = 5A$
$B = \mu_0 n I$
$= 4\pi \times 10^{-7} \times 300 \times 5$
$= 1.9 \times 10^{-3}$ T

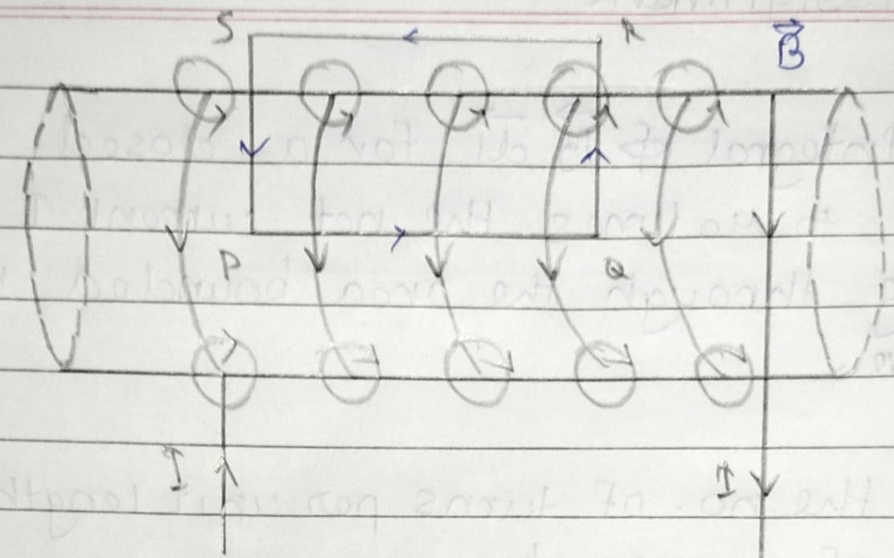
4 $n = \frac{N}{l} = \frac{500}{0.5} = 1000$ turns/m

As $B = \mu_0 n I$

$I = \frac{B}{\mu_0 n}$

$= \frac{2.52 \times 10^{-3}}{4\pi \times 10^{-7} \times 1000} = \underline{2 A}$

2 a



$$\oint \vec{B}\cdot\vec{dl} = \int_{PQ} \vec{B}\cdot\vec{dl} + \int_{QR} \vec{B}\cdot\vec{dl} + \int_{RS} \vec{B}\cdot\vec{dl} + \int_{SP} \vec{B}\cdot\vec{dl}$$

$$= \int B.dl\cos 0^\circ + \int B.dl\cos 90^\circ + \int B.dl\cos 0^\circ$$
$$+ \int B.dl \cos 90^\circ$$

→ The value of first term $\int_{PQ} B.dl = B.L$

→ The second term & Fourth term are zero because angle between magnetic field and the length loop is 90°

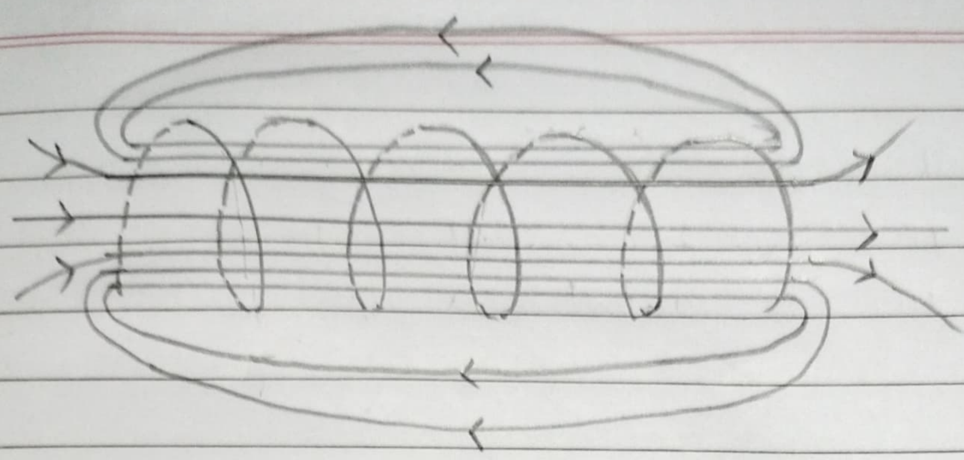
→ The third term is also zero as the value of magnetic field outside the Solenoid is 0.

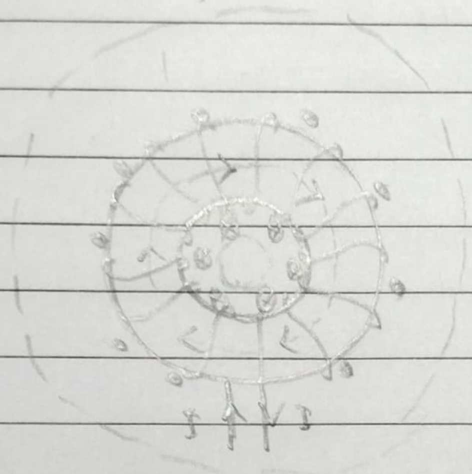
From Ampere's circuital law we get

$BL = \mu_0 (nLI)$

$\therefore B = \mu_0 nI$

b. A toroid is a solenoid bent into the form of a closed ring. The magnetic field lines of solenoid are straight line parallel to the axis inside the solenoid.





c The magnetic field can be increased by :-

→ Increasing the number of turns per unit length of the solenoid.

→ Using a laminated iron core inside a solenoid.

→ Increasing the current magnitude in a solenoid.