# Application of Ampere's Law

06.07.21 Home Assignment

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① According to Ampere's circuital law, the line integral of magnetic field induction along a closed curve is equal to the total current passing through the surface enclosed in the closed curve times the permeability of the medium.

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_{enclosed}.$$

Applying ampere's law for the given toroid

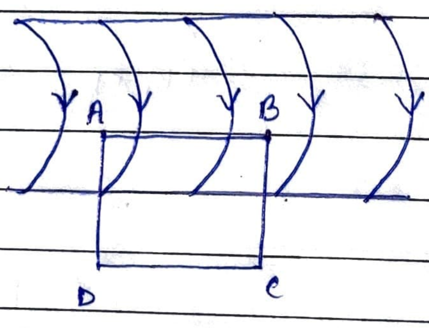
$$B(2\pi r) = \mu_0 N I$$

But $N = 2\pi r n$

$$B = \mu_0 n I.$$

② (a) $\oint B \cdot dl = \mu_0 I_T$ ——— (1).

Solenoid :- infinite length.
having $n$ turns per unit length.
$I$ current is flowing




Square ABCD lying partially inside solenoid.
Side of square $= l$.

$$\oint B \cdot dl = \oint B_{AB} \cdot dl + \oint B_{BC} \cdot dl + \oint B_{CD} \cdot dl + \oint B_{DA} \cdot dl \quad (2)$$

As side BC & CD are perpendicular to the magnetic field. $\oint B_{BC} \cdot dl$ and $\oint B_{CD} \cdot dl$ are zero.

as the side DC is lying outside solenoid. Therefore $B_{DA} = 0$.

So $\oint B_{DA} \cdot dl = 0$.

It reduces to $\oint B \cdot dl = B \oint dl$ $(B_{AB} = B)$.

$$\oint B \cdot dl = Bl \quad \text{—— (3)}$$

total current flowing through side AB

$$I_T = I(nl).$$

$$\mu_0 I_T = \mu_0 I (nl) \quad \text{—— (4)}.$$

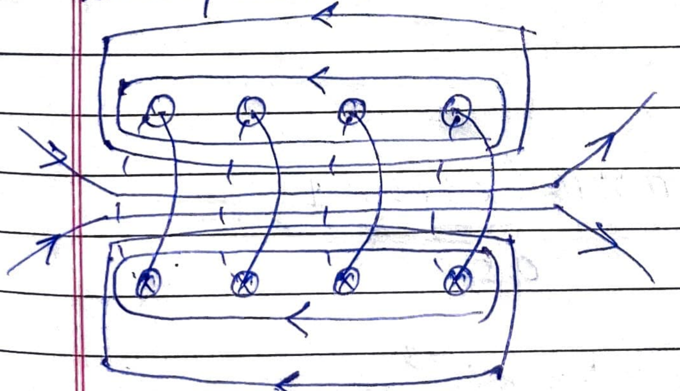
putting (3), (4) in (1).

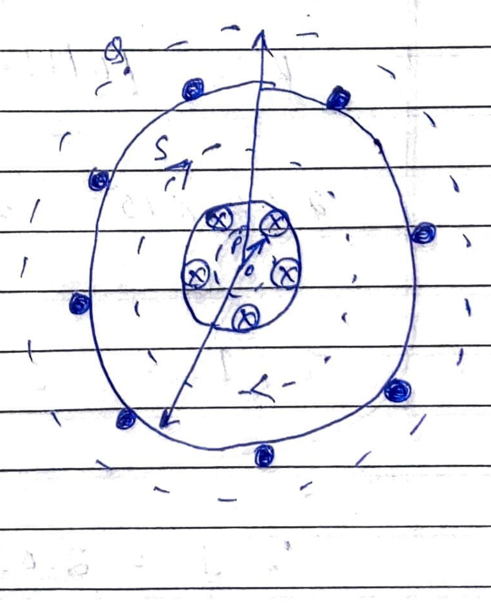
$$Bl = \mu_0 I (nl).$$

$$B = \mu_0 n I$$

∴ magnetic field of the axis of current carrying a very long solenoid is $\mu_0 n I$.

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





(c) We make the magnetic field inside the solenoid strong by inserting a laminated iron core in it and by this there is a increase in the strength of electromagnet of solenoid.

(3). $n = 300$ turns/sec

$I = 5\ A$

$l = 0.5\ m$.

$r = 10^{-2}\ m$

$B = \mu_0 n I = (4\pi \times 10^{-7}) \times 300 \times 5\ T$

$B = 1.9 \times 10^{-3}\ T$. (Ans)

(4) $l = 0.5\ m$

$N = 500$

flux density $= 2.52 \times 10^{-3}\ T$.

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

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

$$2.52 \times 10^{-3} = \frac{4\pi \times 10^{-7} \times 500 \times I}{0.5}$$

$$I = \frac{0.5 \times 2.52 \times 10^{-3}}{4\pi \times 10^{-7} \times 500}$$

$\therefore I = 2.00\ A$.