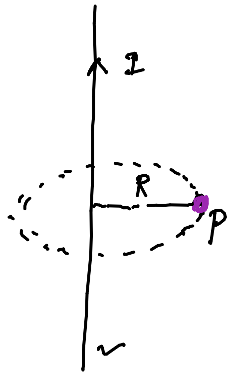
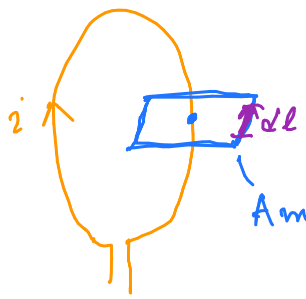


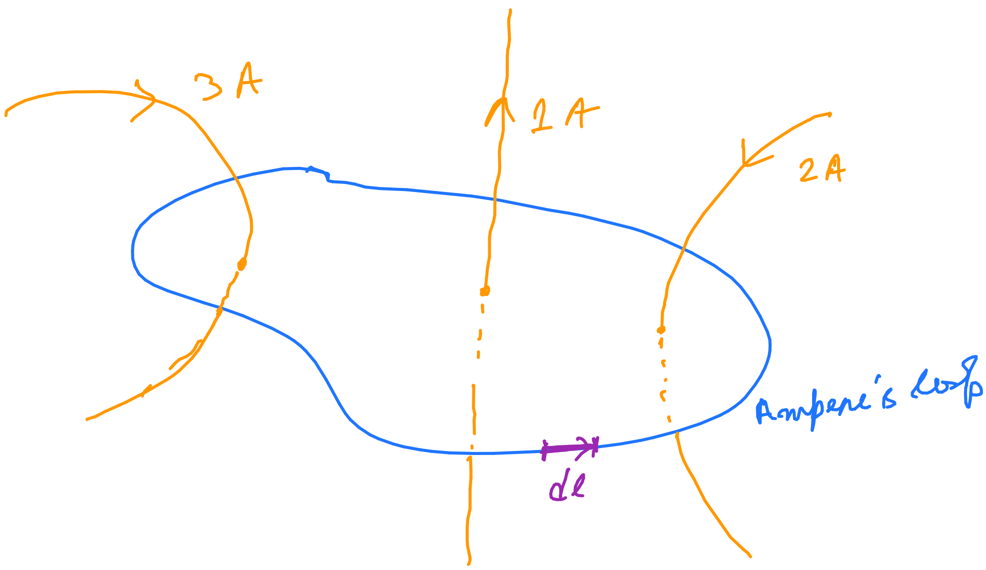
$$H = \frac{I}{2\pi R}$$

- Ampere's Law :

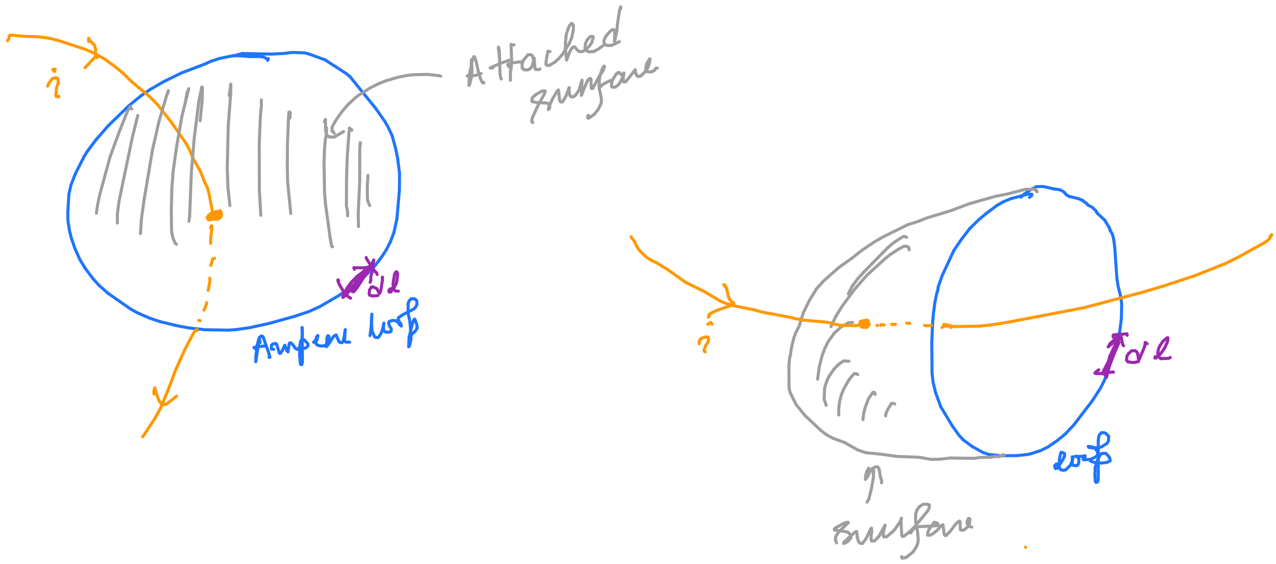
$$\oint_{loop} \vec{H}\cdot d\vec{l} = I_{enclosed}.$$



$$\oint_{loop} \vec{H}\cdot d\vec{l} = i$$



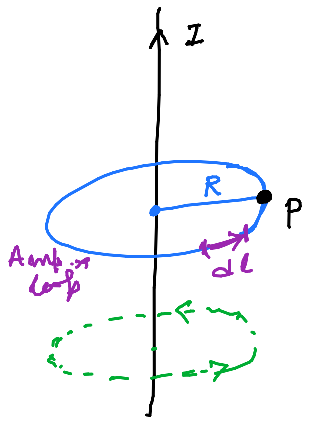
$$\oint_{loop} \vec{H}\cdot d\vec{l} = 3+2-1 = 4\ A.$$



✓ $\oint_{loop} \vec{H} \cdot \vec{dl} = I_{penetrated}$

↑ through the surface (open) attached to the Ampere loop

- Ampere's law can be used to compute magnetic field intensity H by appropriately choosing the path.



$$\oint_{loop} \vec{H} \cdot \vec{dl} = I_{enclosed}$$

- H is constant over the entire path / loop that we have chosen

$$H \oint_{loop} \vec{dl} = I$$

$\oint_{loop}$: loop integral

$$\Rightarrow H(2\pi R) = I$$

$$\Rightarrow \boxed{H = \frac{I}{2\pi R}}$$

ML100

- Some guidelines to choose Ampere's path:

→ Choose a loop s.t. the point of observation P lies on the loop

→ If possible, choose a loop s.t. the magnetic field intensity H is constant along the closed path.

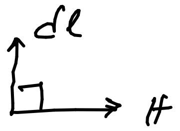
→ If possible, choose a loop s.t. H is parallel to the loop & $\vec{dl}$ is in the same direction as $\vec{H}$.

$$\oint \vec{H} \cdot \vec{dl} = I_{enc}$$

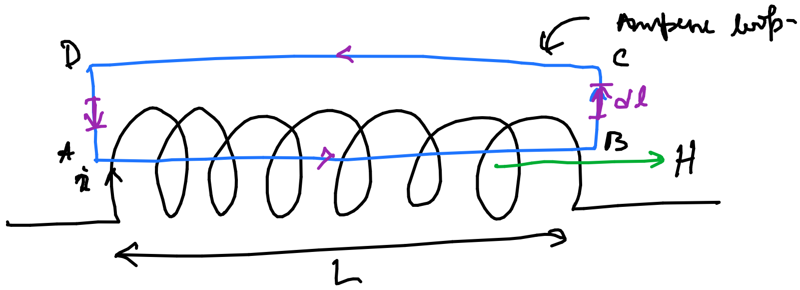
$$\Rightarrow \oint H\,dl = I_{enc} \quad (\text{since } \vec{H} \text{ \& } \vec{dl} \text{ are in same direct}^n)$$

$$\Rightarrow H \oint dl = I_{enc} \quad (\text{since } H \text{ is const. over the entire closed path})$$

→ If possible, choose some or part of the closed path s.t. it is perpendicular to H.



→ Choose a very simple path (circular or rectangular)



$$\oint_{loop} \vec{H}\cdot\vec{dl}$$

AB $\rightarrow$ $\vec{H}$ & $\vec{dl}$ are in same direct'

H is constant.

BC $\rightarrow$ $\vec{H}$ & $\vec{dl}$ are perpendicular

$$\int_B^C \vec{H}\cdot\vec{dl} = 0$$

CD $\rightarrow$ Field intensity is almost zero

DA $\rightarrow$ $\vec{H}$ & $\vec{dl}$ are perpendicular

$$\oint_{loop} \vec{H}\cdot\vec{dl} = H\int_A^B dl = Ni$$

N : Number of turns in the coil.

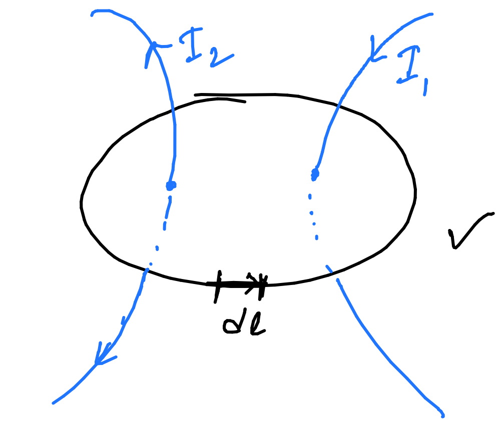
$$\Rightarrow HL = Ni$$

$$\boxed{\Rightarrow H = \frac{N}{L}\, i}$$

- For <u>air</u> B : Magnetic flux density

$$\boxed{B = \mu_0 H}$$

μ_0 : Permeability of free space.

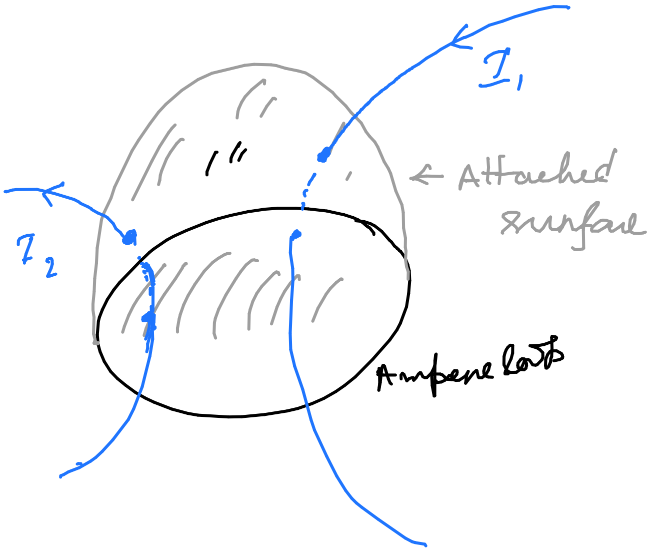


$$\oint_{loop} \vec{H}\cdot\vec{dl} = I_{enclosed}$$

$$= I_{penetrated}$$

↑

th. the surface (open) attached.



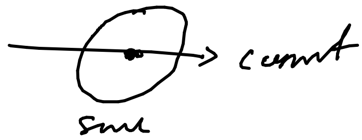
• Current density : J

↑

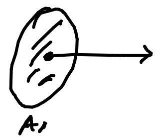
current per unit area.

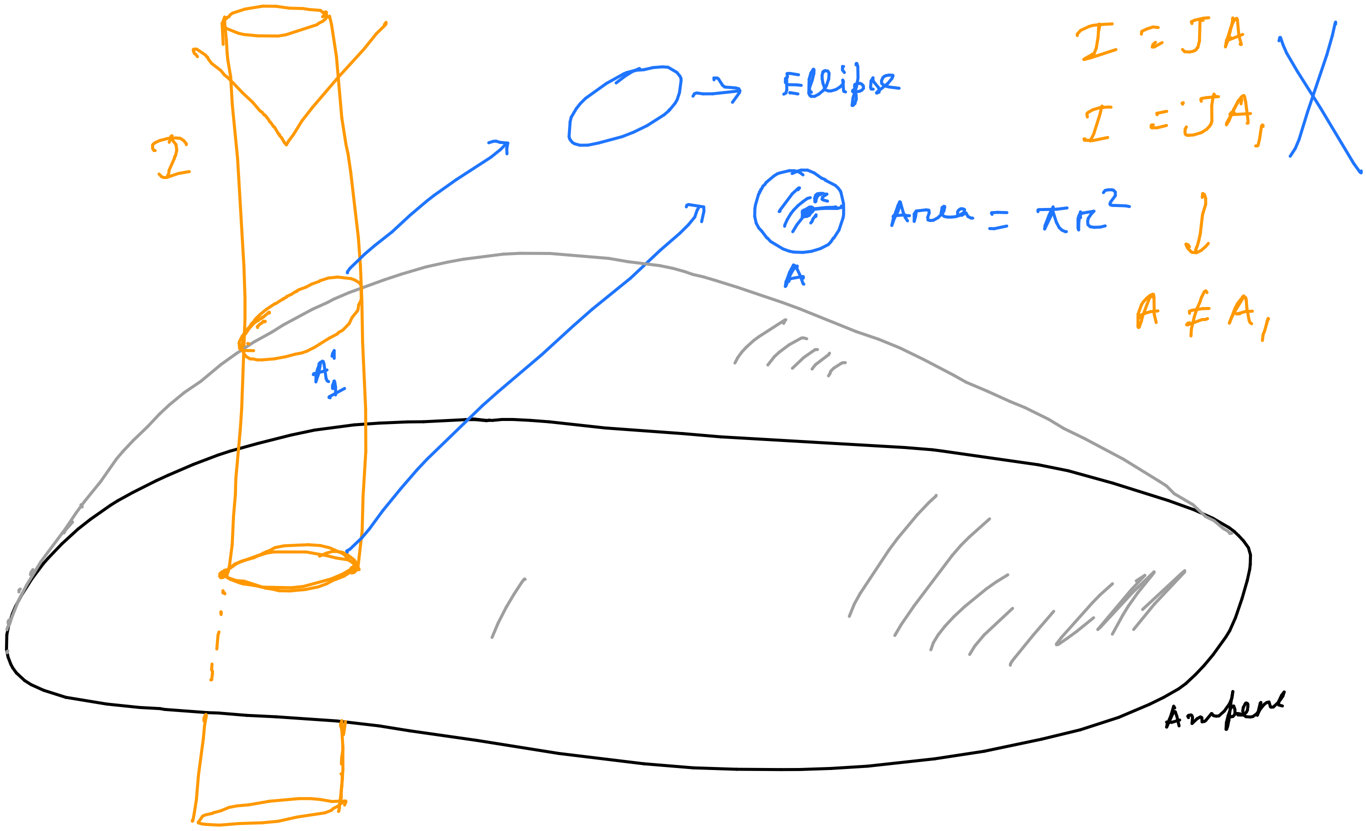
↓

$$I = JA \quad (\text{Area of surface} = A)$$

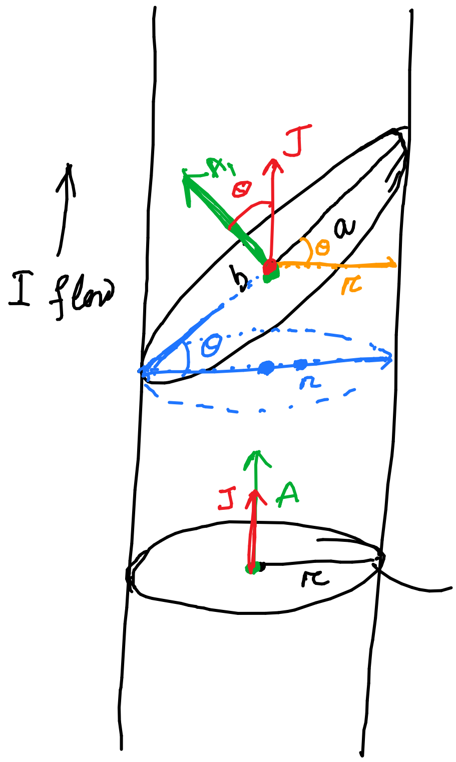


$$I = \vec{J}\cdot\vec{A}$$





I
Ellipse
A
Area = πr^2
A_1
Ampere
$I = JA$
$I = JA_1$
$A \neq A_1$



The area of ellipse $A_1 = \pi a b$

$\cos\theta = \frac{r}{a}$

$\Rightarrow a = \frac{r}{\cos\theta}$

circular. The area of circle $A = \pi r^2$

For elliptical shape $b = r$
$a = ?$

The area of ellipse $A_1 = \pi a b$

$= \pi r \cdot r/\cos\theta$

$= \frac{\pi r^2}{\cos\theta} = \frac{A}{\cos\theta}$

$$\boxed{A_1 = A/\cos\theta}$$

$I = \vec{J}\cdot\vec{A} = JA\cos\theta$

For circular case $\theta = 0^\circ$

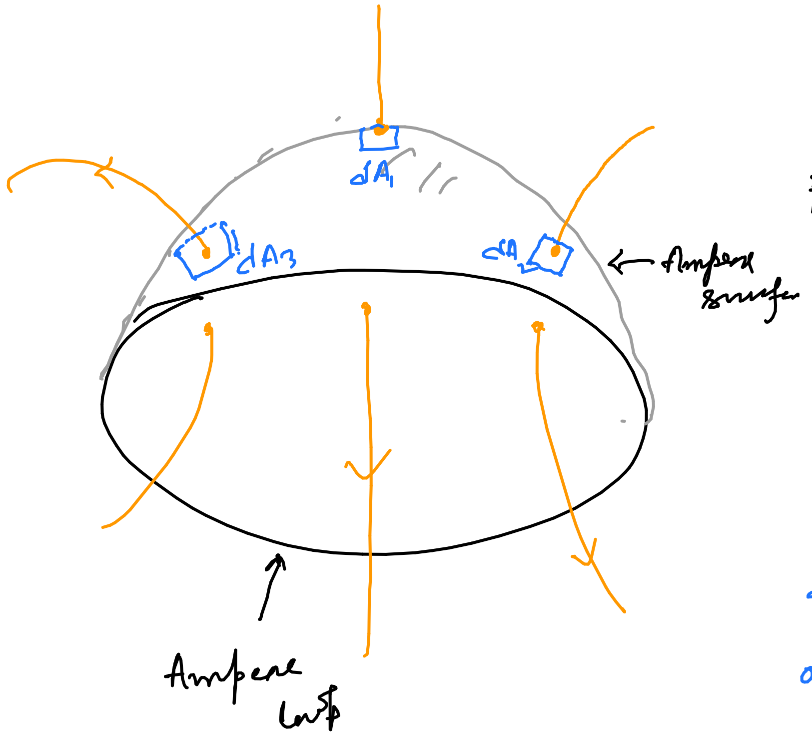
$I = \underline{\underline{JA}}$

For elliptical case

$I = \vec{J}\cdot\vec{A_1} = JA_1\cos\theta = J\frac{A}{\cos\theta}\cos\theta$

$= \underline{\underline{JA}}$

$$\boxed{I = \vec{J} \cdot \vec{A}}$$



Partition the entire area with very small pieces dA

$$I_{enclosed} = \iint \vec{J} \cdot d\vec{A}$$

open surface integral

$$\oint \vec{H} \cdot d\vec{l} = I_{enclosed}$$

$$= I_{penetrated}$$

$$= \iint_{surface} \vec{J} \cdot d\vec{A}$$

$$\oint_{(closed)\ loop} \vec{H} \cdot d\vec{l} = \iint_{(open)\ surface} \vec{J} \cdot d\vec{A}$$

$$B = \mu_0 H$$

$$\oint_{closed\ loop} \vec{B} \cdot d\vec{l} = \mu_0 \iint_{open\ surface} \vec{J} \cdot d\vec{A}$$