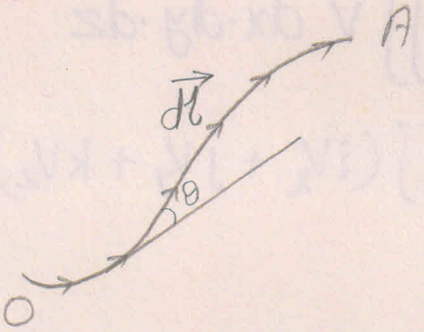
ELECTRO MAGNETIC THEORY

Different definitions of terms

- **line integral of a vector:-**



For line integral of a vector

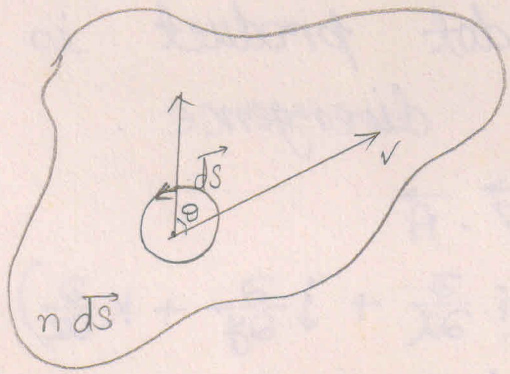
$$\int_O^A \vec{V}\cdot\vec{dl} = l \quad \ldots\ldots (i)$$

where V = force

$$L = \int_O^A V\cdot dl = W_A - W_0$$

= work done by the force between points O and A.

- **Surface integral of a vector:-**



$\int_S \vec{V}\cdot\vec{dS}$ = Surface integral of vector V on S.

- **Volume integral of a vector**

It is expressed by

$$\int_{\tau} \vec{V}\, d\tau = \iiint V\, dx \cdot dy \cdot dz$$

$$= \iiint (iV_x + jV_y + kV_z)\, dx \cdot dy \cdot dz$$

- **Operator ∇**

Operator $\nabla = i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z} \cdots$

Operator ∇ operating on a scaler ϕ is called gradient of ϕ or

$$\text{grad}\,\phi = \overrightarrow{\nabla\phi}$$

$$= \frac{\partial\phi}{\partial x}\cdot\vec{i} + \frac{\partial\phi}{\partial y}\vec{j} + \frac{\partial\phi}{\partial z}\vec{k}$$

Operator ∇ multiplied with a vector as dot product is defined as div for divergence.

$$\text{div}\,\vec{A} = \vec{\nabla}\cdot\vec{A}$$

$$= \left(i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z}\right)$$

$$\cdot\,(iA_x + jA_y + kA_z)$$

$$= \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$$

which is an scaler.

Curl or Rot

The cross product of a vector with ∇ is called curl or rot (rot for rotation). It is expressed as

$$\vec{\nabla} \times \vec{A} = \text{Curl } A$$

$$= \begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ A_x & A_y & A_z \end{vmatrix}$$

$$= i\left(\frac{\partial}{\partial y} A_z - \frac{\partial}{\partial z} A_y\right)$$

$$+ j\left(\frac{\partial}{\partial z} A_x - \frac{\partial}{\partial x} A_z\right)$$

$$+ k\left(\frac{\partial}{\partial x} A_y - \frac{\partial}{\partial y} A_x\right)$$

$\vec{A} \times \vec{B} \times \vec{C}$

$$\vec{A} \times \vec{B} \times \vec{C} = (AC)\vec{B} - (AB)\vec{C}$$

Curl curl $\vec{V}$

$$\text{curl curl } \vec{V} = \vec{\nabla} \times \vec{\nabla} \times \vec{V}$$

$$= \nabla(\nabla \cdot V) - \nabla \cdot \nabla V$$

$$= \text{Grad div } V - \text{div grad } V$$

Gauss divergence theorem

Divergence (Physical meaning)

$$\text{div}\,\vec{A} = \lim_{\delta V \to 0} \frac{\oint \vec{A}_n\, d\vec{S}}{\delta V}$$

$$= \frac{\text{flux}}{\text{volume}}$$

Gauss divergence theorem relates volume integral with the surface integral with the same. Symbolically

$$\int_{\tau} \vec{\nabla} \cdot \vec{A}\, d\tau = \int_{\sigma} \vec{A} \cdot d\vec{\sigma}$$

Stoke's theorem

$$\oint \vec{A} \cdot d\vec{l} = \int_{\sigma} \vec{\nabla} \times \vec{A} \cdot d\vec{\sigma}$$

Faraday's law of electromagnetic induction

$$\text{emf } E = \frac{d\phi}{dt}$$

(rate of change of flux)

F = flux

$$E = -\frac{1}{c}\frac{dF}{dt}$$

$\int E \cdot dl = P.D.$ (Potential difference or potential)

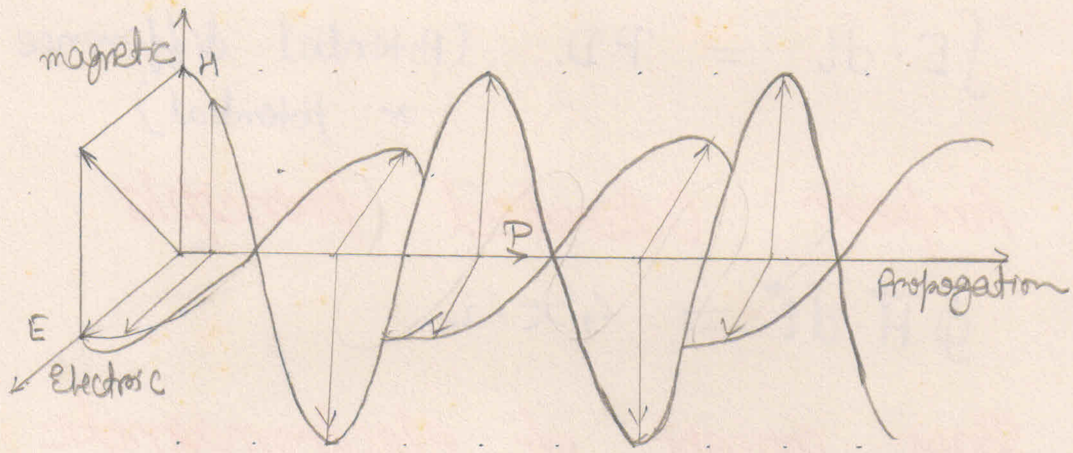
Ampear Odersted principle

$$\oint \vec{H} \cdot \vec{dl} = 4\pi \cdot i_n$$

Basic concept of electromagnetic theory :-

The electromagnetic theory of light was proposed by Maxwell. According to him, which is true for today : Light energy consists of mutualy perpendicular electric and magnetic vibrations. The resultant of these is transverse vibration of light. If x is the direction of the ~~projection~~ propogation y is along electric vector and z along magnetic then the electric and magnetic vectors create a resultant.

$$L = \sqrt{H^2 + E^2}$$



pictorial representation of Electro magnetic wave

Although both electric and magnetic vectors together create electromagnetic wave of radiation, it is actualy the electric vector which is observable, magnetic is always associated as silent contributer.

The electric vector is observed by
a) producing sensation of vision on our eyes
b) by producing fluoresence and
c) by affecting photographic plate.

$$AgBr + h\nu = Ag^+ + Br^-$$

The magnitude of magnetic vector is $\sqrt{\frac{\epsilon}{\mu}}$ times the electric vector

$$\left[B = \sqrt{\frac{\epsilon}{\mu}} \cdot E \right] \text{ — in SI}$$

$$B = \sqrt{K}\, E \text{ — in CGS}$$

refractive index $\eta = \frac{c}{v}$