UNIT - I

Concept of vector potential

* Electric potential depends upon the charges which establishes the field.
* Electric potential is a scalar function & field is gradient of potential function

$$E = -\nabla V \rightarrow (1)$$

* Source for producing a magnetic field is current element. In case of electric field, it is charge. Since charge is a scalar quantity, so the potential in case of electric field is electric scalar potential.
* But in the magnetic case, current element is having direction and magnitude. Hence the potential in case of magnetic field is magnetic vector potential 'A'.

H (or) B can be obtained through the relation

$$B = \nabla \times A \rightarrow (2)$$

In a homogeneous (ε, μ & σ constant), isotropic medium ($D = \varepsilon E$, ε - scalar constant, D & E same direction everywhere), the relation between current element (Idl) & the magnetic vector potential A is

$$dA = k\left(\frac{Idl}{r}\right) \qquad ; \left(k = \frac{\mu}{4\pi}\right)$$

$$dA = \frac{\mu}{4\pi}\left(\frac{Idl}{r}\right)$$

$$A = \int \frac{\mu}{4\pi} \frac{Idl}{r}$$

$$Idl = J dv$$

weber/m^2

$$\therefore A = \int \frac{\mu J dv}{4\pi r} \rightarrow (3)$$

vector potential 'A' at a point due to current distribution is equal to J/r integrated over the volume occupied by the current distribution

J → current density at each volume element dv

r → distance from each volume element to P.

If the current distribution is known, the vector potential A can be found. Knowing A at any point flux density B can be calculated by,

$$\boxed{B = \nabla \times A} \rightarrow (4)$$

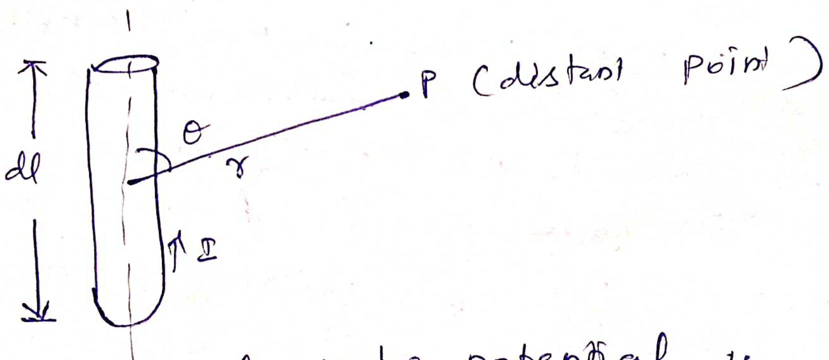
Magnetic field is obtained from B as,

$$\boxed{B = \mu H} \rightarrow (5)$$

Magnetic vector potential : $A = \frac{\mu}{4\pi} \int \frac{I\,dl}{r}$ (or) $\frac{\mu}{4\pi} \int \frac{J\,dv}{r}$ → (6)

Electric Scalar potential $V = \frac{1}{4\pi\varepsilon} \int \frac{\rho\,dv}{r}$ → (7)

Modification of time varying retarded case



If the expression for vector potential is integrated, it follows that potential due to various current elements are added up.

Let the instantaneous current I in the elements be a sinusoidal function of time as,

$$I = I_m \sin \omega t \rightarrow (1)$$

I_m → max/. (or) peak current