

Imp formula

EM Waves

$$(i) \oint \vec{B} \cdot d\vec{l} = \mu_0 i + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 i_d, \text{ where } i_d \text{ is the displacement current.}$$

Numerically, $i_d = i_c$

$$i_d = \epsilon_0 \frac{d\phi_E}{dt}$$

$$i_d = v \frac{dq}{dt} \quad \text{or} \quad i_d = C \frac{dv}{dt}$$

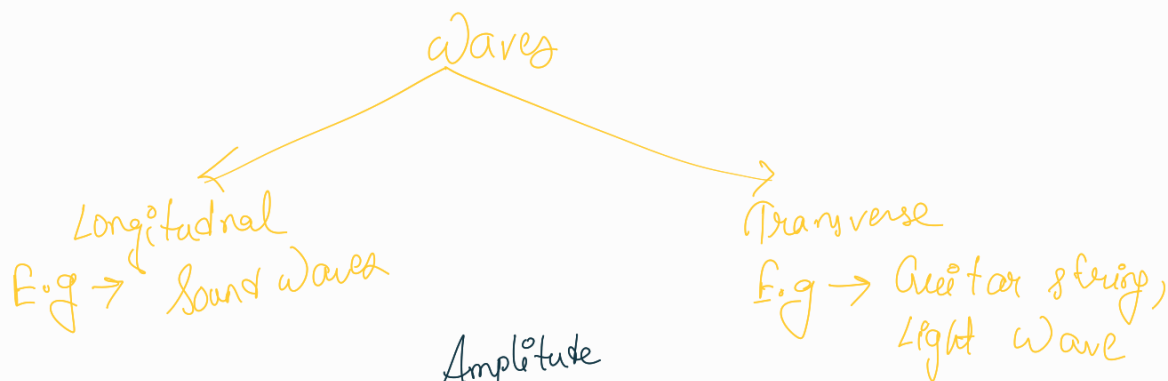
(ii) Maxwell Equation (4 laws)

$$(a) \oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$$

$$(b) \oint \vec{B} \cdot d\vec{s} = 0$$

$$(c) \oint \vec{E} \cdot d\vec{l} = \frac{d\phi_B}{dt}$$

$$(d) \oint \vec{B} \cdot d\vec{l} = \mu_0 (i_c + i_d)$$



Amplitude

$$y = A \sin(kx - \omega t)$$

$$k = \frac{2\pi}{\lambda} \quad \omega = 2\pi f$$

$$v = f\lambda$$

or,

$$v = \frac{\omega}{k}$$

Results :-

$$(i) \hat{E} \times \hat{B} = \hat{c} \quad (ii) \frac{E_0}{B_0} = c ; \frac{E_{RMS}}{B_{RMS}} = c$$
$$; \frac{E}{B} = c$$

$$(iii) E = E_0 \sin(kx - \omega t) \rightarrow \text{Wave is travelling in } +x \text{ direction}$$

$$(iv) \frac{E_0}{B_0} = c = \frac{\omega}{k}$$

$$(v) \frac{\partial E}{\partial z} = - \frac{\partial B}{\partial t}$$

* More Results

$$(i) U_E = \frac{1}{2} \epsilon_0 E_{RMS}^2 = \frac{1}{4} \epsilon_0 E_0^2$$

$$(ii) U_B = \frac{B_{RMS}^2}{2\mu_0} = \frac{1}{4} \frac{B_0^2}{\mu_0}$$

$$(iii) C_v = \frac{1}{\sqrt{\mu_0 \epsilon_0}} \quad (\text{speed of wave in vacuum})$$

$$(iv) C_m = \frac{C_v}{\sqrt{\mu_x \epsilon_x}}$$

$$(v) U_E = U_B$$

$$(vi) U_T = U_E + U_B$$

$$\Rightarrow U_T = 2U_E \quad \text{or} \quad U_T = 2U_B$$

$$(vii) U_T = \frac{1}{2} \epsilon_0 E^2 = \epsilon_0 E_{RMS}^2$$

$$U_T = \frac{B_0^2}{2\mu_0} = \frac{B_{RMS}^2}{\mu_0}$$

(viii) Intensity (Poynting vector)

$$S = \frac{1}{\mu_0} (\vec{E} \times \vec{B})$$

$$(ix) I_{avg} = \frac{E_0 B_0}{2\mu_0} = \frac{E_{RMS} B_{RMS}}{\mu_0}$$

$$(x) I = \frac{\text{Power}}{\text{Area}}$$

$$I = \frac{1}{2} \epsilon_0 E^2 \times C$$

Electromagnetic Spectrum

