

**CL3\_Q1. Explain how Poynting vector explains the energy flow.****Answer**

EM waves carry energy in the direction perpendicular to the E and B field variations and are described by the Poynting vector as,  $\mathbf{S} \equiv c^2 \epsilon_0 \mathbf{E} \times \mathbf{B} = \frac{1}{\mu_0} \mathbf{E} \times \mathbf{B}$

In terms of time varying electric field component and hence to determine the average energy of the wave transmitted per unit time through unit area can be found out as

$$\begin{aligned}\text{Average Energy } \langle S \rangle &= \frac{c\epsilon_0}{T} \int_0^T E_x^2 dt = \frac{c\epsilon_0}{T} \int_0^T E_{ox}^2 \cos^2(\omega t + kz) dt \\ &= \frac{1}{2} \epsilon_0 c E_{ox}^2\end{aligned}$$

**CL3\_Q2. Differentiate between circularly and elliptically polarized light?****Answer**

If light is composed of two plane waves of equal amplitude but differing in phase by  $90^\circ$ , then the light is said to be circularly polarized. If two plane waves of differing amplitude are related in phase by  $90^\circ$ , or if the relative phase is other than  $90^\circ$  then the light is said to be elliptically polarized.

**CL3\_Q3. Find the energy density of electromagnetic wave, if the electric field of amplitude 6.2 V/m oscillates with a frequency of  $2.4 \times 10^{10}$  Hz.****Answer**

From Maxwell's equation, we know, Energy density =  $\epsilon_0 E^2$

Here,  $E_{max} = 6.2 \text{ V/m}$  and  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$

Therefore,

$$\text{Energy Density} = 8.85 \times 10^{-12} \times 6.2 \times 6.2 = 3.4 \times 10^{-10} \text{ J/m}^3.$$