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, $\boldsymbol{s} \equiv \boldsymbol{c^2 \varepsilon_o E \times B} = \frac{\boldsymbol{1}}{\boldsymbol{\mu_o}} \boldsymbol{E \times B}$

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

$$\text{Average Energy} < S > = \frac{c\varepsilon_o}{T}\int_0^T E_x{}^2\, dt = \frac{c\varepsilon_o}{T}\int_0^T \boldsymbol{E_{ox}{}^2 \cos^2(\omega t + kz)}\, dt$$
$$= \frac{1}{2}\varepsilon_o c E_{ox}{}^2$$

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°, then the light is said to be circularly polarized. If two plane waves of differing amplitude are related in phase by 90°, or if the relative phase is other than 90° 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 X 10^{10} Hz.

Answer

From Maxwell's equation, we know, Energy density = $\varepsilon_0 E^2$
Here, E_{max} = 6.2 V/m and ε_0 = 8.85 X 10^{-12} C^2/Nm^2
Therefore,

Energy Density = 8.85 X 10^{-12} X 6.2 X 6.2 = 3.4 X 10^{-10} J/m^3.