Indian Institute of Technology Madras
PH1020, Tutorial Set-9

16-04-2018

Q1. Two plane polarized electromagnetic waves propagate in the positive *z*-direction, with their planes of polarization along *x* and *y* direction, respectively. The electric fields of the two waves have equal amplitudes given by $|E_o|$. The frequency of each wave is ω and the wave vector is $\vec{k}$. a) Write the expression for the electric and magnetic fields of the two waves. b) Find the values of $\frac{\partial U}{\partial t}$ and $\vec{\nabla} \cdot \vec{S}$ for the two waves where U is the electromagnetic energy and $\vec{S}$ is the Poynting vector.

Q2. The electric field of a plane wave in vacuum is $\vec{E} = E_o \hat{e}_z \cos kx \cos \omega t$. Write the components of the corresponding magnetic field $\vec{B}$ such that $\vec{B} = 0$ when $\underline{t}$ = 0. Find the mean flux of the energy.

Q3. Write down the real component of the electric and magnetic fields for a monochromatic plane wave of amplitude E_o, frequency ω, and phase angle zero in vacuum that is a) traveling in the negative x-direction and polarized in the z-direction, (b) traveling along (111) with polarization parallel to the *xy*-plane.

Q4. Calculate the following for a plane sinusoidal electromagnetic wave travelling in free space with an electric field amplitude, $E_o = 40\mu V/m$. a) Average energy density in the wave, b) Peak energy density, and c) Average value of the Poynting vector.

Q5. An electromagnetic wave propagating in an isotropic medium has its electric vector as $\vec{E}(x, y, z, t) = (70\hat{e}_y) \cos\left[\pi \times 10^7 (\frac{x}{3} - 10^8 t)\right] + (50\hat{e}_z) \cos\left[\pi \times 10^7 (\frac{x}{3} - 10^8 t)\right]$ in V/m. *x* is in meters and *t* in seconds. Find a) the refractive index of the material of the medium in which the electromagnetic wave is travelling and b) the corresponding $\vec{H}(x, y, z, t)$. C) Hence calculate the time average value of the Poynting vector $\vec{S}$