Quiz 6

1

For a harmonic uniform plane wave propagating in a simple medium, both $\boldsymbol{E}$ and $\boldsymbol{H}$ vary in accordance with the factor $\exp(-j\boldsymbol{k}\cdot\boldsymbol{R})$ as indicated in

$$\boldsymbol{E}(\boldsymbol{R}) = \boldsymbol{E_0}e^{-j\boldsymbol{k}\cdot\boldsymbol{R}} = \boldsymbol{E_0}e^{-jk\boldsymbol{a_n}\cdot\boldsymbol{R}}$$

and

$$\boldsymbol{H}(\boldsymbol{R}) = \frac{1}{\eta}(\boldsymbol{a_n}\times\boldsymbol{E_0})e^{-jk\boldsymbol{a_n}\cdot\boldsymbol{R}}$$

Show that the four Maxwell's equation for uniform plane wave in a source-free region reduce to the following:

$$\begin{gathered}\boldsymbol{k}\times\boldsymbol{E} = \omega\mu\boldsymbol{H}\\ \boldsymbol{k}\times\boldsymbol{H} = -\omega\epsilon\boldsymbol{E}\\ \boldsymbol{k}\cdot\boldsymbol{E} = 0\\ \boldsymbol{k}\cdot\boldsymbol{H} = 0\end{gathered}$$

2

1. The instantaneous expression for the magnetic field intensity of a uniform plane wave propagating in the +y direction in air is given by

$$\boldsymbol{H} = \boldsymbol{a_z} 4 \times 10^{-6} cos(10^7 \pi t - k_0 y + \frac{\pi}{4})$$

   (a) Determine k_0 and the location where $\boldsymbol{H_z}$ vanishes at $t = 3 \quad (ms)$.

   (b) Write the instantaneous expression for $\boldsymbol{E}$.

2. The $\boldsymbol{E}$-field of a uniform plane wave propagating in a dielectric medium is given by:

$$\boldsymbol{E}(t,z) = \boldsymbol{a_x} 2cos(10^8 t - z/\sqrt{3}) - \boldsymbol{a_y} sin(10^8 t - \sqrt{3})$$

   (a) Determine the frequency and wavelength of the wave.

   (b) What is the dielectric constant of the medium?

   (c) Describe the polarization of the wave.

   (d) Find the corresponding $\boldsymbol{H}$-field