Assignment 2

EP3110 Electromagnetics and applications 21-08-2022

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1. Find out $\vec{H}$ and β, if the electric field is given as $\vec{E} = 0.2\, sin(10\pi y)\, cos(6\pi 10^9\, t - \beta z)\hat{x}$ in air.

2. In a homogeneous nonconducting region where $\mu_r = 1$, find ε_r and ω if $\vec{E} = 30\pi e^{j(\omega t - {}^{4}/_{3}y)}\hat{z}$ (V/m) and $\vec{H} = 1.0e^{j(\omega t - {}^{4}/_{3}y)}\hat{x}$ A/m.

3. Prove that the electric field intensity $\vec{E}(x, y, z) = E_0 e^{-j(k_x x + k_y y + k_z z)}$ satisfies the homogeneous Helmoltz's equation provided that the condition $k_x{}^2 + k_y{}^2 + k_z{}^2 = \omega^2\mu\varepsilon$ is satisfied.

4. If the electric field of a harmonic plane wave in a medium is given by $\vec{E}(R) = E_0 e^{-j\vec{k}\cdot\vec{R}}$, then show that the four Maxwell's equations for uniform plane wave in a source-free region reduce to the following equations i) $\vec{k} \times \vec{E} = \omega\mu\vec{H}$, ii) $\vec{k} \times \vec{H} = -\omega\varepsilon\vec{E}$, iii) $\vec{k} \cdot \vec{E} = 0$, and d) $\vec{k} \cdot \vec{H} = 0$.

5. The E field of a uniform plane wave propagating in a dielectric medium is given by $\vec{E}(t, z) = 2\cos(10^8\, t - {}^{z}/_{\sqrt{3}})\hat{x} - \sin(10^8 t - {}^{z}/_{\sqrt{3}})\hat{y}$ (V/m). 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 $\vec{H}$-field.

6. Show that a plane wave with an instantaneous expression for the electric field $E(z, t) = E_{10}\sin(\omega t - kz)\hat{x} + E_{20} sin(\omega t - kz + \psi)\hat{y}$ is elliptically polarized. Find the polarization.