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4. A uniform plane wave,  $\vec{E}_s = (5\hat{x} + j10\hat{y})e^{-j2z}$  V/m has a frequency of 50 MHz in a lossless non-magnetic material. (a) Find  $\beta$ ,  $\omega$ ,  $v_p$ ,  $\lambda$ ,  $\epsilon_r$ , and  $\eta$ . (b) Calculate  $\vec{E}$  at the origin for  $\omega t = 0, \pi/4, \pi/2, 3\pi/4$ , and  $\pi$ .
5. Parameters for a 50-MHz uniform plane wave propagating in the  $\hat{z}$  direction in a lossy material are  $\gamma = 0.25 + j2$  m<sup>-1</sup> and  $\eta = 600 + j75$   $\Omega$ . (a) Find the relative permeability and permittivity and the conductivity. (b) If  $\vec{E}_s = 100\hat{x}$  V/m at  $z = 0$ , find  $\vec{E}_s$  at  $z = 2$  m and also (c)  $\vec{H}_s$  at  $z = 2$  m.
6. An infinitely long coaxial transmission line is air-filled and has dimensions  $a = 1$  cm,  $b = e$  cm. The field in the dielectric is given as  $\vec{E} = (100/\rho) \cos(10^8 t - \beta z)\hat{\rho}$  V/m. (a) Find  $\beta$ . (b) Use Maxwell's equations to find  $\vec{H}$ . (c) Determine the Poynting vector. (d) Find the average power transmitted by the coax.
7. Most microwave ovens operate at 2.45 GHz. Assume that the stainless steel interior has a conductivity of  $1.1 \times 10^6$  S/m and a relative permeability of 600, and find the depth of penetration (skin depth) for the field. (b) Let  $\vec{E}_s = 10\angle 0^\circ$  V/m at the conductor surface and plot a curve of the amplitude of  $\vec{E}_s$  vs. the angle of  $\vec{E}_s$  as the field propagates into the stainless steel.