

7.26 The magnetic field of a plane wave propagating in a nonmagnetic medium is given by

$$\mathbf{H} = \hat{\mathbf{y}} 60e^{-10z} \cos(2\pi \times 10^8 t - 12z) \quad (\text{mA/m}).$$

Obtain the corresponding expression for \mathbf{E} .

Solution: From the expression for \mathbf{H} ,

$$f = 10^8 \text{ Hz}, \quad \beta = 12 \text{ rad/m}, \quad \alpha = 10 \text{ Np/m}.$$

From Eq. (7.65),

$$\epsilon' = \frac{-(\alpha^2 - \beta^2)}{\omega^2 \mu} = \frac{-(100 - 144)}{(2\pi \times 10^8)^2 \times 4\pi \times 10^{-7}} = 8.87 \times 10^{-11} \text{ F/m},$$

$$\epsilon'' = \frac{2\alpha\beta}{\omega^2 \mu} = \frac{2 \times 10 \times 12}{(2\pi \times 10^8)^2 \times 4\pi \times 10^{-7}} = 48.38 \times 10^{-11} \text{ F/m}.$$

Hence,

$$\begin{aligned} \eta_c &= \sqrt{\frac{\mu}{\epsilon'}} \left(1 - j \frac{\epsilon''}{\epsilon'} \right)^{-1/2} \\ &= \sqrt{\frac{4\pi \times 10^{-7}}{8.87 \times 10^{-11}}} \left(1 - j \frac{48.38 \times 10^{-11}}{8.87 \times 10^{-11}} \right)^{-1/2} \\ &= 119.03(1 - j5.45)^{-1/2} \\ &= 119.03(5.54e^{-j79.6^\circ})^{-1/2} = 119.03(0.42e^{j39.8^\circ}) = 50e^{j39.8^\circ} \Omega. \end{aligned}$$
