EEE3089F Tutorial 9

8.28 A plane wave in air with

$$\widetilde{\mathbf{H}}^{\mathrm{i}} = \hat{\mathbf{y}}\, 2 \times 10^{-2} e^{-j(8x+6z)} \qquad \text{(A/m)}$$

is incident upon the planar surface of a dielectric material, with $\epsilon_{\mathrm{r}} = 9$, occupying the half-space $z \geq 0$. Determine:

(a) The polarization of the incident wave.

(b) The angle of incidence.

(c) The time-domain expressions for the reflected electric and magnetic fields.

(d) The time-domain expressions for the transmitted electric and magnetic fields.

(e) The average power density carried by the wave in the dielectric medium.

8.39 A hollow rectangular waveguide is to be used to transmit signals at a carrier frequency of 6 GHz. Choose its dimensions so that the cutoff frequency of the dominant TE mode is lower than the carrier by 25% and that of the next mode is at least 25% higher than the carrier.

8.41 A waveguide filled with a material whose $\epsilon_r = 2.25$ has dimensions $a = 2\,\text{cm}$ and $b = 1.4\,\text{cm}$. If the guide is to transmit 10.5 GHz signals, what possible modes can be used for the transmission?

2.4 A 1 GHz parallel-plate transmission line consists of 1.2 cm wide copper strips separated by a 0.15 cm thick layer of polystyrene. Appendix B gives $\mu_c = \mu_0 = 4\pi \times 10^{-7}$ (H/m) and $\sigma_c = 5.8 \times 10^7$ (S/m) for copper, and $\epsilon_r = 2.6$ for polystyrene. Use **Table 2-1** to determine the line parameters of the transmission line. Assume that $\mu = \mu_0$ and $\sigma \approx 0$ for polystyrene.

2.13 In addition to not dissipating power, a lossless line has two important features: (1) it is dispersionless (u_p is independent of frequency); and (2) its characteristic impedance Z_0 is purely real. Sometimes, it is not possible to design a transmission line such that $R' \ll \omega L'$ and $G' \ll \omega C'$, but it is possible to choose the dimensions of the line and its material properties so as to satisfy the condition

$$R'C' = L'G' \qquad \text{(distortionless line)}$$

Such a line is called a ***distortionless*** line, because despite the fact that it is not lossless, it nonetheless possesses the previously mentioned features of the lossless line. Show that for a distortionless line,

$$\alpha = R'\sqrt{\frac{C'}{L'}} = \sqrt{R'G'}\,,$$
$$\beta = \omega\sqrt{L'C'}\,,$$
$$Z_0 = \sqrt{\frac{L'}{C'}}\,.$$

2.15 Find α and Z_0 of a distortionless line whose $R' = 2\ \Omega/\text{m}$ and $G' = 2 \times 10^{-4}$ S/m.

2.16 A transmission line operating at 125 MHz has $Z_0 = 40\ \Omega$, $\alpha = 0.02$ (Np/m), and $\beta = 0.75$ rad/m. Find the line parameters R', L', G', and C'.