1.4 \[ E_y = E_0 \cos(\omega t - kz) \quad \text{c} = 2.46 \times 10^8 \, \text{m/s}, \quad E_0 = 30 \, \text{V} \]

a) \[ \eta = \frac{377}{\sqrt{2.55}} = 236 \, \Omega \]
\[ H_x = -\frac{E_y}{\eta} = -0.127 \cos(\omega t - kz) \]

b) \[ v_p = c/\sqrt{\mu_0} = 1.88 \times 10^8 \, \text{m/sec} \]

c) \[ \omega = \frac{c}{v_p} = 80.2 \, \text{m}^{-1} \]
\[ \Delta \phi = -k \Delta z = 551^\circ = 114^\circ \]

1.7 Writing general plane wave fields in each region:
\[ \begin{align*}
\vec{E}^2 &= \hat{x} e^{jkz} \quad &\vec{H}^2 &= \frac{\hat{y}}{\eta_0} e^{jkz} \\
\vec{E}^3 &= \hat{x} \Gamma e^{jkz} \quad &\vec{H}^3 &= \frac{-\hat{y}}{\eta_0} \Gamma e^{jkz} \\
\vec{E}^5 &= \hat{x} (A e^{jkz} + B e^{-jkz}) \quad &\vec{H}^5 &= \frac{\hat{y}}{\eta_0} (A e^{jkz} - B e^{-jkz}) \\
\vec{E}^4 &= \hat{x} \tilde{T} e^{jk5(3-d)} \quad &\vec{H}^4 &= \frac{\hat{y}}{\eta_0} \tilde{T} e^{jk5(3-d)}
\end{align*} \]

Now match \( E_x \) and \( H_y \) at \( z=0 \) and \( z=d \) to obtain four equations for \( \Gamma, T, A, B \):

\[ \begin{align*}
&z=0: \quad 1 + \Gamma = A + B \quad \frac{1}{\eta_0} (1 - \Gamma) = \frac{1}{\eta} (A - B) \\
&z=d: \quad \frac{1}{\eta} (-A + B) = T \quad \frac{1}{\eta} (-A - B) = \frac{T}{\eta_0} \quad \text{(since } d = \lambda_0/4v_p)\end{align*} \]

Solving for \( \Gamma \) gives
\[ \Gamma = \frac{\eta^2 - \eta_0^2}{\eta^2 + \eta_0^2} \]

Check:
\[ \lambda/4 \text{ TRANSFORMER } \Rightarrow Z_m = \eta_0^2/\eta_0 \quad \Gamma = \frac{\eta_0^2/\eta_0 - \eta_0}{\eta_0^2/\eta_0 + \eta_0} = \frac{\eta^2 - \eta_0^2}{\eta^2 + \eta_0^2} \]
1.10.

a) the power transferred from air into copper is given by

\[ 1 - |\Gamma|^2 \]

where

\[ \Gamma = \frac{\eta - \eta_0}{\eta + \eta_0} = -0.999956 - j4.371e-5 \]

This yields a power transfer of –40.6 dB into the copper. Due to the symmetry of the expression for \( \Gamma \), the same power transfer occurs for the copper-air interface. The total loss due to surface reflections is –81.2 dB.

b) Total attenuation = –150 dB = loss at first boundary + loss in copper + loss at second boundary, or

\[ -150 = -40.6 + 20 \log(e^{-t/\delta_s}) - 40.6 \]

\[ -68.8 = 20 \log(e^{-t/\delta_s}) \quad (1). \]

\[ \delta_s = \sqrt{\frac{2}{\omega \mu \sigma}} = 2.09e-6 \text{ meters.} \]

Solving (1) for \( t \) yields a thickness of .01654 mm, or approximately .017 mm.