EE3140 Quiz 3, Fall 2013

Show your work for full credit. Useful constants:

\[
\begin{align*}
\epsilon_0 &= 8.854 \times 10^{-12} \text{ F/m} \\
\mu_0 &= 4\pi \times 10^{-7} \text{ H/m}
\end{align*}
\]

1. The amplitude of \( \vec{E} \) just inside a liquid is 1.0V/m and \( \text{Re}\{\hat{\epsilon}\} = 20 \epsilon_0 \), with \( \sigma = 0.5 \text{mho/m} \). Determine the amplitude of \( \vec{E} \) at a distance of 0.1m inside the medium for \( f=5\text{GHz} \) (5 \( \times \) 10\(^9\) Hz). (5 points)

Solution:

\[
k = \omega \sqrt{\mu \epsilon} \sqrt{1 - j \frac{\sigma}{\omega \epsilon}} = 469.1 - j21.04
\]

Note that \( \frac{\sigma}{\omega \epsilon} = 0.09 \ll 1 \) so \( k_I = \frac{1}{2} \sigma \sqrt{\mu/\epsilon} = 21.06 \).

Then, \( 1.0e^{-k_I(0.1)} = 0.122[V/m] \)

2. Given \( \vec{E} = ((2 - j)\hat{x} + (3 - j)\hat{z}) \exp^{+jy} \),

(a) What direction is the wave traveling? (1 point)

Ans.: -y -direction

(b) What polarization does this wave have, linear, circular, or elliptical? (2 points)

Ans.: elliptical:magnitudes of \( \hat{x}, \hat{y} \) not equal and phases not equal, either. (although not requested, handedness = Right-handed)

(c) What is the wavelength? (2 points)

Solution: \( k=1 \) (from the \( e^{+jy} \) term), so \( \lambda = 2\pi/k=6.28[\text{m}] \)