EE3140 Quiz 3, Fall 2011

Show your work for full credit. Useful constants:

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

1. The amplitude of \( \vec{E} \) just inside a liquid is 1.0V/m and \( \text{Re}\{\hat{\epsilon}\} = 20 \ast \epsilon_o \), with \( \sigma = 0.5 \text{ mho/m} \). Determine the amplitude of \( \vec{E} \) at a distance of 0.1m inside the medium for \( f=5\text{GHz} \ (5 \times 10^9 \text{ Hz}) \). (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 \( k = \frac{1}{2} \sigma \sqrt{\mu / \epsilon} = 21.06 \).
Then, \( 1.0e^{-k(0.1)} = 0.122[V/m] \)

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

(a) What direction is the wave traveling? (2 points)

Solution: The time-dependent form is \( \cos(\omega t + y) \). Because the spatial variable is \( y \), the wave is moving in either the + or - y-direction. Because the signs of the \( \omega t \) and spatial term \( y \) are the same, the wave is moving in the -y -direction.

(b) What polarization does this wave have, linear, circular, or elliptical? (3 points)

Solution: elliptical (magnitudes of \( \hat{x}, \hat{z} \) not equal and phases not equal, either)