Homework 1: ECE 4370

Introduction to Radiating Systems

1. Video review: Please review the following YouTube™ videos on the profdurgin channel for ECE 3025 concepts that we will need in antenna engineering.

   THT01 – Phasor Review (16 min)
   WAV02 – Maxwell’s Equations (50 min)
   WAV03 – Helmholtz Wave Equation (49 min)
   WAV04 – Plane Waves (34 min)

   (5 points)

2. Resonance: Use the internet to estimate the velocity of propagation of the standing wave on the C-string of a cello.

   (5 points)

3. Plane Waves/Vector Calc: A homogeneous plane wave is traveling in a simple, sourceless dielectric medium in the \((\phi, \theta)\) direction. The phasor-form E-field and H-field expressions are given by the following system of equations:

   \[
   \vec{E}(\vec{r}) = \frac{E_0 \hat{\epsilon}}{\sqrt{\mu/\epsilon}} \exp \left( -jk \hat{k} \cdot \vec{r} \right)
   \]

   \[
   \vec{H}(\vec{r}) = \frac{E_0 \hat{\mu}}{\sqrt{\mu/\epsilon}} \exp \left( -jk \hat{k} \cdot \vec{r} \right)
   \]

   \[
   \hat{\epsilon} \times \hat{h} = \hat{k} \quad -\hat{k} = \cos \phi_0 \sin \theta_0 \hat{x} + \sin \phi_0 \sin \theta_0 \hat{y} + \cos \theta_0 \hat{z} \quad k = \frac{2\pi}{\lambda} \quad \vec{r} = x\hat{x} + y\hat{y} + z\hat{z}
   \]

   In the space below, show that the x-component of the E-field satisfies the scalar wave equation. In other words, verify that

   \[
   (\nabla^2 + k^2)(\hat{x} \cdot \vec{E}) = 0
   \]

   (10 points)