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 (ϕ, θ) direction. The phasor-form E-field and H-field expressions are given by the following system of equations:

$$\tilde{\vec{E}}(\vec{r}) = \overbrace{(E_x\hat{x} + E_y\hat{y} + E_z\hat{z})}^{E_o\hat{e}} \exp\left(-jk\hat{k}\cdot\vec{r}\right)$$

$$\tilde{\vec{H}}(\vec{r}) = \underbrace{(H_x\hat{x} + H_y\hat{y} + H_z\hat{z})}_{\frac{E_o}{\sqrt{\mu/\epsilon}}\hat{h}} \exp\left(-jk\hat{k}\cdot\vec{r}\right)$$

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

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

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

(10 points)