

E E / Mteor / Agron 518 Spring 2008
Problem Set 3
Due Tuesday, February 5, 2008

Assigned January 29, 2008

1. Find ω , k_o , k , λ_o , λ , and u_p if:
 - (a) $f = 30$ MHz and $\epsilon_r = 9$.
 - (b) $f = 3$ GHz and $\epsilon_r = 9$.
 - (c) $f = 3$ GHz and $\epsilon_r = 25$.
2. Given $\tilde{\mathbf{E}} = \hat{\mathbf{x}} \tilde{E}_x$, explain why the plane wave $\tilde{E}_x = \tilde{E}_{x_o}^- e^{jkz}$ (assume $\tilde{E}_{x_o}^+$ is purely real) propagates in the $-\hat{\mathbf{z}}$ direction.
 - (a) First find the actual electric field by changing from the time harmonic form.
 - (b) Examine the resulting electric field and recall the form of a wave equation.
3. Given the same complex electric field as in Problem 2
 - (a) show that it solves the Helmholtz equation (or homogeneous wave equation) $\nabla^2 \tilde{\mathbf{E}} + k^2 \tilde{\mathbf{E}} = 0$;
 - (b) find $\tilde{\mathbf{H}}$;
 - (c) show that $\tilde{\mathbf{H}}$ solves the homogeneous wave equation $\nabla^2 \tilde{\mathbf{H}} + k^2 \tilde{\mathbf{H}} = 0$.Note that $\nabla^2 = \partial^2/\partial x^2 + \partial^2/\partial y^2 + \partial^2/\partial z^2$ in Cartesian coordinates.
4. Use “Wave on a String” on the PHET website (now there is a link on the course webpage) to explore wave motion. This is a Shockwave Flash Object: open with a web browser that has the Adobe Flash Player installed. Play and experiment. Then do the following. Set to “No End.” Set to “Oscillate.”
 - (a) Find the wavelength λ and the phase velocity u_p for the settings shown in Figures 1, 2, and 3. Use the “Rulers,” “Timer,” and “draggable reference line” to help. Note that the values for “amplitude,” “frequency,” and “damping” are only relative and not absolute, which means that if you want to find the actual frequency (which may be helpful in determining the phase velocity), you will need to use the “Timer” and count the revolutions of the oscillator.
 - (b) What material (constitutive) electrical property is analogous to “tension” in the simulation?
 - (c) As “tension” is increased, does this material electrical property increase or decrease? Explain how you determined this.
5. Given the plane wave $\tilde{\mathbf{E}} = \hat{\mathbf{x}} \tilde{E}_{x_o}^+ e^{-jkz}$, $f = 1$ GHz, $\epsilon_r = 15$, and $\tilde{E}_{x_o}^+ = 20$ V m⁻¹:
 - (a) find the real field $\mathbf{E}(t)$;
 - (b) illustrate how $\mathbf{E}(t)$ propagates in the $\hat{\mathbf{z}}$ direction by generating a MATLAB figure (consider using the example m-file from the last Problem Set);
 - (c) find the only non-zero component of $\tilde{\mathbf{H}}$;
 - (d) find the real field $\mathbf{H}(t)$;



Figure 1: Settings for part 4a.

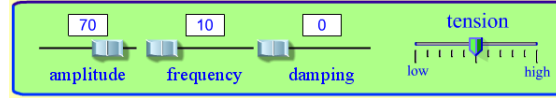


Figure 2: Settings for part 4a.

- (e) illustrate how $\mathbf{H}(t)$ propagates by generating a MATLAB figure.
 - (f) How will the figures change (qualitatively, you don't need to illustrate with a figure) if $\tilde{E}_{x_0}^+$ is *not* purely real?
6. Read "Scientists Add Up Gains, Losses In Bush's New Vision for NASA." Follow these directions for find the article. Go to the ISU library website, point to "Collections" and click on "e-Journals & e-Books," search for the journal "Science" and click on the "Highwire Press" site. Then find page 444 of volume 303. Alternatively, use the digital object identifier (doi) 10.1126/science.303.5657.444.
 - (a) What is the president's vision for NASA?
 - (b) Why are some concerned?
 - (c) Who was the NASA Administrator at that time? According to him, what will happen to earth science?
 - (d) What was the reaction of the space programs of other countries?
 7. Read "NASA Terminates Two Earth Observation Missions" using the link to this *Eos* article on the course website. *Eos* is the weekly periodical of the American Geophysical Union, a professional association of earth and space scientists.
 - (a) What does Richard Anthes, president of Universities Corporation for Atmospheric Research (UCAR), say about the cancellations of two new satellite missions?
 - (b) What effort is Anthes leading for the National Research Council?
 - (c) Define the Earth System Science Pathfinder (ESSP) program.
 - (d) How would have soil moisture data been used?
 - (e) What made Hydros unique as compared to other current and planned satellites?
 - (f) What point is made by Francisco Valero, PI of the DSCOVR mission, in response to Jack Kayes' assertion that tough budget choices must be made?

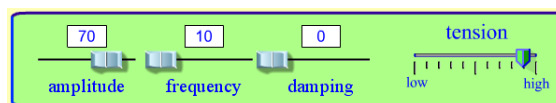


Figure 3: Settings for part 4a.