EP440: Engineering Electromagnetics

Fall 2012, J. B. Snively

Homework #12: Due 12/6/2012 at 5:00 (Put in Byron Lowry's Mailbox)!

For this assignment... Work out the following problems on separate sheets. Staple all, including this front page, for your submission.

Please make note: In the figure, E is plotted as E/eta, so that it has the same amplitude as H. *If you are trying this exercise as a PS250 Honors Program student, note that B=μH, so that if B=E/c, then H=E/(cμ)=E/eta, where eta=μc=sqrt(μ/epsilon). You will be pleased to find that this results in a simpler expression for S!*

1) Using the MATLAB file "emwave.m":

- **a.** Fix a small bug in the code. Presently, wavelength is calculated incorrectly. Change this expression for wavelength to read "lambda=xdomain/M".
- **b.** Modify the code to include a second subplot in the figure window showing instantaneous Poynting vector flux *S*.
- **c.** Generate a standing wave at ~2.4 GHz frequency, and a horizontal dimension sufficient to hold exactly 3 half-wavelengths. Note that the code calculates frequency based on horizontal dimension and number of desired wavelengths to fit in the box. So, you will do this by adjusting the grid point step size and number of desired wavelengths to fit in the box. (Hint: Pick a Gaussian width = 1/5 of total simulation time, that peaks at 1/2 simulation time.)
- **d.** Print a plot of your standing wave field variables and instantaneous *S* after the simulation has completed. Discuss in a few sentences the features of *E*, *H*, and *S*.
- **e.** Run a second case resulting in a ~2.4 GHz frequency, but now with a horizontal dimension able to hold 10 wavelengths. Adjust the Gaussian width and peak time (as fraction of total time) to produce a packet which is small relative to the total domain (similar to that which you saw in the initial example file).
- **f.** Print a plot of your wave field variables at three interesting times: When the wave is left-going, when the wave is reflecting, and when the wave is right-going. Discuss in a few sentences the features of *E*, *H*, and *S*.

In submitting this part of the assignment, include a copy of the code, with comments noting each change made (for example, wavelength, domain size, routine to plot S*).*

2) Cheng Problem P.8-15. Verify that the result of (a) holds for a dispersive wave of your choice.

3) Cheng Problem P.8-34. This is extra credit, but a great problem if you are looking for a challenge and **10 extra homework points**. Take advantage of results from sections 8-10.2 and 8-10.3, but fully document your progress.

4) Cheng Problem P.9-3.

5) Cheng Problem P.9-10.