ECE5340/6340: Homework 8

Write your section (ECE5340 or ECE6340) by your name. Turn in a printed copy containing the problem solutions, plots, and the code used to generate them. Remember to comment and format the code so is legible to the graders. Label the plots appropriately, including units for each axis and for the values plotted. Assume all units to be SI units unless stated differently. Due Wednesday 3/7 BEFORE class begins.

Problem 1

(10 points) From the sample code given in class, develop a 1D FDTD code with simple absorbing boundary conditions (ABC) on the RIGHT side of the model (left side will be a PEC). Consider 200 cells on the Z direction, and a TEM sinusoidal wave. Place the E field source at the cell number 150. Turn in a plot of the resulting E field on the problem space after 400 iterations.

Problem 2

Starting from the code in Problem 1, modify the program to add the LEFT side ABC so the simulation space is properly terminated.

1. (10 points) Run the same simulation for 400 iterations, and turn in a plot of the resulting E field used to verify that the ABCs are working properly. Turn in your code (printed).
2. (ECE6340: 20 points, ECE5340: 30 points) Modify the code once again to account for the existence of a dielectric medium. Run the same simulation as before, this time using a dielectric medium having a relative permittivity of 4 instead than in vacuum. Run the simulation for 400 iterations, and turn in a plot of the resulting E field and your code.
3. Answer: Is this what you expected as a result? why?

Problem 3

Solve using your 1D FDTD code: Consider a 1GHz plane wave (sinusoidal) travelling through free space and impinging on a 10 cm slab of a dielectric losless material. The slab material has a dielectric constant of $\epsilon_r = 5$.

1. (ECE6340: 10 points, ECE5340:20 points) Calculate values of Δt and Δz appropriate for this problem. For full credit, show the rationale, not just the numerical values.

2. (ECE 6340: 20 points, ECE5340: 30 points) Run a 1D FDTD simulation using the parameters above, and draw 3 plots showing:

   (a) the wave travelling through space about to enter the slab.

   (b) the wave travelling inside the slab about to exit the slab.

   (c) the wave after exiting the slab into free space.

   on each plot, mark the position of the dielectric slab.

Problem 4 (ECE6340 only)

Using the same slab as in the previous problem and a new FDTD simulation, and assuming that the material is *dispersive*, numerically calculate the reflection and transmission coefficients at the two interfaces (entering and exiting the slab) for 10GHz. Feel free to use any waveform you may consider adequate.

Report:

1. (10 points) values for the transmission and reflection coefficients at the first interface.

2. (10 points) values for the transmission and reflection coefficients at the second interface.

3. (10 points) plots of the E field to substantiate the numerical values observed.