Homework 6

EE691-82 Applied EM- FDTD Method, Spring 2012

Wednesday, March 21, 2012

1) Starting with Ampere's Law per (7.53a), derive the UPML FDTD update equations, using the auxiliary differential equation approach (see section 7.8), for all the electric field components. Use the Yee cell indices/locations as shown in Figure 1b (i.e., those shown centered on visible cell faces) of the Chapter 3 notes.

2) Starting with Faraday's Law per (7.53b), derive the UPML FDTD update equations, using the auxiliary differential equation approach (see section 7.8), for all the magnetic field components. Use the Yee cell indices/locations as shown in Figure 1a (i.e., those shown centered on visible cell faces) of the Chapter 3 notes.

3) Draw the applicable spatial FDTD mesh for the TE_y-mode. Layout mesh with z being the vertical axis and x being the horizontal axis. Then, using the results of 1) and 2), derive the UPML FDTD update equations for a 2D problem in the TE_y-mode.

4) A $5\Delta \times 5\Delta$ TE_y-mode FDTD modeling space of a dielectric ($5\varepsilon_0$, μ_0) medium is to be surrounded by a polynomial-graded UPML that is 5Δ thick. Using a square lattice, draw the entire spatial FDTD mesh. Assuming only far-field waves (i.e., propagating fields) are incident on the UPML and $\Delta = 2$ cm: a) determine the appropriate κ_x, b) calculate $\sigma_{x,\text{opt}}$ for third and fourth-order polynomial tapers (i.e., $m = 3$ and 4) per (7.67), c) write-out expressions for s_x for both cases, and d) on a single graph, plot σ_x versus x for the entire span of the FDTD lattice ($0 \le x \le 15\Delta$) putting markers at 0.5Δ intervals, i.e., at the locations of the various field components.

Show **<u>all</u>** work for full credit.

Due Wednesday, March 28, 2012