Homework 7

EE691-82 Applied EM- FDTD Method, Spring 2012

Wednesday, April 04, 2012

1) The top surface S_{top} ($x_{\text{back}} \le x' \le x_{\text{front}}$, $y_{\text{left}} \le y' \le y_{\text{right}}$, & $z' = z_{\text{top}}$) of an overall surface S is selected for doing a near-to-far-field transformation. On S_{top}, determine the equivalent electric and magnetic surface currents associated with each of the six electric and magnetic fields. As applicable, use the field locations $x' = i\Delta x$, $y' = (j+0.5)\Delta y$, & $z' = (k_{\text{top}} + 0.5)\Delta z$; $x' = i\Delta x$, $y' = j\Delta y$, & $z' = (k_{\text{top}} + 0.5)\Delta z$; $x' = (i+0.5)\Delta x$, $y' = j\Delta y$, & $z' = (k_{\text{top}} + 0.5)\Delta z$; or $x' = (i+0.5)\Delta x$, $y' = (j+0.5)\Delta y$, & $z' = (k_{\text{top}} + 0.5)\Delta z$.

2) Using the results of 1), find the contributions to the vector potential $\bar{W}$ due to the equivalent electric surface currents on S_{top}. Neglect time delay for this step.

3) Using the results of 1), find the contributions to the vector potential $\bar{U}$ due to the equivalent magnetic surface currents on S_{top}. Neglect time delay for this step.

4) For the far-field point $r = 100$ m, $\theta = \pi/3$, & $\phi = \pi/4$, determine the time delay τ_d for the electric field component E_y located at $\left((i+0.5)\Delta x, j\Delta y, (k_{top}+0.5)\Delta z\right)$ when $i = 25$, $j = 20$, $k_{\text{top}} = 200$, $\Delta x = \Delta y = \Delta z = 2$ cm, and $c = 3 \bullet 10^8$ m/s. If a Courant stability factor of 0.5 is used, determine Δt and the fractional number of time steps $f = \dfrac{\tau_d}{\Delta t}$ required to arrive at the far-field from E_y. Given $E_y^{90}() = 2000$ V/m and $E_y^{91}() = 2150$ V/m, determine the contribution $\Delta U_?$ to the vector potential $\bar{U}$ as well as the time indices nn and $nn+1$. Then, calculate the contributions $(1-a)\Delta U_?$ and $a\,\Delta U_?$ to $U_?^{nn}$ and $U_?^{nn+1}$ respectively.

5) For the far-field point $r = 100$ m, $\theta = \pi/3$, & $\phi = \pi/4$, determine the time delay τ_d for the magnetic field component H_y interpolated to the position $\left(i\Delta x, (j+0.5)\Delta y, (k_{top}+0.5)\Delta z\right)$ when $i = 25$, $j = 20$, $k_{\text{top}} = 200$, $\Delta x = \Delta y = \Delta z = 2$ cm, and $c = 3 \bullet 10^8$ m/s. If a Courant stability factor of 0.5 is used, determine Δt and the fractional number of time steps $f = \dfrac{\tau_d}{\Delta t}$ required to arrive at the far-field from H_y. Given $H_y^{89.5}\left(i, j+0.5, k_{top}\right) = 4.4$ A/m, $H_y^{89.5}\left(i, j+0.5, k_{top}+1\right) = 4.1$ A/m, $H_y^{90.5}\left(i, j+0.5, k_{top}\right) = 5$ A/m, & $H_y^{90.5}\left(i, j+0.5, k_{top}+1\right) = 4.8$ A/m, determine the contribution $\Delta W_?$ to the vector potential $\bar{W}$ as well as the time indices nn and $nn+1$. Then, calculate the contributions $(1-a)\Delta W_?$ and $a\,\Delta W_?$ to $W_?^{nn}$ and $W_?^{nn+1}$ respectively.

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Due Friday, April 13, 2012