Subject: Hw 3 — 810100511 — [illegible]

Year. Month. Date. ( )

Q. 3.32 8 no variation with respect to ϕ

Yee's Algo for TM

$$\hookrightarrow H_\phi^{n+1}(i,j) = H_\phi^{n}(i,j) + \alpha\left[E_z^{n+1/2}(i,j+\tfrac12) - E_z^{n+1/2}(i,j-\tfrac12)\right] - \alpha\left[E_\rho^{n+1/2}(i+\tfrac12,j) - E_\rho^{n+1/2}(i-\tfrac12,j)\right]$$

$$E_z^{n+3/2}(i,j+\tfrac12) = \gamma E_z^{n+1/2}(i,j+\tfrac12) + \beta\left[\frac{1}{j} H_\phi^{n+1}(i,j+\tfrac12) + H_\phi^{n+1}(i,j+1) - H_\phi^{n+1}(i,j)\right]$$

$$E_\rho^{n+3/2}(i+\tfrac12,j) = \gamma E_\rho^{n+1/2}(i+\tfrac12,j) - \beta\left[H_\phi^{n+1}(i+1,j) - H_\phi^{n+1}(i,j)\right]$$

$$\alpha = \frac{\delta t}{\mu \delta},\quad \beta = \frac{\delta t}{\epsilon \delta},\quad \gamma = 1 - \frac{\sigma \delta t}{\epsilon},\quad \delta = \Delta\rho = \Delta z$$

$$H_\phi(z,\rho,t) = H_\phi(z = i\Delta z,\ \rho = (j-\tfrac12)\Delta\rho,\ t = n\delta t) = H_\phi^n(i,j)$$

TM waves $\rightarrow H_z = 0,\ E_z \neq 0,\ \frac{\partial}{\partial\phi} = \phi \Rightarrow H_\rho = \phi,\ E_\phi = \phi \Rightarrow$ معادله ماکسول میشه $\rightarrow$

$$\epsilon \frac{\partial}{\partial t} E_\rho = -\frac{\partial}{\partial z} H_\phi - \sigma E_\rho$$

$$\epsilon \frac{\partial}{\partial t} E_z = \frac{1}{\rho}\frac{\partial}{\partial \rho}(\rho H_\phi) - \sigma E_z = \frac{\partial}{\partial\rho} H_\phi + \frac{H_\phi}{\rho} - \sigma E_z$$

$$\mu \frac{\partial}{\partial t} H_\phi = \frac{\partial}{\partial \rho} E_z - \frac{\partial}{\partial z} E_\rho$$

3.82

$$\hookrightarrow \frac{\partial}{\partial x} F^n(i,j,k) = \frac{F^n(i+\tfrac12,j,k) - F^n(i-\tfrac12,j,k)}{\delta}$$

$$\frac{\partial}{\partial t} F^n(i,j,k) = \frac{F^{n+1/2}(i,j,k) - F^{n-1/2}(i,j,k)}{\Delta t}$$

3.83

$\frac{\Delta t}{\mu\delta}$, $\frac{\partial}{\partial\rho} E_z$

$$\Rightarrow H_\phi^{n+1/2}(i,j) = H_\phi^n(i,j) + \alpha\left[E_z^{n+1/2}(i,j+\tfrac12) - E_z(i,j-\tfrac12)\right] - \alpha\left[E_\rho^{n+1/2}(i+\tfrac12,j) - E_\rho(i-\tfrac12,j)\right]$$

z, ρ, $\frac{\partial}{\partial z} E_\rho$, z, ρ

$\frac{\partial}{\partial t}$

$$\Rightarrow E_z^{n+3/2}(i,j+\tfrac12) = \gamma E_z^{n+1/2}(i,j+\tfrac12) + \beta\left[H_\phi^{n+1}(i,j+1) - H_\phi^{n+1}(i,j) + \frac{1}{j} H_\phi^{n+1}(i,j+\tfrac12)\right]$$

$1 - \frac{\sigma\delta t}{\epsilon}$, $\frac{\delta t}{\epsilon\delta}$, $\frac{\partial}{\partial\rho}$, $\frac{H_\phi}{\rho}$, ρ

$\left(\frac{\epsilon}{\delta t}\right)(\cdot)$

$$E_\rho^{n+3/2}(i+\tfrac12,j) = \gamma E_\rho^{n+1/2}(i+\tfrac12,j) - \beta\left[H_\phi^{n+1}(i+1,j) - H_\phi^{n+1}(i,j)\right]$$

σE_ρ, $1 - \frac{\sigma\delta t}{\epsilon}$, $\frac{\Delta t}{\epsilon\delta}$, $\rightarrow \frac{\partial}{\partial z}$, z

PAPCO

Subject:
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Q 3.34 PML Modification of Maxwell's Eq. $\rightarrow$ 12 eqs

Perfectly Match Layer

$E_z \rightarrow E_{zx} + E_{zy}$ | $H_z \rightarrow H_{zx} + H_{zy}$

$E_y \rightarrow E_{yx} + E_{yz}$ | $H_y \rightarrow H_{yx} + H_{yz}$

$E_x \rightarrow E_{xy} + E_{xz}$ | $H_x \rightarrow H_{xy} + H_{xz}$

$$\begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 0 & 0 & 0 \end{vmatrix}$$

$$\begin{cases} \vec{\nabla} \times \vec{H} = \varepsilon_0 \frac{\partial}{\partial t} \vec{E} + \sigma \vec{E} \\ \vec{\nabla} \times \vec{E} = -\mu \frac{\partial}{\partial t} \vec{H} - \sigma^* \vec{H} \end{cases}$$

$\Rightarrow$ ① $\varepsilon_0 \frac{\partial}{\partial t} E_{xy} + \sigma_y^* E_{xy} = \frac{\partial}{\partial y}(H_{zx} + H_{zy})$

② $\varepsilon_0 \frac{\partial}{\partial t} E_{xz} + \sigma_y^* E_{xz} = -\frac{\partial}{\partial z}(H_{yx} + H_{yz})$

③ $\varepsilon_0 \frac{\partial}{\partial t} E_{yz} + \sigma_z^* E_{yz} = -\frac{\partial}{\partial x}(H_{zx} + H_{zy})$

④ $\varepsilon_0 \frac{\partial}{\partial t} E_{yx} + \sigma_x^* E_{yx} = -\frac{\partial}{\partial x}(H_{zx} + H_{zy})$

⑤ $\varepsilon_0 \frac{\partial}{\partial t} E_{zx} + \sigma_x^* E_{zx} = \frac{\partial}{\partial x}(H_{yx} + H_{yz})$

⑥ $\varepsilon_0 \frac{\partial}{\partial t} E_{zy} + \sigma_y^* E_{zy} = -\frac{\partial}{\partial x}(H_{xy} + H_{xz})$

⑦ $\mu_0 \frac{\partial}{\partial t} H_{xy} + \sigma_y^* H_{xy} = -\frac{\partial}{\partial y}(E_{zx} + E_{zy})$

⑧ $\mu_0 \frac{\partial}{\partial t} H_{xz} + \sigma_z^* H_{xz} = \frac{\partial}{\partial z}(E_{yx} + E_{yz})$

⑨ $\mu_0 \frac{\partial}{\partial t} H_{yz} + \sigma_z^* H_{yz} = -\frac{\partial}{\partial z}(E_{xy} + E_{xz})$

⑩ $\mu_0 \frac{\partial}{\partial t} H_{yx} + \sigma_x^* H_{yx} = -\frac{\partial}{\partial x}(E_{zx} + E_{zy})$

⑪ $\mu_0 \frac{\partial}{\partial t} H_{zx} + \sigma_x^* H_{zx} = -\frac{\partial}{\partial z}(E_{yx} + E_{yz})$

⑫ $\mu_0 \frac{\partial}{\partial t} H_{zy} + \sigma_y^* H_{zy} = -\frac{\partial}{\partial y}(E_{xy} + E_{xz})$

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