2007 Schol. OUTLINE SOLNS

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$$\operatorname{curl} \underline{F} = \begin{pmatrix} \partial_y F_3 - \partial_z F_2 \\ \partial_z F_1 - \partial_x F_3 \\ \partial_x F_2 - \partial_y F_1 \end{pmatrix}$$

$$(\operatorname{curl} \operatorname{curl} \underline{F})_1 = \partial_y (\partial_x F_2 - \partial_y F_1) - \partial_z (\partial_z F_1 - \partial_x F_3)$$

$$= \partial_y \partial_x F_2 + \partial_z \partial_x F_3 + \partial_x \partial_x F_1 - (\partial_x^2 + \partial_y^2 + \partial_z^2) F_1$$

$$= \partial_x (\underline{\nabla} \cdot \underline{F}) - \Delta F_1$$

$$= (\operatorname{grad} \operatorname{div} \underline{F} - \Delta \underline{F})_1$$

$$\underline{H} = \operatorname{curl} \frac{\partial \underline{Z}}{\partial t}$$

$$\underline{E} = \operatorname{curl} \operatorname{curl} \underline{Z}$$

$$\operatorname{div} \underline{H} = \operatorname{div}\left(\operatorname{curl} \frac{\partial \underline{Z}}{\partial t}\right) = 0$$

$$\because \operatorname{div} \operatorname{curl} \underline{F} = 0$$

$$\nabla \underline{F}$$

$$\operatorname{div} \underline{E} = \operatorname{div}\left(\operatorname{curl}(\operatorname{curl} \underline{Z})\right)$$

$$= 0 \qquad \text{as above}$$

$$\operatorname{curl} \underline{H} = \operatorname{curl} \operatorname{curl} \frac{\partial \underline{Z}}{\partial t}$$

$$= \frac{\partial}{\partial t} \operatorname{curl} \operatorname{curl} \underline{Z} = \frac{\partial \underline{E}}{\partial t}$$

$$\operatorname{curl} \underline{E} = \operatorname{curl}\left(\operatorname{grad} \operatorname{div} \underline{Z} - \Delta \underline{Z}\right)$$

$$= -\operatorname{curl} \frac{\partial^2 \underline{Z}}{\partial t^2} = -\frac{\partial \underline{H}}{\partial t} \quad \because \operatorname{curl} \operatorname{grad} \phi = 0$$

$$\& \text{ using } \Delta \underline{Z} = \frac{\partial^2 \underline{Z}}{\partial t^2}$$