(1). $\vec{J} = I(t')\delta(x')\delta(y')\hat{z}$.

$$\vec{A} = \frac{\mu_0}{4\pi}\int \frac{J}{|\vec{x}-\vec{x}'|}d^3x' = \frac{\mu_0}{4\pi}\int \frac{I(t'-\frac{|\vec{x}-\vec{x}'|}{c})\delta(x')\delta(y')}{|\vec{x}-\vec{x}'|}d^3x'.$$

$$= \frac{\mu_0}{4\pi}\int \frac{I(t'-\frac{\sqrt{r^2+z'^2}}{c})}{\sqrt{r^2+z'^2}}dz' = \frac{\mu_0 k}{2\pi}\int_0^{\sqrt{c^2t^2-r^2}} \left(\frac{t}{\sqrt{r^2+z'^2}} - \frac{1}{c}\right)dz'.$$

$$\vec{E} = -\frac{\partial\vec{A}}{\partial t} = \frac{-\mu_0 k}{2\pi}\left(\ln\frac{\sqrt{c^2t^2-r^2}+ct}{r} + \frac{r(c^2t^2/\sqrt{c^2t^2-r^2})}{\sqrt{c^2t^2-r^2}+ct} - \frac{ct}{\sqrt{c^2t^2-r^2}}\right).$$

$$= \frac{\mu_0 k}{2\pi}\left(\ln\frac{\sqrt{c^2t^2-r^2}+ct}{r}\,t - \frac{\sqrt{c^2t^2-r^2}}{c}\right).$$

$$\vec{B} = \nabla\times\vec{A} = \cancel{\begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 0 & 0 & |A| \end{vmatrix}} = -\frac{\partial A_z}{\partial r}\hat{\phi}.$$

$$= \frac{\mu_0 k}{2\pi}\left(\frac{ct^2}{r\sqrt{c^2t^2-r^2}} - \frac{r}{c\sqrt{c^2t^2-r^2}}\right)\hat{\phi}.$$

(2). $$\vec{A} = \frac{\mu_0}{4\pi}\int \frac{I(t'-\frac{\sqrt{r^2+z'^2}}{c})}{\sqrt{r^2+z'^2}}dz' = \frac{\mu_0 q_0}{4\pi}\int \frac{\delta(t-\frac{\sqrt{r^2+z'^2}}{c})}{\sqrt{r^2+z'^2}}dz'.$$

$$= \frac{\mu_0 q_0}{2\pi}\cdot\frac{c\,\Theta(ct-r)}{\sqrt{c^2t^2-r^2}}.$$

$$\vec{E} = -\frac{\partial\vec{A}}{\partial t} = \frac{\mu_0 q_0}{2\pi}\frac{c^3 t}{(c^2t^2-r^2)^{3/2}}.$$

$$\vec{B} = -\frac{\partial A_z}{\partial r}\hat{\phi} = -\frac{\mu_0 q_0}{2\pi}\frac{cr}{(c^2t^2-r^2)^{3/2}}\hat{\phi}.$$

6.13.

(a) $\vec{E} = E\hat{z}$. $\vec{B} = B\hat{x}$.

$$\frac{\partial^2 E}{\partial y^2} + \left(\frac{\omega}{c}\right)^2 E = 0. \quad E = \frac{\mu_0 I}{ba\omega} - \frac{2a^2+3y^2-6ay}{6ab}\mu_0 I$$

$$H = \frac{I}{b} - \frac{Iy}{ab} + \frac{2a^2y-3ay^2+y^3}{6ac^2b}\cdot I$$

(b). $E = \frac{I}{\omega\varepsilon_0 ab}$. $H = \frac{I}{ab}y - \frac{I}{b}$.

$$X = \frac{4\omega}{I^2}\int(\omega_1-\omega_e)d^3x \approx \frac{4\omega}{|I|^2}\int\left(\frac{\varepsilon_0}{4}E^2 - \frac{\mu_0}{4}H^2\right)d^3x = \omega L - \frac{1}{\omega C}$$