$$\vec{\boldsymbol{A}} = \mu I_m l \frac{e^{-jkr}}{4\pi r} \hat{\boldsymbol{z}} \tag{1}$$

$$\hat{\boldsymbol{z}} = \cos\theta \cdot \hat{\boldsymbol{r}} - \sin\theta \cdot \hat{\boldsymbol{\theta}} \tag{2}$$

Thus, plugging (2) $\rightarrow$ (1)

$$\vec{\boldsymbol{A}} = \mu I_m l \frac{e^{-jkr}}{4\pi r} [\cos\theta \cdot \hat{\boldsymbol{r}} - \sin\theta \cdot \hat{\boldsymbol{\theta}}] \tag{3}$$

$$\vec{\boldsymbol{H}} = \boldsymbol{\nabla} \times \vec{\boldsymbol{A_T}} \tag{4}$$

$$\vec{\boldsymbol{H}}_r = 0 \tag{5}$$

$$\vec{\boldsymbol{H}}_\theta = \frac{\mu I_m l}{4\pi} \frac{1}{r} \Big(\frac{1}{\sin\theta} \cancelto{0}{\frac{\partial A_r}{\partial \varphi}} - \frac{\partial (r \cdot \cancelto{0}{A_\varphi})}{\partial r} \Big) = 0 \tag{6}$$

$$\vec{\boldsymbol{H}}_\varphi = \frac{\mu I_m l}{4\pi} \frac{1}{r} \Big(\frac{\partial (r \cdot A_\theta)}{\partial r} - \frac{\partial A_r}{\partial \theta} \Big) \tag{7}$$

$$= \frac{\mu I_m l}{4\pi} \frac{1}{r} \left(\frac{\partial}{\partial r} \left(r \frac{e^{-jkr}}{r} (-\sin\theta) \right) - \frac{\partial}{\partial \theta} \left(\frac{e^{-jkr}}{r} (\cos\theta) \right) \right) \tag{8}$$

$$= \frac{\mu I_m l}{4\pi} \frac{1}{r} \left(\frac{\partial}{\partial r} \big(e^{-jkr} (-\sin\theta) \big) - \frac{\partial}{\partial \theta} \left(\frac{e^{-jkr}}{r} (\cos\theta) \right) \right) \tag{9}$$

$$= \frac{\mu I_m l}{4\pi} \frac{1}{r} \left(jk (e^{-jkr} \sin\theta) - (\frac{e^{-jkr}}{r} (-\sin\theta)) \right) \tag{10}$$

$$\vec{\boldsymbol{H}}_\varphi = \mu I_m l \frac{e^{-jkr}}{4\pi r} (jk + \frac{1}{r}) \sin\theta \cdot \hat{\boldsymbol{\varphi}} \tag{11}$$

$$\vec{\boldsymbol{E}} = \frac{1}{j\omega\varepsilon}\boldsymbol{\nabla} \times \vec{\boldsymbol{H}} \tag{12}$$

$$\vec{\boldsymbol{E}}_r = \frac{\mu I_m l}{j\omega\varepsilon}\frac{1}{4\pi}\frac{1}{r\sin\theta}\Big(\frac{\partial(H_\varphi \sin\theta)}{\partial\theta} - \frac{\cancelto{0}{\partial H_\theta}}{\partial\varphi}\Big) \tag{13}$$

$$= \frac{\mu I_m l}{j\omega\varepsilon}\frac{1}{4\pi}\frac{1}{r\sin\theta}\Big(\frac{\partial}{\partial\theta}\Big(\frac{e^{-jkr}}{r}(jk+1/r)\sin^2(\theta)\Big)\Big) \tag{14}$$

$$= \frac{\mu I_m l}{j\omega\varepsilon}\frac{e^{-jkr}}{4\pi r^2}(jk+1/r)\frac{1}{\sin\theta}2\cos\theta\sin\theta \tag{15}$$

$$\vec{\boldsymbol{E}}_r = 2\frac{\mu I_m l}{j\omega\varepsilon}\frac{e^{-jkr}}{4\pi r^2}(jk+1/r)\cos\theta\cdot\hat{\boldsymbol{r}} \tag{16}$$