I) $d << r$ $\quad \phi(r,\theta,t) = \frac{1}{4\pi\varepsilon_0}\left\{ \frac{q_0 \cos(w_* (t + \frac{r_+}{c})}{r_+} - \frac{q_0 \cos(w_*(t + \frac{r_-}{c}))}{r_-} \right\}$ (3

$$r_- = \sqrt{r^2 + \frac{d^2}{4} + r d \cos\theta} \simeq \sqrt{r^2\left(1 + \frac{d}{r}\cos\theta\right)} = r\sqrt{1 + \frac{d}{r}\cos\theta} \simeq$$

$$\simeq r * \left(1 + \frac{d}{2r}\cos\theta\right)$$ used McLaurin expansion

$$\frac{1}{r_-} = \frac{1}{r * \underbrace{\left(1 + \frac{d}{2r}\cos\theta\right)}_{-x}} = \frac{1}{r}\left(1 - \frac{1}{2}\frac{d}{r}\cos\theta + \left(-\frac{d}{2r}\cos\theta\right)^2 + \dots\right) \simeq$$

$$\simeq \frac{1}{r} * \left(1 - \frac{d}{2r}\cos\theta\right)$$ used Mc Lawrin expansion

$$\cos\left(w\left(t + \frac{r_-}{c}\right)\right) = \cos\left(w\left(t + \frac{1}{c} * r * \left(1 + \frac{d}{2r}\cos\theta\right)\right)\right) = \cos\left(wt + \frac{wr}{c} + \frac{w \cancel{r} d \cos\theta}{2c\cancel{r}}\right)$$

$$= \cos\left(wt + \frac{wr}{c} + \frac{w}{c}\frac{d}{2}\cos\theta\right) = \cos\left[w\left(t + \frac{r}{c}\right) - \left(\frac{-w}{c}\frac{d}{2}\cos\theta\right)\right]$$

use difference identities $\#$

$$= \cos\left[w\left(t + \frac{r}{c}\right)\right]\cos\left(\frac{-w}{c}\frac{d}{2}\cos\theta\right) + \sin\left[w\left(t + \frac{r}{c}\right)\right]\sin\left(\frac{-w}{c}\frac{d}{2}\cos\theta\right)$$

$\#$ $\cos(a - b) = \cos a \cos b + \sin a \sin b$