Subject:

Year. Month. Date. ( )

۹۲۱۰۲۸۴۶ محمد سینا

تمرین سری ۸ الکترومغناطیس دکتر کمالی

۱. $\vec{B} = B_0\hat{x} \quad , \quad \vec{E} = E_0\hat{z}$

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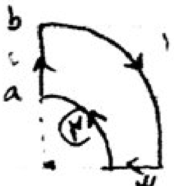
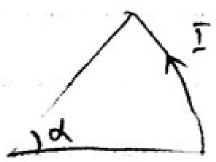
۲. الف) $K = \frac{I}{۲\pi a}$

ب) $\Rightarrow \quad I = \int J \cdot ds = \int \frac{k}{r} \times ۲\pi r\, dr = ۲\pi h a$

$k = \frac{I}{2\pi a} \quad \Rightarrow \quad J = \frac{I}{2\pi a \times \pi a^۲}$

۴.





$$\frac{\mu_0 I}{4\pi}\int_0^\alpha \frac{R\,d\varphi\,\hat{\varphi} - \rho\hat{r}}{R^2}$$

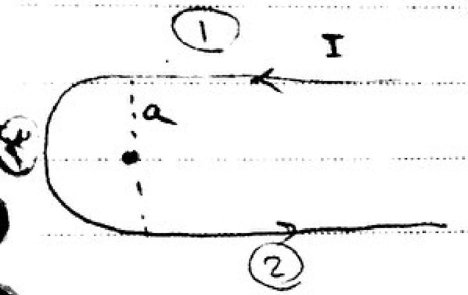
$$\frac{\mu_0 I}{4\pi R}\int_0^\alpha d\varphi = \frac{\mu_0 I \alpha}{4\pi R}\hat{z}$$

$$B(۱) = \frac{\mu_0 I \times \frac{\pi}{2}}{4\pi b} = \frac{-\mu_0 I}{8b}\hat{z}$$

$$B(۲) = \frac{\mu_0 I \times \frac{\pi}{2}}{4\pi a} = \frac{\mu_0 I}{8a}\hat{z}$$

$$B_{(+)} = \frac{\mu_0 I}{4\pi}\int \frac{d\vec{l}\times\vec{R}}{R^2} = \frac{\mu_0 I}{4\pi}\int \frac{-dx\,\hat{x}\times -x\hat{x}}{x^3} = 0$$

$$B_{(4)} = 0 \Longrightarrow B_p = \frac{\mu_0 I\hat{z}}{8}\left(\frac{1}{a}-\frac{1}{b}\right)$$



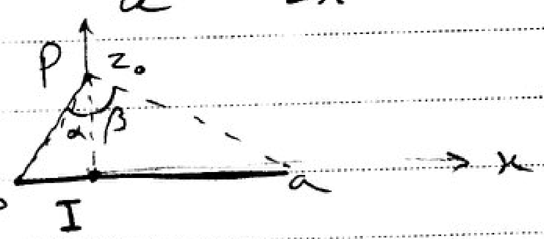
$$B_1 = B_2 = \frac{\mu_0 I}{4\pi a}\left(\sin\theta_2 - \sin\theta_1\right) \qquad \theta_2 = \frac{\pi}{2},\ \theta_1 = 0$$

$$B_1 = B_2 = \frac{\mu_0 I}{4\pi a}$$

$$B_\alpha = \frac{\mu_0 I \alpha}{4\pi a} = \frac{\mu_0 I}{4a}$$

$$\rightarrow B_p = \frac{\mu_0 I}{a}\left(\frac{1}{2\pi}+\frac{1}{4}\right)$$

5)



$a+b = l \qquad dl = dx\,\hat{x}$

$z_0 \operatorname{tg}\beta = a \qquad R = -x\hat{x} + z_0\hat{y}$

$z_0 \operatorname{tg}\alpha = b$

$$B = \frac{\mu_0 I}{4\pi}\int_{-b}^{a} \frac{dx\,\hat{x}\times(-x\hat{x}+z_0\hat{y})}{\left(\sqrt{x^2+z_0^2}\right)^2} = \frac{\mu_0 I}{4\pi}\int_{-z_0\operatorname{tg}\alpha}^{z_0\operatorname{tg}\beta} \frac{dx\, z_0\hat{z}}{\sqrt{x^2+z_0^2}}$$

$$= \frac{\mu_0 I z\hat{z}}{4\pi}\times \frac{x}{z_0^2\sqrt{x^2+z_0^2}}\Bigg|_{-z_0\operatorname{tg}\alpha}^{z_0\operatorname{tg}\beta} = \frac{\mu_0 I}{4\pi z_0}\left(\sin\beta - \sin\alpha\right)$$

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6)  $\alpha = \dfrac{180 - \frac{360}{n}}{2} = 90 - \dfrac{180}{n} = \dfrac{\pi}{2} - \dfrac{\pi}{n}$

$$\Rightarrow B = \frac{n\mu_0 I}{4\pi R \sin\left(\frac{\pi}{2} - \frac{\pi}{n}\right)} \left(\sin\left(\frac{\pi}{2} - \frac{\pi}{n}\right) - \sin\left(\frac{\pi}{n} - \frac{\pi}{2}\right)\right)$$

$$n \to \infty \qquad B = B_{\text{حلقه}} = \frac{\mu_0 I}{2R}$$

7) $K = \sigma R \sin\theta\, \omega \hat{\varphi} \qquad \sigma = \dfrac{Q}{4\pi R^2}$

$$B = \frac{\mu_0}{4\pi} \int \frac{\sigma R \omega \sin\theta\, \hat{\varphi} \times -R\hat{r}}{R^3} \times R^2 \sin\theta$$

$$= \frac{\mu_0 \sigma \omega}{4\pi R} \int \sin^2\theta\, \hat{\theta}\, d\theta = \frac{\mu_0 \sigma \omega}{4\pi R} \int_0^{\pi} \sin^2\theta\, \hat{\theta}\, d\theta = \frac{\mu_0 \sigma \omega}{4\pi R}$$

$$\int_0^{\pi}\int_0^{2\theta} \sin^2\theta \left(\cos\theta \cos\varphi\, \hat{x} + \cos\theta \sin\varphi\, \hat{y}\right)$$

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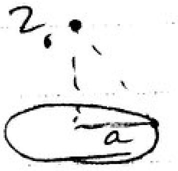
9) الف) $B = \dfrac{\mu_0 I}{4\pi} \oint_{c'} \dfrac{dl \times \hat{r}}{r^2}$



$\vec{r} = -a\hat{r} + z_0\hat{z} \qquad dl' = a\,d\varphi\,\hat{\varphi}$

$|r| = \sqrt{a^2 + z^2}$

$$\Rightarrow B = \frac{\mu_0 I}{4\pi} \int_0^{2\pi} \frac{a z\, d\varphi\, \hat{r} + a^2 d\varphi\, \hat{z}}{\left(\sqrt{a^2 + z_0^2}\right)^3} = \frac{\mu_0 I}{4\pi} \int_0^{2\pi} \frac{a^2 d\varphi}{\left(\sqrt{a^2 + z_0^2}\right)^3} \hat{z}$$

$$= \frac{\mu_0 I a^2 \hat{z}}{2\left(\sqrt{a^2 + z_0^2}\right)^3}$$

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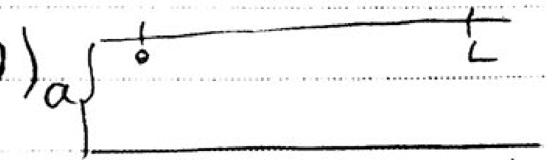
ب) $dt = \frac{a\,d\varphi}{a\omega} = \frac{d\varphi}{\omega}$ $\Rightarrow \frac{dq}{dt} = I = \lambda a\omega$

$dq = \lambda a\, d\varphi$

$$\Rightarrow B = \frac{\mu_0 \lambda a^2 \omega\, \hat{z}}{2\left(\sqrt{a^2+z^2}\right)^3}$$

10)



$\frac{dq}{dt} = \lambda \Rightarrow \frac{dq}{dt} = \lambda \frac{dl}{dt} \Rightarrow I = \lambda V$

$dF_b = dq\, V \times B = I\, L \times B$

$dF_e = dq \cdot E$

$$F_e = \int_0^L \lambda\, dl \times \frac{\lambda}{2\pi\varepsilon_0 a} = \frac{\lambda^2 L}{2\pi\varepsilon_0 a}$$

$$F_b = \frac{\mu_0 I^2 L}{2\pi a} = \frac{\mu_0 \lambda^2 V L}{2\pi a} \Rightarrow F_e = F_b \Rightarrow \frac{\lambda^2 L}{2\pi\varepsilon_0 a} = \frac{\mu_0 \lambda^2 V^2 L}{2\pi a}$$

$$\Rightarrow V^2 = \frac{1}{\mu_0 \varepsilon_0} \Rightarrow V = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

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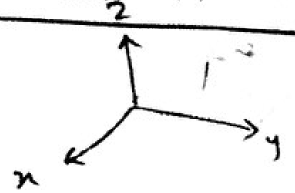
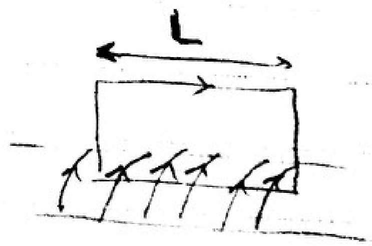
12) الف)



$$2BL = \mu_0 I_{enc} = \mu_0 k L \Rightarrow B = \frac{\mu_0 k}{2}\hat{y} \qquad y>0$$

$$B = -\frac{\mu_0 k \hat{y}}{2} \qquad y<0$$

ب)

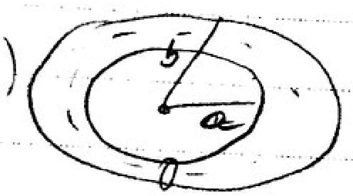


$$\oint B \cdot dl = BL = \mu_0 n L I$$

$$B = \mu_0 n I$$

تعداد دور در واحد طول

ج)



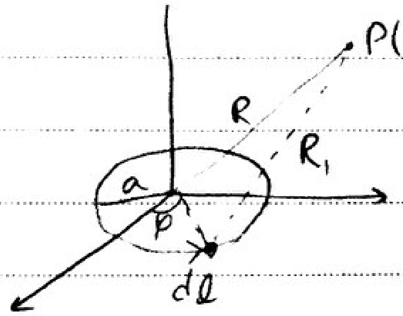
$$\oint B \cdot dl = 2\pi r B_\varphi = \mu_0 N I$$

$$B_\varphi = \frac{\mu_0 N I}{2\pi r}$$

13) $B_{1n} = B_{2n} \Rightarrow \mu_1 H_{1n} = \mu_2 H_{2n}$ $\qquad E_{1t} = E_{2t}$

$H_{1t} - H_{2t} = J_{ms}$ $\qquad D_{1n} - D_{2n} = \rho_s$

14) $B = \frac{\mu}{4\pi} \times \frac{1}{r^3} \left[3(m \cdot \hat{r})\hat{r} - m \right]$



$P(R, \theta, \frac{\pi}{2})$ بدلیل تقارن نقطه‌ی مورد بررسی را در صفحه‌ی z-y در نظر می‌گیریم

$$dl = (-\sin\varphi \hat{x} + \cos\varphi \hat{y})\, a\, d\varphi$$

$$\Rightarrow A = \frac{\mu_0 I}{4\pi} \int \frac{-a\sin\varphi \hat{x} + a\cos\varphi \hat{y}}{R_1} d\varphi$$

$$B = \frac{\mu_0 m}{4\pi R^3} \left(2\cos\theta \hat{r} + \sin\theta \hat{\theta} \right)$$

$$m = (m \cdot \hat{r})\hat{r} + (m \cdot \hat{\theta})\hat{\theta} = m\cos\theta \hat{r} - m\sin\theta \hat{\theta}$$

$$\Rightarrow 3(m \cdot \hat{r})\hat{r} - m = 3m\cos\theta - m\cos\hat{y} + m\sin\theta \hat{\theta}$$

$$= 2m\cos\theta \hat{r} + m\sin\theta \hat{\theta}$$