$$E_{1n} = \frac{\varepsilon_{r2}}{\varepsilon_{r1}} E_{2n} = \frac{1}{2.5} 12\cos 60^o = 2.4$$

$$E_1 = \sqrt{E_{1t}^{\ 2} + E_{1n}^{\ 2}} = \underline{\underline{10.67}}$$

$$\tan\theta_1 = \frac{\varepsilon_{r1}}{\varepsilon_{r2}} \tan\theta_2 = \frac{2.5}{1} \tan 60^o = 4.33 \quad \longrightarrow \quad \underline{\underline{\theta_1 = 77^o}}$$

Note that $\theta_1 > \theta_2$.

P. E. 5.10

$$D = \varepsilon_o E = \frac{10^{-9}}{36\pi}(60, 20, -30)x10^{-3} = \underline{\underline{0.531a_x + 0.177a_y - 0.265a_z}} \text{ pC/m}^2$$

$$\rho_s = D_n = |D| = \frac{10^{-9}}{36\pi}(10)\sqrt{36+4+9}(10^{-3}) = \underline{\underline{0.619}} \text{ pC/m}^2$$

Prob. 5.1

$$I = \int \mathbf{J} \bullet d\mathbf{S}, \qquad d\mathbf{S} = dydz\mathbf{a}_x$$

$$I = \iint e^{-x}\cos(4y)dydz\Big|_{x=2} = e^{-2}\int_0^{\pi/3}\cos(4y)dy\int_0^4 dz$$

$$= 4e^{-2}\left(\frac{\sin 4y}{4}\Big|_0^{\pi/3}\right) = e^{-2}\left(\sin(\frac{4\pi}{3}) - 0\right) = \underline{\underline{-0.1172 \text{ A}}}$$

Prob. 5.2

Method 1:

$$I = \int \mathbf{J} \bullet d\mathbf{S} = \iint \frac{10}{r}e^{-10^3 t}r^2 \sin d\theta d\phi\Big|_{t=2ms, r=4m}$$

$$= 10(4)e^{-10^3 \times 2 \times 10^{-3}}\int_{\theta=0}^{\pi}\sin\theta d\theta\int_{\phi=0}^{2\pi}d\phi = 40e^{-2}(2)(2\pi) = 160\pi e^{-2}$$

$$= \underline{\underline{68.03 \text{ A}}}$$

Method 2:

$$I = \int J \bullet dS = \iint \frac{10}{r} e^{-10^3 t} dS = \frac{10}{r} e^{-10^3 t} (4\pi r^2)$$

since r is constant on the surface.

$$I = 40\pi r e^{-2} = 160\pi e^{-2} \quad = \underline{\underline{68.03 \text{ A}}}$$

Prob. 5.3

$$I = \int J \cdot dS = \iint \frac{10}{\rho} \sin\phi \rho d\phi dz = 10 \int_0^5 dz \int_0^\pi \sin\phi d\phi$$

$$= 10(5)(-\cos\phi)\Big|_0^\pi = \underline{\underline{100 \text{ A}}}$$

Prob. 5.4

$$I = \int J \bullet dS \quad = 5 \int_{\rho=0}^{a} \int_{\phi=0}^{2\pi} e^{-10\rho} \rho d\phi d\rho = 5 \int_0^{2\pi} d\phi \int_{\rho=0}^{a} \rho e^{-10\rho} d\rho$$

$$= 5(2\pi)\left(\frac{e^{-10\rho}}{100} (-10\rho - 1) \right)\Bigg|_0^a = \frac{10\pi}{100}\left[e^{-10a}(-10a-1) - 1(-0-1) \right]$$

$$= \frac{\pi}{10}\left[e^{-0.04}(-0.04-1)+1 \right] = \frac{\pi}{10}(0.00078) = \underline{\underline{244.7 \ \mu\text{A}}}$$

Prob. 5.5

$$I = -\frac{dQ}{dt} = 3x10^{-4} e^{-3t}$$

I(t=0) = $\underline{0.3 \text{ mA}}$, I(t=2.5) = 0.3 $e^{-7.5}$ = $\underline{166 \text{ nA}}$

Prob. 5.6

$$R = \frac{l}{\sigma S} \quad \longrightarrow \quad \sigma = \frac{l}{RS} = \frac{2\times10^{-2}}{10^6(\pi)(4\times10^{-3})^2} = \underline{\underline{3.978\times10^{-4} \text{ S/m}}}$$

Prob. 5.7 (a) $R = \frac{l}{\sigma S} = \frac{8\times10^{-2}}{3\times10^4 \pi (25)10^{-6}} = \frac{8}{75\pi} = \underline{\underline{33.95\text{m}\Omega}}$

(b) $I = V/R = 9\times\frac{75\pi}{8} = \underline{\underline{265.1}}$ A

Prob. 5.28

$$\begin{bmatrix} D_x \\ D_y \\ D_z \end{bmatrix} = \varepsilon_o E_o \begin{bmatrix} 4 & 1 & 1 \\ 1 & 3 & 1 \\ 1 & 1 & 2 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \\ -1 \end{bmatrix}$$

$$D_x = \varepsilon_o E_o (4+1-1) = 4\varepsilon_o E_o$$
$$D_y = \varepsilon_o E_o (1+3-1) = 3\varepsilon_o E_o$$
$$D_z = \varepsilon_o E_o (1+1-2) = 0$$
$$\underline{\underline{\boldsymbol{D} = \varepsilon_o E_o (4\boldsymbol{a}_x + 3\boldsymbol{a}_y) \text{ C/m}^2}}$$

Prob. 5.29

Since $\frac{\partial \rho_v}{\partial t} = 0$, $\nabla \bullet \boldsymbol{J} = 0$ must hold.

(a) $\nabla \bullet \boldsymbol{J} = 6x^2 y + 0 - 6x^2 y = 0 \longrightarrow$ This is <u>possible</u>.

(b) $\nabla \bullet \boldsymbol{J} = y + (z+1) \neq 0 \longrightarrow$ This is <u>not possible</u>.

(c) $\nabla \bullet \boldsymbol{J} = \frac{1}{\rho} \frac{\partial}{\partial \rho}(z^2) + \cos\phi \neq 0 \longrightarrow$ This is <u>not possible.</u>

(d) $\nabla \bullet \boldsymbol{J} = \frac{1}{r^2} \frac{\partial}{\partial r}(\sin\theta) = 0 \longrightarrow$ This is <u>possible</u>.

Prob. 5.30

$$\nabla \bullet J = \frac{\partial J_x}{\partial x} + \frac{\partial J_y}{\partial y} + \frac{\partial J_z}{\partial z} = 2e^{-2y}\cos 2x - 2e^{-2y}\cos 2x + 1 = 1 = -\frac{\partial \rho_v}{\partial t}$$

Hence, $\frac{\partial \rho_v}{\partial t} = \underline{\underline{-1 \text{ C/m}^3 s}}$

Prob. 5.31

(a) $\nabla \bullet \boldsymbol{J} = \frac{1}{\rho} \frac{\partial}{\partial \rho}\left(\frac{100}{\rho}\right) = -\frac{100}{\rho^3}$

$$-\frac{\partial \rho_v}{\partial t} = \nabla \bullet \boldsymbol{J} = -\frac{100}{\rho^3} \longrightarrow \frac{\partial \rho_v}{\partial t} = \underline{\underline{\frac{100}{\rho^3} \text{ C/m}^3.s}}$$

(b) At (0, 1,0), **R = a**$_y$

$$dH = \frac{4\boldsymbol{a}_x \times \boldsymbol{a}_y}{4\pi(1)^3} = 0.3183\boldsymbol{a}_z \text{ A/m}$$

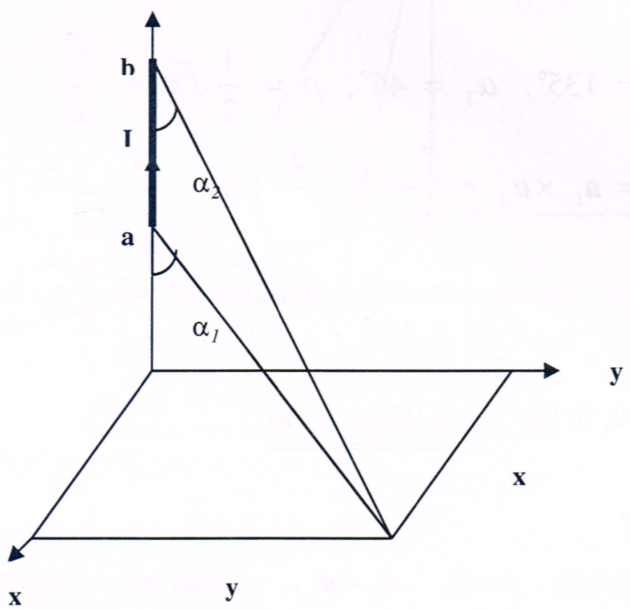
(c) At (0,0,1), **R =a**$_z$

$$dH = \frac{4\boldsymbol{a}_x \times \boldsymbol{a}_z}{4\pi(1)^3} = -0.3183\boldsymbol{a}_y \text{ A/m}$$

(d) At (1,1,1), **R**=(1,1,1)

$$dH = \frac{4\boldsymbol{a}_x \times (\boldsymbol{a}_x + \boldsymbol{a}_y + \boldsymbol{a}_z)}{4\pi(3)^{3/2}} = 61.26(-\boldsymbol{a}_y + \boldsymbol{a}_z) \text{ mA/m}$$

Prob. 7.5



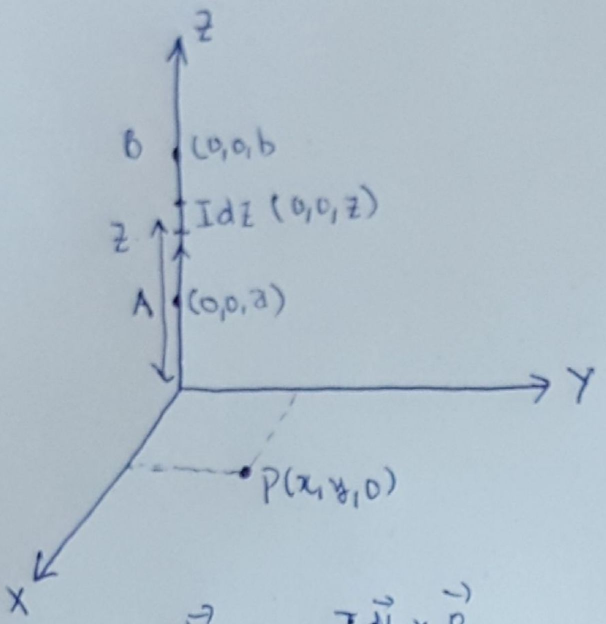
$$\boldsymbol{H} = \frac{I}{4\pi\rho}(\cos\alpha_2 - \cos\alpha_1)\boldsymbol{a}_\phi$$

$$\rho = \sqrt{x^2 + y^2}, \cos\alpha_1 = \frac{a}{\sqrt{a^2 + \rho^2}}, \cos\alpha_2 = \frac{b}{\sqrt{b^2 + \rho^2}}$$

$\boldsymbol{a}_\phi = \boldsymbol{a}_l \times \boldsymbol{a}_\rho = \boldsymbol{a}_z \times \boldsymbol{a}_\rho = \boldsymbol{a}_\phi$. Hence,

$$\boldsymbol{H} = \frac{I}{4\pi\sqrt{x^2 + y^2}}\left[\frac{b}{\sqrt{x^2 + y^2 + b^2}} - \frac{a}{\sqrt{x^2 + y^2 + a^2}}\right]\boldsymbol{a}_\phi$$

7.5



$\vec{r} = (x, y, 0)$ – location of $d\vec{H}$

$\vec{r}' = (0, 0, z)$ – location of $I\vec{dl}$

$$d\vec{H} = \frac{I\vec{dl} \times \vec{R}}{4\pi R^3} \qquad I\vec{dl} = I\,dz\,\vec{a}_z$$

$$\vec{R} = \vec{r} - \vec{r}' = (x, y, 0) - (0, 0, z) = (x, y, z)$$

$$R^3 = (x^2 + y^2 + z^2)^{3/2}$$

$$d\vec{H} = \frac{I\,dz\,\vec{a}_z \times (x\vec{a}_x + y\vec{a}_y + z\vec{a}_z)}{4\pi (x^2 + y^2 + z^2)^{3/2}}$$

converting to Cylindrical coordinates

$$= \frac{I\,dz\,\vec{a}_z \times (\rho\vec{a}_\rho + z\vec{a}_z)}{4\pi (\rho^2 + z^2)^{3/2}} \qquad \rho^2 = x^2 + y^2$$

$$d\vec{H} = \frac{I\rho\,dz\,a_\phi}{4\pi(\rho^2 + z^2)^{3/2}}$$

$$\Rightarrow \vec{H} = \int d\vec{H} = \frac{I\rho}{4\pi}\int_a^b \frac{\vec{a}_\phi\,dz}{(\rho^2+z^2)^{3/2}} = \frac{I\rho}{4\pi} \left.\frac{z}{\rho^2\sqrt{\rho^2+z^2}}\right|_a^b \vec{a}_\phi$$

$$= \vec{a}_\phi \frac{I}{4\pi\rho}\left[\frac{b}{\sqrt{\rho^2+b^2}} - \frac{a}{\sqrt{\rho^2+a^2}}\right] = \frac{I}{4\pi\sqrt{x^2+y^2}}\left[\frac{b}{\sqrt{x^2+y^2+b^2}} - \frac{a}{\sqrt{x^2+y^2+a^2}}\right]\vec{a}_\phi \quad //$$

$\uparrow$ $\rho = \sqrt{x^2+y^2}$

(a) Consider the figure above.

$$AB = (1, 1, 0) - (2, 0, 0) = (-1, 1, 0)$$

$$AC = (0, 0, 5) - (2, 0, 0) = (-2, 0, 5)$$

$AB \cdot AC = 2$, i.e AB and AC are not perpendicular.

$$\cos(180^\circ - \alpha_1) = \frac{AB \cdot AC}{|AB||AC|} = \frac{2}{\sqrt{2}\sqrt{29}} \rightarrow \cos\alpha_1 = -\sqrt{\frac{2}{29}}$$

$$BC = (0, 0, 5) - (1, 1, 0) = (-1, -1, 5)$$

$$BA = (1, -1, 0)$$

$$\cos\alpha_2 = \frac{\bar{B}C \cdot B\bar{A}}{|BC||BA|} = \frac{-1+1}{|BC||BA|} = 0$$

i.e. $BC = \rho = (-1, -1, 5), \quad \rho = \sqrt{27}$

$$\boldsymbol{a}_\phi = \boldsymbol{a}_l \times \boldsymbol{a}_\rho = \frac{(-1, 1, 0)}{\sqrt{2}} \times \frac{(-1, -1, 5)}{\sqrt{27}} = \frac{(5, 5, 2)}{\sqrt{54}}$$

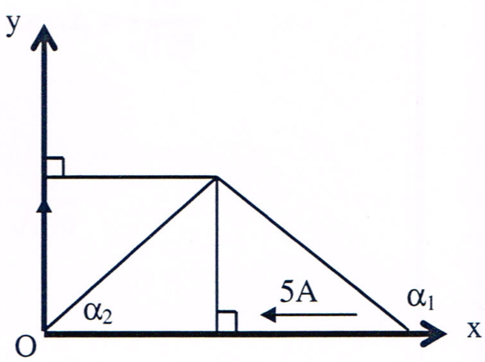
$$\boldsymbol{H}_2 = \frac{10}{4\pi\sqrt{27}}\left(0 + \sqrt{\frac{2}{29}}\right)\frac{(5, 5, 2)}{\sqrt{2}\sqrt{27}} = \frac{5}{2\pi\sqrt{29}} \cdot \frac{(5, 5, 2)}{27} \text{ A/m}$$

$$= \underline{\underline{27.37\,\boldsymbol{a}_x + 27.37\boldsymbol{a}_y + 10.95\,\boldsymbol{a}_z \text{ mA/m}}}$$

(b) $$\boldsymbol{H} = \boldsymbol{H}_1 + \boldsymbol{H}_2 + \boldsymbol{H}_3 = (0, -59.1, 0) + (27.37, 27.37, 10.95) + (-30.63, 30.63, 0)$$

$$= \underline{\underline{-3.26\,\boldsymbol{a}_x - 1.1\,\boldsymbol{a}_y + 10.95\boldsymbol{a}_z \text{ mA/m}}}$$

Prob. 7.9



(a) Let $\boldsymbol{H} = \boldsymbol{H}_x + \boldsymbol{H}_y = 2\boldsymbol{H}_x$

$$\boldsymbol{H}_x = \frac{I}{4\pi\rho}(\cos\alpha_2 - \cos\alpha_1)\boldsymbol{a}_\phi$$

where $a_\phi = -a_x \times a_y = -a_z, \; \alpha_1 = 180^\circ, \; \alpha_2 = 45^\circ$

$$H_x = \frac{5}{4\pi(2)}\left(\cos 45^\circ - \cos 180^\circ\right)\left(-a_z\right)$$

$$= \underline{\underline{-0.6792\, a_z \text{ A/m}}}$$

(*b*) $H = H_x + H_y$

where $H_x = \dfrac{5}{4\pi(2)}(1-0)\, a_\phi, \; a_\phi = -a_x \times -a_y = a_z$

$$= 198.9 a_z \text{ mA/m}$$

$H_y = 0$ since $\alpha_1 = \alpha_2 = 0$

$H = \underline{\underline{0.1989\, a_z \text{ A/m}}}$

(*c*) $H = H_x + H_y$

where $H_x = \dfrac{5}{4\pi(2)}(1-0)\left(-a_x \times a_z\right) = 198.9\, a_y$ mA/m

$$H_y = \frac{5}{4\pi(2)}(1-0)\left(a_y \times a_z\right) = 198.9\, a_x \text{ mA/m}$$

$$H = \underline{\underline{0.1989\, a_x + 0.1989\, a_y \text{ A/m.}}}$$

Prob. 7.10

For the side of the loop along y-axis,

$$H_1 = \frac{I}{4\pi\rho}\left(\cos\alpha_2 - \cos\alpha_1\right) a_\phi$$

where $a_\phi = -a_x, \; \rho = 2\tan 30^\circ = \dfrac{2}{\sqrt{3}}, \; \alpha_2 = 30^\circ, \; \alpha_1 = 150^\circ$

$$H_1 = \frac{5}{4\pi}\frac{\sqrt{3}}{2}\left(\cos 30^\circ - \cos 150^\circ\right)\left(-a_x\right) = -\frac{15}{8\pi}a_x$$

$$H = 3H_1 = -1.79 a_x \text{ A/m}$$

(*b*) From Eq. (7.29),

$$H_\phi = \begin{cases} \dfrac{I\rho}{2\pi a^2}, & \rho < a \\ \dfrac{I}{2\pi\rho}, & \rho > a \end{cases}$$

At $(0, 1\text{ cm}, 0)$,

$$H_\phi = \frac{3\times1\times10^{-2}}{2\pi\times4\times10^{-4}} = \frac{300}{8\pi}$$

$$\boldsymbol{H} = 11.94\,\boldsymbol{a}_\phi \text{ A/m}$$

At $(0, 4\text{ cm}, 0)$,

$$H_\phi = \frac{3}{2\pi\times4\times10^{-2}} = \frac{300}{8\pi}$$

$$\boldsymbol{H} = 11.94\,\boldsymbol{a}_\phi \text{ A/m}$$

Prob. 7.22

For $0 < \rho < a$

$$\oint_L \boldsymbol{H}\bullet d\boldsymbol{l} = I_{enc} = \int \boldsymbol{J}\bullet d\boldsymbol{S}$$

$$H_\phi 2\pi\rho = \int_{\phi=0}^{2\pi}\int_{\rho=0}^{\rho}\frac{J_o}{\rho}\rho\, d\phi\, d\rho$$

$$= J_o 2\pi\rho$$

$$H_\phi = J_o$$

For $\rho > a$

$$\int \mathbf{H}\bullet d\boldsymbol{l} = \int \boldsymbol{J}\bullet d\boldsymbol{S} = \int_{\phi=0}^{2\pi}\int_{\rho=0}^{a}\frac{J_o}{\rho}\rho\, d\phi\, d\rho$$

$$H_\rho 2\pi\rho = J_o 2\pi a$$

$$H_\phi = \frac{J_o a}{\rho}$$

$$\text{Hence } H_\phi = \begin{cases} J_o, & 0<\rho<a \\ \dfrac{J_o a}{\rho}, & \rho>a \end{cases}$$

Prob. 7.23

(a) $\boldsymbol{J} = \nabla \times \boldsymbol{H} = \frac{1}{\rho}\frac{d}{d\rho}(\rho H_\phi)\boldsymbol{a}_z = \frac{1}{\rho}\frac{d}{d\rho}(k_o \frac{\rho^2}{a})\boldsymbol{a}_z = \underline{\underline{\frac{2k_o}{a}\boldsymbol{a}_z}}$

(b)For ρ>a,

$$\oint \boldsymbol{H}\cdot d\boldsymbol{l} = I_{enc} = \int \boldsymbol{J}\cdot d\boldsymbol{S} = \int_{\rho=0}^{a}\int_{\phi=0}^{2\pi} \frac{2k_o}{a}\rho d\rho d\phi = \frac{2k_o}{a}(2\pi)\frac{\rho^2}{2}\Big|_0^a$$

$$H_\phi 2\pi\rho = 2\pi k_o a \longrightarrow H_\phi = \frac{k_o a}{\rho}$$

$$\underline{\underline{\boldsymbol{H} = k_o\left(\frac{a}{\rho}\right)\boldsymbol{a}_\phi, \qquad \rho > a}}$$

Prob. 7.24

$$\boldsymbol{J} = \nabla \times \boldsymbol{H} = \begin{vmatrix} \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ y^2 & x^2 & 0 \end{vmatrix} = (2x - 2y)\boldsymbol{a}_z$$

At (1,-4,7), x =1, y = -4, z=7,

$\boldsymbol{J} = [2(1) - 2(-4)]\boldsymbol{a}_z = \underline{\underline{10\boldsymbol{a}_z \text{ A/m}^2}}$

Prob. 7.25

(a)

$$\boldsymbol{J} = \nabla \times \boldsymbol{H} = \frac{1}{\rho}\frac{\partial}{\partial\rho}(\rho H_\phi)\boldsymbol{a}_z = \frac{1}{\rho}\frac{\partial}{\partial\rho}(10^3\rho^3)\boldsymbol{a}_z$$

$$= \underline{\underline{3\rho \times 10^3 \boldsymbol{a}_z \text{ A/m}^2}}$$

(b)

Method 1:

$$I = \int_S \boldsymbol{J}\bullet d\boldsymbol{S} = \iint 3\rho\ \rho d\phi d\rho 10^3 = 3\times 10^3 \int_0^2 \rho^2 d\rho \int_0^{2\pi} d\phi$$

$$= 3\times 10^3 (2\pi)\frac{\rho^3}{3}\Big|_2^2 = 16\pi \times 10^3 A = \underline{\underline{50.265 \text{ kA}}}$$

Method 2:

$$I = \oint_L \boldsymbol{H}\bullet d\boldsymbol{l} = 10^3 \int_0^{2\pi} \rho^2\ \rho d\phi = 10^3(8)(2\pi) = \underline{\underline{50.265 \text{ kA}}}$$

Prob. 7.46

$$B = \nabla \times A = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial\theta}(A_\phi \sin\theta) - \frac{\partial A_\theta}{\partial\phi}\right]\boldsymbol{a}_r + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial A_r}{\partial\phi} - \frac{\partial}{\partial r}(rA_\phi)\right]\boldsymbol{a}_\theta$$

$$+\frac{1}{r}\left[\frac{\partial}{\partial r}(rA_\theta) - \frac{\partial A_r}{\partial\theta}\right]\boldsymbol{a}_\phi$$

$$= \frac{1}{r\sin\theta}\frac{10}{r}2\sin\theta\cos\theta\boldsymbol{a}_r - \frac{1}{r}\frac{\partial}{\partial r}(10)\sin\theta\boldsymbol{a}_\theta + 0\boldsymbol{a}_\phi$$

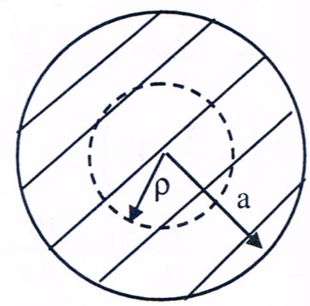
$$B = \frac{20}{r^2}\cos\theta\boldsymbol{a}_r$$

At $(4, 60^\circ, 30^\circ)$, $r = 4$, $\theta = 60^\circ$

$$H = \frac{B}{\mu_o} = \frac{1}{4\pi\times10^{-7}}\left[\frac{20}{4^2}\cos 60^o\boldsymbol{a}_r\right] = \underline{\underline{4.974\times10^5\boldsymbol{a}_r \text{ A/m}}}$$

Prob. 7.47

Applying Ampere's law gives



$$H_\phi \cdot 2\pi\rho = J_o \cdot \pi\rho^2$$

$$H_\phi = \frac{J_o}{2}\rho$$

$$B_\phi = \mu_o H_\phi = \mu_o\frac{J_o\rho}{2}$$

But $\boldsymbol{B} = \nabla\times\mathbf{A} = -\frac{\partial A_Z}{\partial\rho}\bar{a}_\varphi + \ldots$

$$-\frac{\partial A_Z}{\partial\rho} = \frac{1}{2}\mu J_o\rho \longrightarrow A_Z = -\mu_o\frac{J_o\rho^2}{4}$$

$$\text{or } \mathbf{A} = \underline{\underline{-\frac{1}{4}\mu_o J_o\rho^2\,\boldsymbol{a}_z}}$$

Prob. 7.48

$$B = \nabla\times A = \begin{vmatrix}\frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ 0 & 0 & A_z(x,y)\end{vmatrix} = \frac{\partial A_z}{\partial y}\boldsymbol{a}_x - \frac{\partial A_z}{\partial x}\boldsymbol{a}_y$$

$$= \underline{\underline{-\frac{\pi}{2}\sin\frac{\pi x}{2}\sin\frac{\pi y}{2}\boldsymbol{a}_x - \frac{\pi}{2}\cos\frac{\pi x}{2}\cos\frac{\pi y}{2}\boldsymbol{a}_y}}$$

Prob. 7.49

$$\boldsymbol{B} = \nabla \times \boldsymbol{A} = \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(A_\phi \sin\theta)\boldsymbol{a}_r - \frac{1}{r}\frac{\partial}{\partial r}(rA_\phi)\boldsymbol{a}_\theta$$

$$= \frac{1}{r\sin\theta}\frac{A_o}{r^2}(2\sin\theta\cos\theta)\boldsymbol{a}_r - \frac{A_o}{r}\sin\theta(-r^{-2})\boldsymbol{a}_\theta$$

$$= \underline{\underline{\frac{A_o}{r^3}(2\cos\theta\boldsymbol{a}_r + \sin\theta\boldsymbol{a}_\theta)}}$$

Prob. 7.50

(a) $$\boldsymbol{J} = \nabla \times \boldsymbol{H} = \begin{vmatrix} \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ xy^2 & x^2 z & -y^2 z \end{vmatrix} = (-2yz - x^2)\boldsymbol{a}_x + (2xz - 2xy)\boldsymbol{a}_z$$

At (2,-1,3), x=2, y=-1, z=3.

$\underline{\underline{\boldsymbol{J} = 2\boldsymbol{a}_x + 16\boldsymbol{a}_z \text{ A/m}^2}}$

(b) $$-\frac{\partial \rho_v}{\partial t} = \nabla \bullet \boldsymbol{J} = 0 - 2x + 2x = 0$$

At (2,-1,3),

$$\frac{\partial \rho_v}{\partial t} = \underline{\underline{0 \text{ C/m}^3\text{s}}}$$

Prob. 7.51

(*a*) $\mathbf{B} = \nabla \times \boldsymbol{A}$

$$= \left[\frac{1}{\rho}\frac{\partial A_z}{\partial \phi} - \frac{\partial A_\phi}{\partial z}\right]\boldsymbol{a}_\rho + \left[\frac{\partial A_\rho}{\partial z} - \frac{\partial A_z}{\partial \rho}\right]\boldsymbol{a}_\phi + \frac{1}{\rho}\left[\frac{\partial}{\partial \rho}(\rho A_\phi) - \frac{\partial A_\rho}{\partial \phi}\right]\boldsymbol{a}_z$$

$$= -\frac{\partial A_z}{\partial \rho}\boldsymbol{a}_\phi = 20\rho\boldsymbol{a}_\phi \ \mu\text{Wb/m}^2$$

$$\boldsymbol{H} = \frac{\boldsymbol{B}}{\mu_o} = \underline{\underline{\frac{-20\rho}{\mu_o}\boldsymbol{a}_\phi \ \mu\text{A/m}}}$$

$$\boldsymbol{J} = \nabla \times \boldsymbol{H} = \frac{1}{\rho}\frac{\partial}{\partial \rho}(\rho A_\phi)\boldsymbol{a}_z$$

$$= \frac{1}{\mu_o \rho}(-40\rho)\boldsymbol{a}_z = \underline{\underline{\frac{-40}{\mu_o}\boldsymbol{a}_z \ \mu\text{A/m}^2}}$$