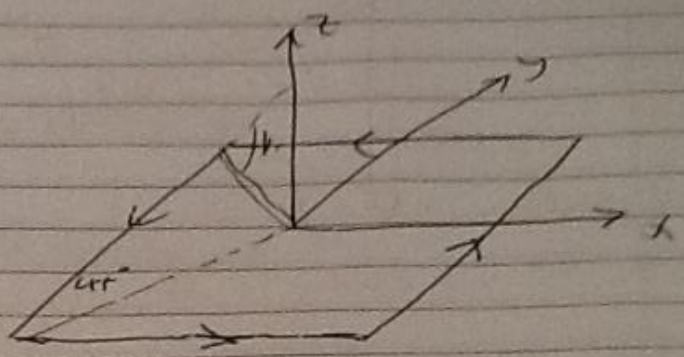
Question 1



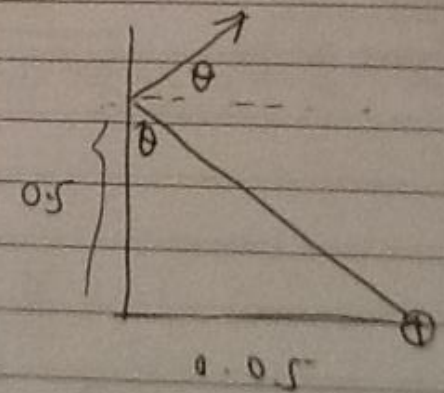
(a) at (0, 0, 0), field are in the z direction and are all equal

$$\underline{H} = 4\underline{H}_1 = 4 * \frac{I}{4\pi\rho}(\cos\alpha_2 - \cos\alpha_1)\underline{a}_z$$

$$\underline{H} = \frac{4 * 2}{4 * \pi * 0.05}\left(\frac{1}{\sqrt{2}} - \left(-\frac{1}{\sqrt{2}}\right)\right)\underline{a}_z$$

$$\underline{H} = \frac{40}{\pi} * \frac{2}{\sqrt{2}}\underline{a}_z = \frac{40\sqrt{2}}{\pi}\underline{a}_z \ A/m$$

(b)



At (0, 0, 0.5), all components cancel

Question 1 (2)

Field are only in z direction.

$\underline{H} = 4\underline{H}_z = 4H_1 \sin\theta$

$\underline{H} = 4 * \frac{I}{4\pi * \sqrt{(0.5)^2+(0.05)^2}} \left(\cos\alpha_2 - \cos\alpha_1\right) * 5 \cdot 0$

$\cos\alpha_2 = -\underline{a}_y \cdot \frac{(-0.05\underline{a}_x - 0.05\underline{a}_y + 0.5\underline{a}_z)}{\sqrt{(0.5)^2+(0.05)^2+0.05^2}}$

$\cos\alpha_2 = \frac{0.05}{\sqrt{(0.05)^2+(0.05)^2+(0.5)^2}}$

$\cos\alpha_1 = -\cos\alpha_2 = \frac{-0.05}{\sqrt{(0.05)^2+(0.05)^2+(0.5)^2}}$

$\underline{H} = \frac{4 * 2}{4\pi\sqrt{(0.5)^2+(0.05)^2}} * \frac{2*0.05}{\sqrt{2(0.05)^2+(0.5)^2}} * \frac{0.05}{\sqrt{(0.5)^2+(0.05)^2}}$

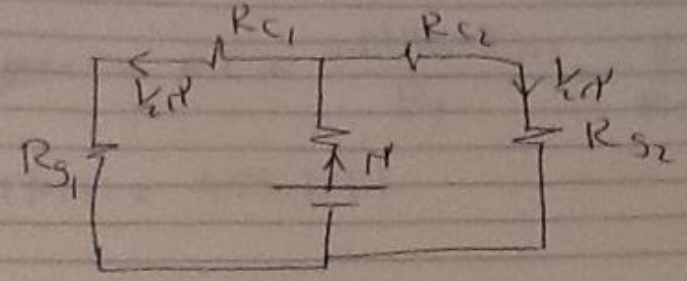
$\underline{a}_z$

c) $\underline{F} = q\underline{v} \times \underline{B}$

$\underline{F} = 0.1 \times 10^{-9} * 5\underline{a}_y * \mu H_0 \underline{a}_z$

Question 2

equivalent circuit



$$R_{C_1} = \frac{(0.06+0.08+0.06-0.004)}{\mu \times 4\times 10^{-4}}$$

$$R_{C_1} = \frac{0.196}{4\pi\times 10^{-7}\times 1000\times 4\times 10^{-4}}$$

$$R_{C_1} = 389.986\times 10^{3} = R_{C_2}$$

$$R_{g_1} = R_{g_2} = \frac{0.004}{4\pi\times 10^{-7}\times 4\times 10^{-4}} = 7.9577\times 10^{6}$$

$$H = \frac{NI}{R_{C_0} + 0.5(R_{C_1}+R_{g_1})} = \frac{NI}{R_T}$$

with $R_{C_0} = \frac{0.06}{4\pi\times 10^{-7}\times 1000\times 4\times 10^{-4}} = 153.15\times 10^{3}$

$$\Rightarrow H = \frac{500}{153.15\times 10^{3} + 0.5(389.92\times 10^{3} + 7.957\times 10^{6})}$$

$$H = 115.39\times 10^{-6}\ Wb$$

$$B = \frac{\Phi}{A} = \frac{115.33 \times 10^{-6}}{4 \times 1 \times 10^{-4}} = 298.45 \times 10^{-2}$$

$$MMF = NI \times \frac{0.5(R_{C_1} + R_{S_1})}{R_T} \times \frac{R_{S_1}}{R_{S_1} + R_{C_1}}$$

$$MMF = 459.1766$$

Question:

$$\underline{A} = 10\rho^2 \times 10^{-6}\, a_z$$

a) $$\underline{B} = \nabla \times \underline{A} = -\frac{\partial A_z}{\partial \rho} a_\phi$$

$$\underline{B} = -10 \times 10^{-6} \times 2\rho\, a_\phi$$

$$\underline{B} = -2 \times 10^{-5} \rho\, a_\phi$$

b) $$\underline{H} = \frac{\underline{B}}{\mu_0} = \frac{-2 \times 10^{-5} \rho}{\mu_0} a_\phi$$

c) $$\underline{J} = \nabla \times \underline{H} = \frac{1}{\rho}\left(\frac{\partial \rho H_\phi}{\partial \rho}\right) a_z$$

$$\underline{J} = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\frac{-2 \times 10^{-5} \rho^2}{\mu_0}\right) a_z$$

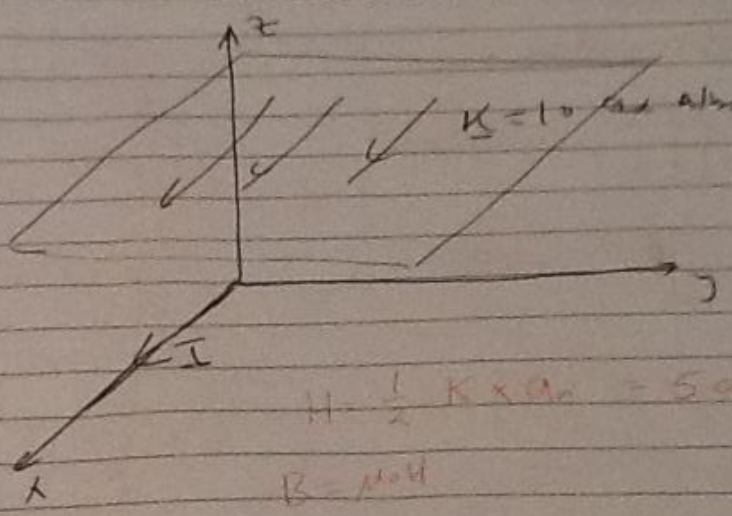
$$\underline{J} = -\frac{4 \times 10^{-5} \rho}{\mu_0} a_z$$

d) $$I = \int\int \underline{J} \cdot d\underline{r}$$

$$I = \frac{4 \times 10^{-5}}{\mu_0} \int_0^2 \int_0^{2\pi} \rho\, d\phi\, d\rho$$

$$I = 400\ A$$

Question 4



$H = \frac{1}{2} K \times a_n = 5 a_y$

$B = \mu_0 H$

$$\underline{B} = \frac{\mu_0}{2} \underline{K} \times \underline{a}_n$$

$$= \frac{\mu_0}{2} K \underline{a}_x \times (-\underline{a}_z)$$

$$\underline{B} = \frac{\mu_0 K}{2} \underline{a}_y = 5\mu_0 \underline{a}_y$$

$$= 6.28 \times 10^{-6} \underline{a}_y$$

$$\underline{F} = I \underline{l} \times \underline{B} = I l \underline{a}_x \times B_0 \underline{a}_y$$

$$\underline{F} = I l B_0 \underline{a}_z$$

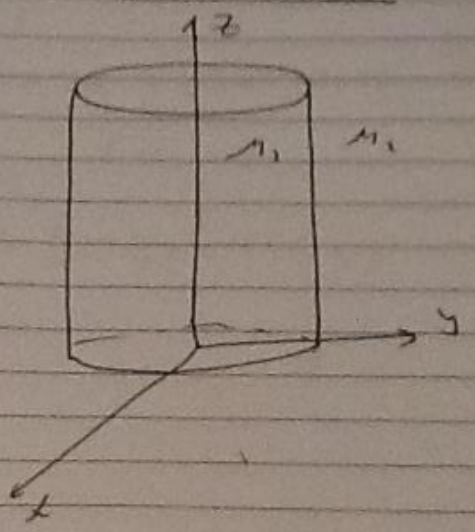
$$\underline{F} = 2.5 * 1 * \frac{4\pi \times 10^{-7}}{2} * 10 \underline{a}_z$$

$$\underline{F} = 5\pi \times 10^{-6} \underline{a}_z \text{ N/m}$$

$$= 15.7 \times 10^{-6} \underline{a}_z \text{ N/M}$$

$$= 1.57 \times 10^{-5} \underline{a}_z \text{ N/M}$$

Question (1)



$\underline{H}_1 = 229\,\underline{a}_\phi + 459\,\underline{a}_\phi$

a) $H_{1T} = H_{2T}$

$\Rightarrow \underline{H}_{2T} = 45\,\underline{a}_\phi$

(5)

$\underline{B}_{1N} = \mu_1 \times \underline{H}_{1N} \Rightarrow \underline{B}_{1N} = 400\mu_0 \times 2$

$\underline{B}_{2N} = \underline{B}_{1N} = 8800\mu_0\,\underline{a}_\rho$

$\underline{H}_{2N} = \frac{\underline{B}_{2N}}{\mu_0} = 8800\,\underline{a}_\rho$

$\underline{H}_2 = \underline{H}_{2T} + \underline{H}_{2N}$ (5)

$= 45\,\underline{a}_\phi + 8800\,\underline{a}_\rho$

Q5 (2)

$\underline{B}_2 = \mu_0 \underline{H}_2$

$\underline{B}_2 = 45\mu_0 a_\phi + 8800\mu_0 a_\rho$ (5)

$\underline{M}_1 = \chi_m \underline{H}_1 = (\mu_r - 1)\underline{H}_1$

$\underline{M}_1 = 399\,(22 a_\rho + 45 a_\phi)$ (5)

$\underline{M}_2 = \underline{0}$