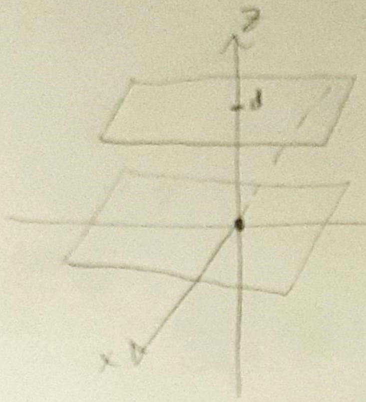
Questão 1 - 96708 - ELT 225 - 7/10/20.



a) $H = \frac{1}{2}\vec{K}\times\vec{a}_n$

$\vec{H}_0 = \frac{K_0}{2}\vec{a}_y$ e $\vec{H}_d = +\frac{K_0}{2}\vec{a}_y$

$$W_m = \frac{1}{2}\int_0^1\int_0^W\int_0^d \mu H^2\,dz\,dy\,dx = \frac{\mu_0 K_0^2\, x\big|_0^1\, y\big|_0^W\, z\big|_0^d}{2\cdot 4}$$

$$W_m = \frac{\mu_0 W d K_0}{8} \Rightarrow \boxed{\frac{W_m}{W} = \frac{\mu_0 d K_0^2}{8}} \; [J/m]$$

Para as duas placas: $\frac{W_m}{W} = \frac{\mu_0 d K_0^2}{2}$ [J/m]

b) $$W = \frac{LI^2}{2} \Rightarrow \frac{\mu_0 d K_0^2 W}{8_4} = \frac{LI^2}{2} \Rightarrow \frac{L}{W} = \frac{\mu_0 d K_0^2 W}{4I^2} = \frac{\mu_0 d \cancel{K_0^2} W}{4\cancel{K_0^2} W^2} \Rightarrow \frac{L}{W} = \frac{\mu_0 d}{4W^2}$$

Sendo $I = K_0 W$ $\boxed{\frac{L}{W} = \frac{\mu_0 d}{4W^2}}$ $\left[\frac{H}{m}\right]$

Para duas placas: $\boxed{\frac{L}{W} = \frac{\mu_0 d}{W^2}}$ $\left[\frac{H}{m}\right]$

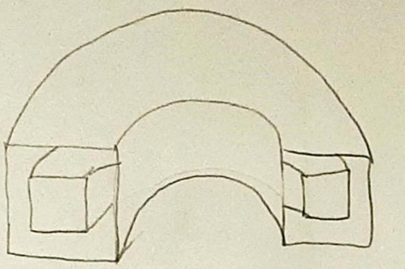
c) $$\emptyset = \int \vec{B}\cdot d\vec{S} = \int_0^d\int_0^1 \mu_0 \vec{H}\,dx\,dz = \frac{\mu_0 K_0\, d\cdot 1}{2} \Rightarrow \boxed{\emptyset = \frac{\mu_0 K_0 d}{2}} \; Wb$$

$$L = \frac{N\emptyset}{I} = \frac{1\,\mu_0 \cancel{K_0} d}{2\cancel{K_0} W} \Rightarrow L = \frac{\mu_0 d}{2W} \Rightarrow \boxed{\frac{L}{W} = \frac{\mu_0 d}{2W^2}} \; \left[\frac{H}{m}\right]$$

Para duas placas:

$$\frac{L}{W} = \frac{\mu_0 d}{W^2}$$

Questão 2



$N_i = 500$ E.

$N_E = 4000$ E.

$\mu_r = 1$

$S_i = 1.4^2 \, cm^2$; $l_i = 20.1$ cm

$S_E = 2.4^2 \, cm^2$; $l_E = 20.1$ cm

interna:

$$B = \mu_0 \cdot \frac{I_i N_i}{2\pi\rho} \vec{a}_\phi =$$

$$\phi_i = \int \vec{B} \cdot d\vec{S} = \int_{z_1}^{z_2} \int_{\rho_1}^{\rho_2} \frac{\mu_0 I_i N_i}{2\pi\rho} d\rho \, dz = \frac{\mu_0 I_i N_i}{2\pi} \ln\left|\frac{\rho_2}{\rho_1}\right| \overbrace{(z_2 - z_1)}^{1.4 \times 10^{-2}} =$$

$$L_i = \frac{N_i \phi_i}{I_i} = \frac{N_i^2 \mu_0}{2\pi} \ln\left|\frac{\rho_2}{\rho_1}\right| (1.4) = 311.3 \, \mu H$$

Externa:

$$B = \mu_0 \frac{I_E N_E}{2\pi\rho} \vec{a}_\phi \quad \Big\} \quad \phi_E = \int_{z_1}^{z_2} \int_{\rho_1}^{\rho_2} \frac{\mu_0 I_E N_E}{2\pi\rho} d\rho \, dz = \frac{\mu_0 I_E N_E}{2\pi} \ln\left|\frac{\rho_0}{\rho_1}\right| (2.4 \times 10^{-2})$$

$$L_E = \frac{N_E^2 \mu_0}{2\pi} \ln\left|\frac{4.4}{2}\right| (2.4 \times 10^{-2}) = 60.55 \, m[H]$$

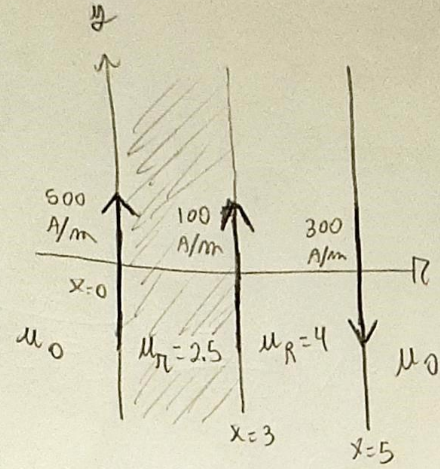
mutua:

$$M_{12} = \frac{N_1 \phi_{12}}{I_2} = \frac{N_i \phi_E}{I_E} = \frac{N_i \mu_0 \cancel{I_E} N_E}{2\pi \cancel{I_E}} \ln\left|\frac{4.4}{2}\right| (2.4 \cdot 10^{-2}) =$$

$$M_{12} = 7.57 \, mH$$

* Valores calculados aproximadamente.

Questão 3



Logo:

$H = \frac{1}{2}\, 500\, \vec{a_y} \times (-\vec{?}) = 250\, \vec{a_z}$

Para K_0 $\begin{cases} x < 0: \vec{H} = \frac{1}{2}\, 500\, \vec{a_y} \times (-\vec{a_x}) = 250\, \vec{a_z} \ A/m \\ x > 0: \vec{H} = \frac{1}{2}\, 500\, \vec{a_y} \times (\vec{a_x}) = -250\, \vec{a_z} \ A/m \end{cases}$

Para K_3 $\begin{cases} x < 3: \vec{H} = \frac{1}{2}\, 100\, \vec{a_y} \times (-\vec{a_x}) = 50\, \vec{a_z} \ A/m \\ x > 3: \vec{H} = \frac{1}{2}\, 100\, \vec{a_y} \times (\vec{a_x}) = -50\, \vec{a_z} \ A/m \end{cases}$

Para K_5 $\begin{cases} x < 5: \vec{H} = \frac{1}{2}\, 300\, (-\vec{a_y}) \times (-\vec{a_x}) = -150\, \vec{a_z} \ A/m \\ x > 5: \vec{H} = \frac{1}{2}\, 300\, (-\vec{a_y}) \times (\vec{a_x}) = 150\, \vec{a_z} \ A/m \end{cases}$

Para $x < 0$:

$B = 250\mu_0 + 125\mu_0 - 600\mu_0 = -225\mu_0\, \vec{a_z} \ \left[\frac{Wb}{m^2}\right]$

Para $0 < x < 3$:

$B = (-250 + 125 - 600)\mu_0 = -725\mu_0\, \vec{a_z} \ \left[\frac{Wb}{m^2}\right]$

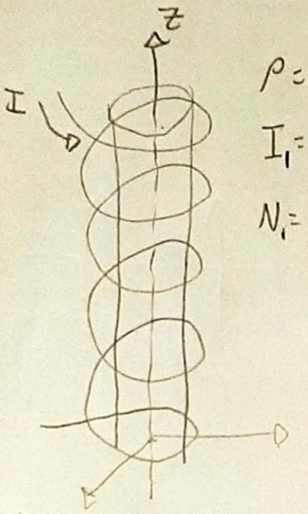
Para $3 < x < 5$:

$B = (-250 - 50 - 600)\mu_0 = -975\mu_0\, \vec{a_z} \ \left[\frac{Wb}{m^2}\right]$

Para $5 < x$:

$B = (-250 - 50 + 600)\mu_0 = 225\mu_0\, \vec{a_z} \ \left[\frac{Wb}{m^2}\right]$

Questão 4



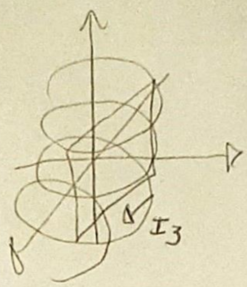
$\rho = 3 \times 10^{-2} m$

$I_1 = 5\, a_\phi\, [A]$

$N_1 = 30 \left[\frac{esp}{cm}\right]$

$B = \mu_0 \frac{N\, I}{L}\, \vec{a_z}$ Região interna $0 < \rho < 3\, cm$

b)



Dipolo magnético:

$\mu = \int I\, \vec{ds}$

$\tau = \vec{\mu} \times \vec{B}$

a) origem: $(0,0,0)$, $\rho = 2\, cm$, $z = 0$ e $I_2 = 2\, \vec{a_\phi}$

Para este solenoide, $B = \frac{\mu_0 N I}{L}$, e como o campo é uniforme $F_T = 0$,

e $d\tau = I\, \vec{ds} \times \vec{B}$.

$d\tau = I_2\, \rho\, d\phi\, d\rho\, \vec{a_z} \times \frac{\mu_0 N I}{L} \vec{a_z} = 0\, [N.m]$, pois estão na mesma direção. $(\vec{a_z} \times \vec{a_z} = 0)$

b) $I_3 = 3\, a$

Da mesma forma o campo é uniforme, logo $F_T = 0$, Portanto:

$d\tau = I\, \vec{ds} \times B$: $I_3\, dx\, dz\, (-\vec{a_y}) \times N_1 I_1 (\vec{a_z}) \Rightarrow$

$\tau = \int_{-1}^{1} \int_{-4}^{0} -I_3 I_1 N\, \vec{a_x} = -\mu_0 I_1 I_3 N_1 x (2 \times 10^{-2})(4 \times 10^{-2}) = -45.24\, \mu\, [N.m]$