PROBLEM 2:

$z = 0$

$y = 0.3$

$B = 2x^2 \hat{a}_z$

$x = 10t + t^3$

$t = 0.5\,s$

$dS = y\ dx\ \hat{a}_z$

$= 0.3\ dx\ \hat{a}_z$

$$\phi = \int_S B \cdot dS$$

$$= \int_0^x 2x^2\ \hat{a}_z \cdot 0.3\ dx\ \hat{a}_z$$

$$= \int_0^x 0.6\ x^2\ dx$$

$$= \frac{0.6\ x^3}{3}$$

$$= 0.2x^3$$

$$\phi = 0.2\ [10t + t^3]^3$$

$$= 0.2x^9 + 6x^7 + 60x^5 + 200x^3$$

$$V_{emf} = \frac{-d\phi}{dt} = -\frac{d}{dt}\phi$$

$$= -0.6\ (10x + x^3)^2 (10 + 3x^2)$$

@ $t = 0.5s$ $\quad V = -169.413\ V$

PROBLEM 3:

$l_g = 1mm$

$I_2 = 0.3A$ → FORCE ON WIRE

$I_2 = 0\ A$ → FORCE ACROSS AIR GAP

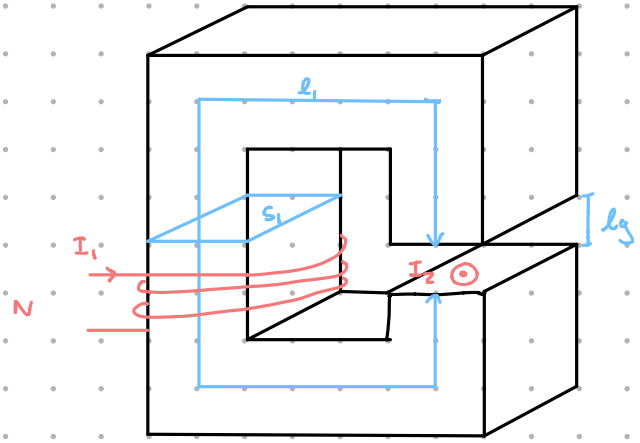
$N = 200$

$I_1 = 1A$

$\mu_r = 200$

$S_1 = 0.16m^2$

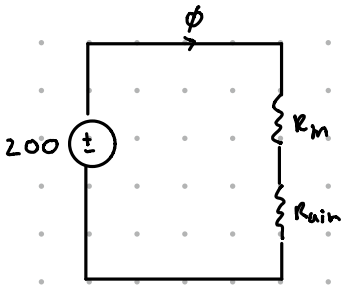
$l_1 = 0.25m$



a)

$$F = \frac{\mu_0 H^2 A}{2} = \frac{B^2 A}{2\mu_0} \quad \text{→ } S_1$$

$$B = \frac{\phi}{S_1} \qquad \phi = \frac{NI}{R} \qquad R = \frac{l}{\mu_0 \mu_r S_1}$$



$$R_m = \frac{0.25}{4\pi \times 10^{-7}(200)(0.16)} = 6216.99$$

$$R_{air} = \frac{1 \times 10^{-3}}{4\pi \times 10^{-7}(0.16)} = 4973.59$$

$$NI = 200(1A) = 200$$

$$\phi = \frac{200}{6216 + 4973} = 0.01787$$

$$B = \frac{0.00536}{0.16} = 0.1117$$

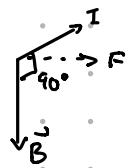
$$F = \frac{0.1117^2 (0.16)}{2(4\pi \times 10^{-7})} = 794.32\ N$$

b) $F = BIl\sin\theta$ → angle between $\vec{B}$ & $\vec{I}$

$B = 0.1117\ T$

$I = I_2 = 0.3A$

RHR:

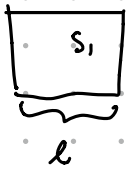


$\sin 90° = 1$

$$F = 0.1117(0.3)(\sqrt{0.16})$$

$$= 0.0134$$

$l = \sqrt{0.16}$



PROBLEM 4:

$a = 5 \times 10^{-3}\ m$

$b = 12 \times 10^{-3}\ m$

$a < \rho < c \rightarrow$ material

$c = 7.1 \times 10^{-3}\ m$

$\mu_r = 400$

$c < \rho < b \rightarrow$ air

$$\phi = LI = \left[\frac{\mu_0 \mu_{r_1} I}{2\pi} \int_a^c \ell \cdot \frac{dr}{r}\right] + \left[\frac{\mu_0 \mu_{r_2}}{2\pi} \int_c^b \ell \frac{dr}{r}\right]$$

$$L = \frac{\mu_0}{2\pi}\left[\mu_{r_1} \ln\left(\frac{c}{a}\right) + \mu_{r_2} \ln\left(\frac{b}{c}\right)\right]$$

$$= \frac{2}{\cancel{4\pi} \times 10^{-7}}{\cancel{2\pi}}\left[400 \ln\left(\frac{7.1 \times \cancel{10^{-3}}}{5 \times \cancel{10^{-3}}}\right) + \ln\left(\frac{12 \times \cancel{10^{-3}}}{7.1 \times \cancel{10^{-3}}}\right)\right]$$

$$L/m = 2.82 \times 10^{-5}\ H/m$$

PROBLEM 5:

$N = 6600$

$R = 200$

$x^2 + y^2 = 1.8^2$, $z = 0$

$B = 0.001 \cos(120\pi t)\, a_x + 0.001 \sin(120\pi t)\, a_z$ T

$\phi = B \cdot S = B \cdot \pi r^2$ $\qquad emf = -N \frac{d\phi}{dt}$

$$emf = -6600\, \pi (1.8)^2 \frac{d}{dt}\left(0.001\cos(120\pi t) + 0.001\sin(120\pi t)\right)$$

$$= -6600\, \pi (1.8)^2 (0.001)(120\pi) \underbrace{\left(\cos(120\pi t) - \sin(120\pi t)\right)}_{\text{max when } -1} \rightarrow -1$$

$=$

$$I = \frac{emf}{R} = \frac{50652.4}{200} = 126.63 \qquad I_{rms} = \frac{126.63}{\sqrt{2}} = 89.54$$

$$P = I_{rms}^2 \cdot R = 1603540.315$$