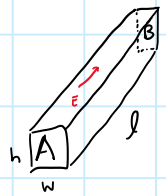
ASN4

Wednesday, January 31, 2024 11:57 AM

1)



$E = 3.8\ V/m$
$\ell = 1.3\ m$
$\sigma = 37.3\ S/m$
$w = 2.2\ cm = 0.022\ m$
$h = 1.3\ cm = 0.013\ m$

$V_{AB}, I_{AB} = ?$

$I_{AB} = \sigma \vec{E} A = 0.0405\ A = 40.54\ mA$

$V_{AB} = E\ell = 3.8 \times 1.3 = 4.94\ V$

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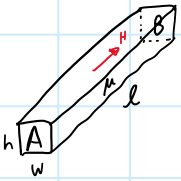
2)



$H = 8\ A/m$
$\ell = 1.3\ m$
$\mu = 1450\ \mu_0\ H/m$
$w = 1.8\ cm = 0.018\ m$
$h = 1.4\ cm = 0.014\ m$

$\Delta U_{AB}, \phi_{AB} = ?$

$\Delta U_{AB} = H\ell = 8 \times 1.3 = 10.4\ A$

$\phi_{AB} = H \mu A = (8)(1450\mu_0)(0.018)(0.014) = 3.6734\ \mu Wb$

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3) a) Find B given $H = 150\ A/m$

$$\text{Solve}\left(\frac{1.1-0.72}{\log10(200)-\log10(100)} = \frac{1.1-x}{\log10(200)-\log10(150)}, x\right)$$

$x = 0.9423$

b) Find H given $B = 0.9\ T$

$$\text{Solve}\left(\frac{1.1-0.72}{\log10(200)-\log10(100)} = \frac{1.1-0.9}{\log10(200)-\log10(x)}, x\right)$$

$x = 138.8651$

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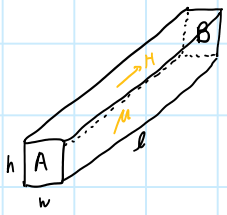
4) $H = 2523.83\ A/m \rightarrow B = 1.62016$



$H = 2583.83\ A/m$
$l = 0.7\ m$
$w = 0.7\ cm = 0.007\ m$
$h = 1.9\ cm = 0.019\ m$

$U, \phi, \mu_r = ?$

$U_{AB} = Hl = 1766.681\ A$ (drop)

$B = \frac{\phi}{A} \rightarrow \phi_{AB} = A \cdot B = hw \cdot B = 0.0002155\ Wb = 215.4813\ \mu Wb$

$H = \frac{\phi}{\mu A} \rightarrow \mu = \frac{\phi}{HA} = \frac{\phi}{H\,hw} = 6.419E{-}4$

$\mu_r = \frac{\mu}{\mu_0} = 510.844$

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5) $l = 13_{in} = 0.3302\ m$

$A = 0.9\ in^2 = 0.000580644\ m^2$

$N = 290$

$I = 0.189754\ A$

$B, \phi, L = ?$

$NI = Hl$

$H = \frac{NI}{l} = 166.6525\ A/m$

Solve $\left(\frac{1.1 - 0.72}{\log10(200) - \log10(100)} = \frac{1.1 - B}{\log10(200) - \log10(166.65)}, B\right)$

$B = 1\ T$

$\phi = BA = 5.8064E{-}4 = 580.6442\ \mu Wb$

$\lambda = N\phi = 0.1684$

$\lambda = LI \rightarrow L = \frac{\lambda}{I} = 0.8874\ H$

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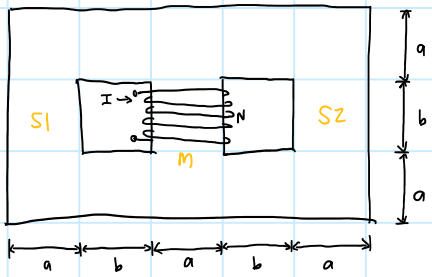
6)



$N = 1780$
$a = 7cm = 0.07m$
$b = 14cm = 0.14\ m$

$B_a = 0.4T$
$B_b = 0.8T$

a) $I = ?$ → c) $\mathcal{R}_{center,right} = ?$
b) $I = ?$ → d) $\mathcal{R}_{centre,right} = ?$

a) $B_m = B_a = 0.4T \rightarrow H_m = 63.6649\ A/m$

$B_{S1} = B_{S2} = \frac{0.4}{2} = 0.2T$ By symmetry $\rightarrow H_S = 44.7214\ A/m$

$l_m = a + b = 0.21\ m$

$l_{S1} = l_{S2} = l_m = 0.21_m$

Total length of side lengths: $3 \cdot 0.21 = 0.63_m = l_S$

b) $B_m = B_B = 0.8\ T \rightarrow H_m = 115.711\ A/m$

$B_{S1} = B_{S2} = \frac{0.8}{2} = 0.4T \rightarrow H_S = 63.6649\ A/m$

$I = 3.618E{-}2\ A = 36.18\ mA$

Total length of side lengths: $3 \cdot 0.21 = 0.63_m = \ell_s$

$$NI = H\ell \rightarrow I = \frac{H_m \ell_m + H_s \ell_s}{N} = 2.334E\text{-}2A = 23.34\,mA$$

c) $\Phi_m = B_m \cdot A = B_m \cdot a^2 = 0.00196$

$mmf = H_m \ell_m = 13.3696$

$\mathcal{R}_m = \frac{mmf}{\Phi_m} = 6821.2386 \frac{1}{H}$

$\Phi_R = \frac{\Phi_m}{2} = 0.00098$

$mmf = H_s \ell_s = 28.1745$

$\mathcal{R}_s = \frac{mmf}{\Phi_R} = 28749.445 \frac{1}{H}$

d) $\Phi_m = 0.00392$

$\rightarrow 24.2997$

$\rightarrow 6198.8048 \frac{1}{H}$

$\rightarrow 0.00196$

$\rightarrow 40.1089$

$\rightarrow 20463.7157 \frac{1}{H}$

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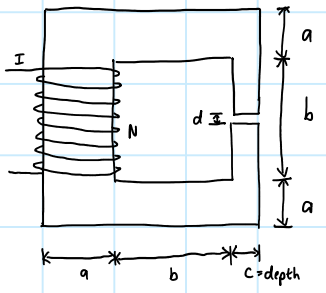
7)



N = 550

effective air gap area ↑ 5%

a = 10.4 cm = 0.104m

b = 19.6 cm = 0.196m

c = 4 cm = 0.04m

d = 0.11 cm = 0.0011 m

a) I = ? $B_{AG} = 1.2T$

b) $\Phi_{TOT} = ?$

c) $B_{top} = ?$

d) L = ?

$B_{gap} = 1.2T \rightarrow H_{gap} = 247.5766\ A/m$

$\Phi = B_{gap} \times A_{gap} = 0.002016\ Wb = 2.016\ mWb$ — b)

$A_{gap} = c^2 \cdot 1.05 = 0.00168$ (5% increase)

$A_{top} = a \cdot c = 0.00416$

$B_{top} = \frac{\Phi}{A_{top}} = 0.4846\ T$ — c) $\rightarrow H_{top} = 70.4810\ A/m$

$\ell_{top+left+btm} = 2(b+c) + b + a = 0.772$

$A_{right} = c^2 = 0.0016$

$B_{right} = \frac{\Phi}{A_{right}} = 1.26 \rightarrow H_{right} = 281.3956\ A/m$

$B_{right} = \frac{\Phi}{A_{right}} = 1.26 \rightarrow H_{right} = 281.3956\ A/m$

$\ell_{right} = a+b-d = 0.2989$ $\quad H_{gap} = \frac{B_{gap}}{\mu_0}$

$I = \frac{\Sigma H\ell}{N} = \frac{H_{right}\ell_{right} + H_{top}\ell_{center} + H_{gap}\,d}{N} = 2.162\,A = 2161.715\,mA$ —a)

$L = \frac{N\Phi}{I} = 0.51791H$ —d)

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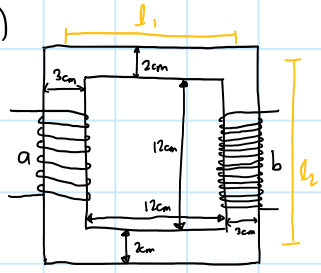
8)



$\mu = 1600\mu_0$
SF = 0.92
b = 22500
a = 3550
V = 120V, f = 60Hz, left coil

I at coil a; V at coil B; R=35500Ω at coil B, I at coil A=?
(last solved)

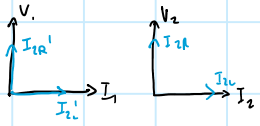
$V_a = \frac{a}{b}V_b$

$\frac{120b}{a} = V_b \rightarrow V_b = 760.5634V$

$I_b = \frac{V_b}{R} = 2.142E\text{-}2\ A = 21.42\ mA$

$I_a = \frac{b}{a}I_b = 0.135788\ A = 135.788mA$

C)



$I_{RMS} = \sqrt{(I_1 + I_{2L}')^2 + I_{2R}'}$

$area\_side = 0.03 \times 0.03 \times 0.92 = 0.000828$

$area\_tb = 0.02 \times 0.03 \times 0.92 = 0.000552$

$\ell_1 = 0.12 + 0.03 = 0.15_m$

$\ell_2 = 0.12 + 0.02 = 0.14\ m$

$\mathcal{R}_{side} = \frac{\ell_2}{area\_side\ \mu_0\mu_r} = 84094.55\ \frac{1}{H}$

$\mathcal{R}_{tb} = \frac{\ell_1}{area\_tb\ \mu_0\mu_r} = 135151.96\ \frac{1}{H}$

$\mathcal{R}_{total} = 2(\mathcal{R}_{side} + \mathcal{R}_{TB}) = 438493.012\ \frac{1}{H}$

$L = \frac{a^2}{\mathcal{R}_{TOTAL}} = 28.740$

$X_{L1} = \omega L = 10834.906$

$I_n = \frac{V_s}{X} = 11.0953\ mA$

$$I_a = \frac{V_s}{X_L} = 11.0753 \text{ mA}$$

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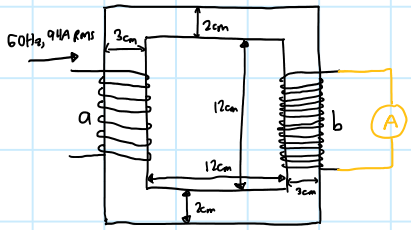
9)

ideal iron



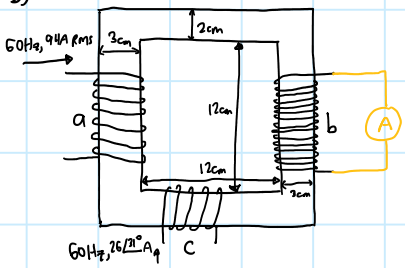
a = 700

b = 600

a) I at ammeter = ?

$$94 \cdot \frac{700}{600} = 80.57 \text{ A}$$

b)



C=1000, I at ammeter = ?

$$a I_a + c I_c = b I_B$$

$$I_B = \frac{a I_a + c I_c}{b} = 146.81 + j\,22.32 \text{ A}$$

$$|I_B| = 148.497 \text{ A}$$

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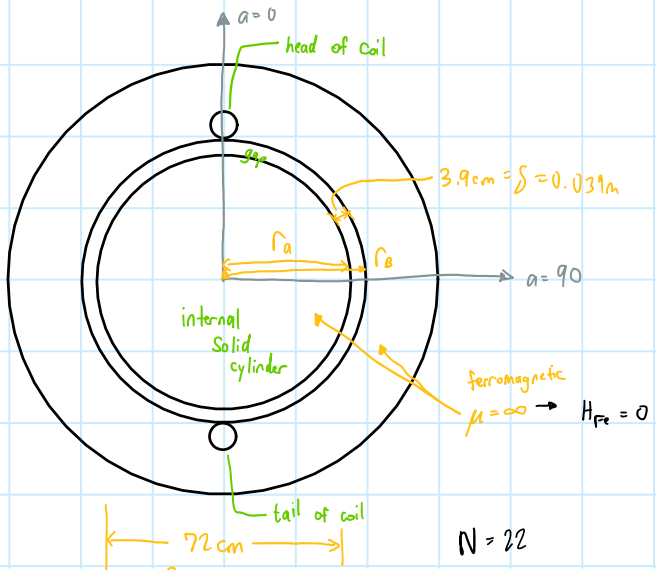
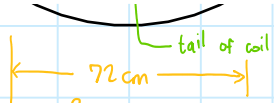
10)



N = 22



$N = 22$

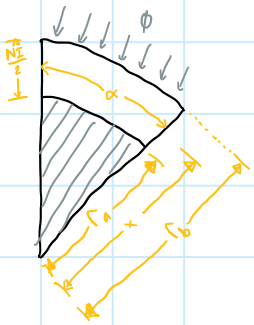
$\ell = 21.6\text{ cm} = 0.216\text{m}$

$\rightarrow r_a = \frac{0.072}{2} = 0.36\text{m} \rightarrow r_b = 0.36 + 0.039 = 0.399\text{m}$

a) $I_{coil} = 9.5A$, H @ $\alpha = 60°, \alpha = 120° = ?$

$$MMF_{total} = NI \rightarrow \frac{NI}{2} = \int_{r_a}^{r_b} H(x)\,dx$$

$$\approx \frac{NI}{2} = H\delta_0$$



$$B_0(x) = \frac{\phi}{\ell \alpha x} \qquad H_0(x) = \frac{\phi}{\mu_0 \ell \alpha x}$$

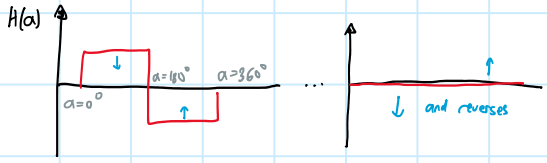
substitute

$$\frac{NI}{2} = \frac{\phi}{\mu_0 \ell \alpha}\int_{r_a}^{r_b}\frac{dx}{x} = \frac{\phi}{\mu_0 \ell \alpha}\ln\frac{r_b}{r_a}$$

$$\rightarrow H_0(x) = \frac{NI}{2x\ln\frac{r_b}{r_a}} \rightarrow H_0(r_a) = \frac{NI}{2r_a\ln\frac{r_b}{r_a}}$$

$H_0(60°) = 2822.1384\ \frac{A}{m} = 2.822\ \frac{A}{mm}$

$H_0(120°) = -2.822\ \frac{A}{mm}$



b) At $t = 0.002s$, $i(t) = 9.5\sin(377t)$

$\rightarrow H_0(30°) = \frac{NI}{2r_a\ln\frac{r_b}{r_a}} = 1931.92\ \frac{A}{m} = 1.931\ \frac{A}{mm}$

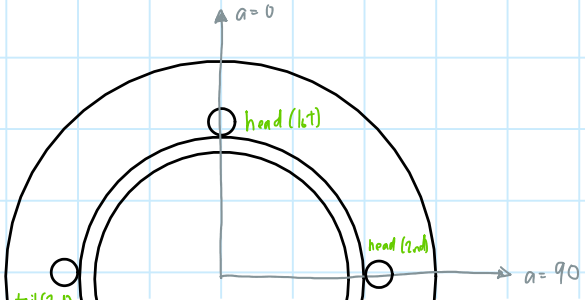
$H_0(330°) = -1.931\ \frac{A}{mm}$

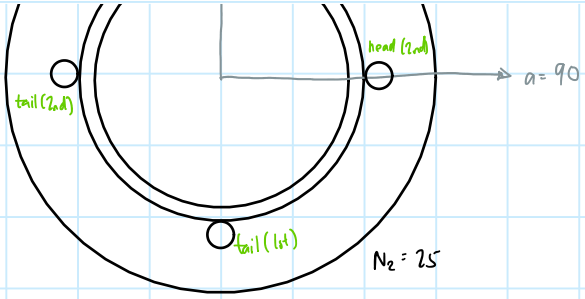
At $t = 0.015s$

$H_0(190°) = 1658.507\ \frac{A}{m} = 1.659\ \frac{A}{mm}$

$H_0(350°) = 1.659\ \frac{A}{mm}$

c)





$i(t) = 9.5 \sin\left(377t - \frac{\pi}{2}\right)$ A

$t = 0.003$ s

$H(45°) = \frac{N_1 I_1 - N_2 I_2}{2 r_a \ln \frac{r_b}{r_a}} = 3918.97 \frac{A}{m} = 3.919 \frac{A}{mm}$

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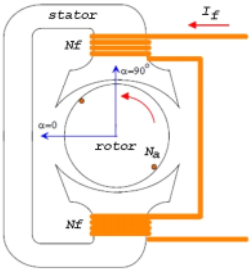
1)



$B_a(\alpha) = B_{max} \cdot \sin(\alpha)$

$r_{rotr} = \frac{49cm}{2} = 0.245$ m

$l_{rotr} = 24.5cm = 0.245$ m

$N_f = 1080$

$I_f = 3.4A$

$\delta_0 = 8.16668mm$

$\rightarrow 0.00816668$ m

a) $B_{max} = \frac{NI\mu_0}{\delta_0} = 0.565$

$\phi = 2 B_{max} \cdot r_{rotr} \cdot l_{rotr} = 6.783E\text{-}2$ Wb $= 67.8311$ mWb

b) $N_a = 62$, 1200 rpm turn

$w = \frac{1200 \cdot 2\pi}{60} = 40\pi$

$E = N_b \phi w \sin(\omega t)$

$E(0.003) = 194.547$ V

$E(0.008) = 446.213$ V