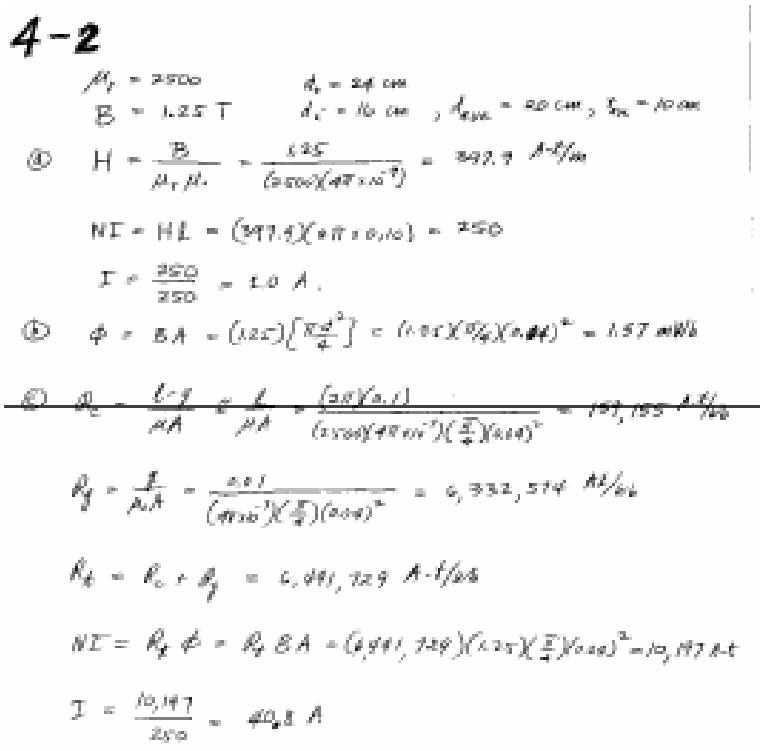
KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

ELECTRICAL ENGINEERING DEPARTMENT

EE 306

Solved-HW # 2: Magnetic Circuits



4-2

$\mu_r = 2500$ $\quad l_c = 24$ cm

$B = 1.25$ T $\quad l_c = 16$ cm, $l_{gap} = 0.2$ cm, $S_{in} = 10$ cm

(a) $H = \frac{B}{\mu_r \mu_o} = \frac{1.25}{(2500)(4\pi \times 10^{-7})} = 397.9$ A-t/m

$NI = Hl = (397.9)(0.24 + 0.16) = 250$

$I = \frac{250}{250} = 1.0$ A.

(b) $\Phi = BA = (1.25)\left[\pi \frac{d^2}{4}\right] = (1.25)(\pi)(\frac{1}{4})(0.04)^2 = 1.57$ mWb

(c) ~~$\mathcal{R}_c = \frac{l-g}{\mu A} + \frac{g}{\mu_o A} = \frac{(2.4)(0.1)}{(2500)(4\pi \times 10^{-7})(\frac{\pi}{4})(0.04)^2} = 152,155$ A-t/Wb~~

$\mathcal{R}_g = \frac{g}{\mu_o A} = \frac{0.002}{(4\pi \times 10^{-7})(\frac{\pi}{4})(0.04)^2} = 6,332,574$ A-t/Wb

$\mathcal{R}_t = \mathcal{R}_c + \mathcal{R}_g = 6,484,729$ A-t/Wb

$NI = \mathcal{R}_t \Phi = \mathcal{R}_t BA = (6,484,729)(1.25)(\frac{\pi}{4})(0.04)^2 = 10,197$ A-t

$I = \frac{10,197}{250} = 40.8$ A

4-3

$l_c = 1\text{ mm}$; $l_a = 2\text{ mm}$, $A = (5)(5) = 25\text{ mm}^2 = 25\times10^{-6}\text{ m}^2$

$N = 200$ turns, $\mu_r = 2500$

(a) $\mathcal{R}_c = \dfrac{l_c}{\mu A} = \dfrac{1\times10^{-3}}{(4\pi\times10^{-7})(2500)(25\times10^{-6})} = 3.183\times10^{5}\text{ A-t/wb}$

$\phi = BA = (0.75)(25\times10^{-6}) = 1.875\times10^{-5}\text{ wb}$

$NI = \mathcal{R}_c\phi = (3.183\times10^{5})(1.875\times10^{-5}) = 596.83\text{ A-t}$

$I = \dfrac{596.83}{200} = 2.984\text{ A}$

$V = RI = (2.5)(2.984) = 7.46\text{ V}$

(b) $\mathcal{R}_a = \dfrac{l_a}{\mu A} = \dfrac{2\times10^{-3}}{(4\pi\times10^{-7})(25\times10^{-6})} = 636,620\text{ A-t/wb}$

$\phi_a = \dfrac{NI}{\mathcal{R}_a} = \dfrac{596.83}{636,620} = 9.375\times10^{-4}\text{ wb}$

$\phi_c = \phi_a + \phi_c = 9.375\times10^{-4} + 18.75\times10^{-6} = 28.125\times10^{-4}$

$= 2.8125\times10^{-3}\text{ wb}$

4-4

(a) $\mathcal{R}_c = 3.183\times10^{5}\text{ A-t/wb}$

$\phi_c = BA = 1.875\times10^{-5}\text{ wb}$

$NI = \mathcal{R}_c\phi_c = 596.83\text{ A-t}$

$I = \dfrac{596.83}{200} = 2.984\text{ A}$

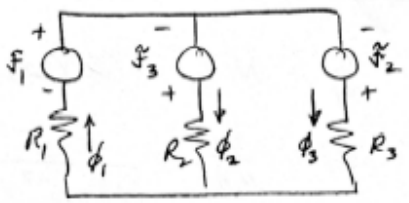
$V = RI = 7.46\text{ V}$

(b) $\mathcal{R}_a = 0$

$\phi_a = 0$

$\phi_{fg} = \phi_c = 1.875\times10^{-5}\text{ wb}$

4-8



$$R_1 = R_2 = R_3 = 7.958 \times 10^6 \text{ At/Wb} = R$$

$$\mathcal{F}_1 = N_1 I_1 = (80)(12) = 960 \text{ At}$$

$$\mathcal{F}_2 = N_2 I_2 = (100)(10) = 1000 \text{ At}$$

$$\mathcal{F}_3 = N_2 I_3 = (125)(8) = 1000 \text{ At}$$

$$\phi_1 = \phi_2 + \phi_3$$

$$\phi_3 = \phi_1 - \phi_2$$

$$\mathcal{F}_1 + \mathcal{F}_3 = R_1 \phi_1 + R_2 \phi_2$$

$$\mathcal{F}_1 + \mathcal{F}_2 = R_1 \phi_1 + R_3 \phi_3$$

$$\mathcal{F}_1 + \mathcal{F}_2 = (R_1 + R_3)\phi_1 - R_3 \phi_2$$

$$1960 = R\phi_1 + R\phi_2$$

$$1960 = 2R\phi_1 - R\phi_2$$

$$\phi_1 = \frac{2(1960)}{3(7.958 \times 10^6)} = 0.1642 \text{ mWb}$$

$$\phi_2 = \frac{1960}{3(7.958 \times 10^6)} = 0.0821 \text{ mWb}$$

$$\phi_3 = 0.1642 - 0.0821 = 0.0821 \text{ mWb}$$

$$B_1 = \frac{0.1642 \times 10^{-3}}{5 \times 10^{-4}} = 0.328 \text{ T}$$

$$B_2 = \frac{0.0821 \times 10^{-3}}{5 \times 10^{-4}} = 0.164 \text{ T}$$

$$B_3 = \frac{0.0821 \times 10^{-3}}{10 \times 10^{-4}} = 0.082 \text{ T}$$