

4-2

$$\mu_r = 2500$$

$$d_o = 24 \text{ cm}$$

$$B = 1.25 \text{ T}$$

$$d_i = 16 \text{ cm}, d_{ave} = 20 \text{ cm}, r_{ave} = 10 \text{ cm}$$

$$\textcircled{a} \quad H = \frac{B}{\mu_r \mu_0} = \frac{1.25}{(2500)(4\pi \times 10^{-7})} = 397.9 \text{ A-t/m}$$

$$NI = HL = (397.9)(2\pi \times 0.10) = 250$$

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

$$\textcircled{b} \quad \phi = BA = (1.25) \left[\frac{\pi d^2}{4} \right] = (1.25) \left(\frac{\pi}{4} \right) (0.04)^2 = 1.57 \text{ mWb}$$

$$\textcircled{c} \quad R_c = \frac{l-g}{\mu A} \approx \frac{l}{\mu A} = \frac{(2\pi)(0.1)}{(2500)(4\pi \times 10^{-7}) \left(\frac{\pi}{4} \right) (0.04)^2} = 159,155 \text{ A-t/Wb}$$

$$R_g = \frac{g}{\mu_0 A} = \frac{0.01}{(4\pi \times 10^{-7}) \left(\frac{\pi}{4} \right) (0.04)^2} = 6,332,574 \text{ A-t/Wb}$$

$$R_t = R_c + R_g = 6,491,729 \text{ A-t/Wb}$$

$$NI = R_t \phi = R_t BA = (6,491,729) (1.25) \left(\frac{\pi}{4} \right) (0.04)^2 = 10,197 \text{ A-t}$$

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

4-3

$$g_c = 1 \text{ mm}; g_A = 2 \text{ mm}, A = (5 \times 5) = 25 \text{ cm}^2 = 25 \times 10^{-4} \text{ m}^2$$

$$N = 200 \text{ turns}, R = 2.5 \Omega$$

$$\textcircled{a} \quad R_c = \frac{g_c}{\mu_0 A} = \frac{1 \times 10^{-3}}{(4\pi \times 10^{-7})(25 \times 10^{-4})} = 318,310 \text{ A-t/Wb}$$

$$\phi_c = BA = (0.75)(25 \times 10^{-4}) = 1.875 \times 10^{-3} \text{ Wb}$$

$$NI = R_c \phi_c = (318,310)(1.875 \times 10^{-3}) = 596.83 \text{ A-t}$$

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

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

4.3 (contd.) (b) $R_A = \frac{l}{\mu_0 A} = \frac{2 \times 10^{-3}}{(4\pi \times 10^{-7})(25 \times 10^{-4})} = 636,620 \text{ At/Wb}$

$$\phi_A = \frac{NI}{R_A} = \frac{596.83}{636,620} = 9.375 \times 10^{-4} \text{ Wb}$$

$$\begin{aligned}\phi_B &= \phi_A + \phi_c = 9.375 \times 10^{-4} + 18.75 \times 10^{-4} = 28.125 \times 10^{-4} \\ &= 2.8125 \times 10^{-3} \text{ Wb}\end{aligned}$$

4-4

(a) $R_c = 318,310 \text{ At/Wb}$

$$\phi_c = BA = 1.875 \times 10^{-3} \text{ Wb}$$

$$NI = R_c \phi_c = 596.83 \text{ At}$$

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

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

(b) $R_B = 0$

$$\phi_A = 0$$

$$\phi_B = \phi_c = 1.875 \times 10^{-3} \text{ Wb}$$

4-11

(a) $R_g = \frac{l}{\mu_0 A} = \frac{2 \times 10^{-3}}{(4\pi \times 10^{-7})(16 \times 10^{-4})} = 994,718 \text{ At/Wb}$

$$F = NI = (500)(4) = 2000 \text{ At}$$

$$\phi = \frac{NI}{R_g} = \frac{2000}{994,718} = 2 \text{ mWb}$$

(b) $\lambda = N\phi = (500)(2 \times 10^{-3}) = 1 \text{ Wb-t}$

(c) $L = \frac{\lambda}{I} = \frac{1}{4} = 0.25 \text{ H}$