Lecture-19
Tutorial

Lecture Delivered by

Objectives

At the end of this lecture, student will be able to:

- Solve Problems on series magnetic circuits
- Solve problems on Parallel magnetic circuits

Problem No. 1

A coils of 200 turns is uniformly wound around a wooden ring with a mean circumference of 600 mm and area of cross-section of 500 mm^2. If the current flowing into the coil is 4 A, Calculate

(a) the magnetic field strength

(b) flux density density

(c) total flux

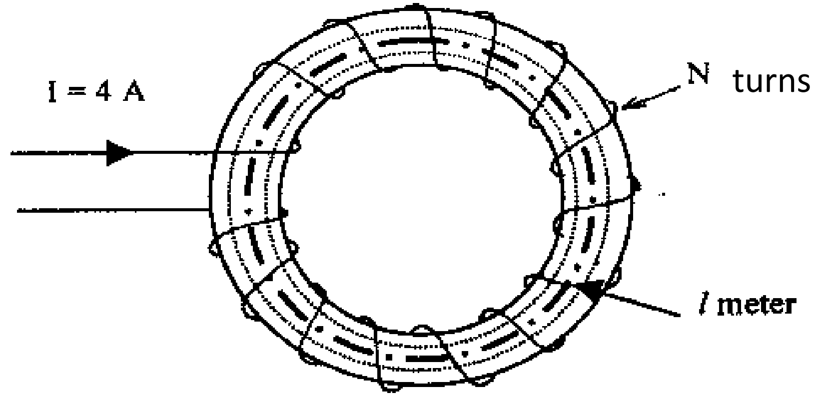
Solution

$N = 200$ turns

$l = 600 \times 10^{-3}$ m

$A = 500 \times 10^{-6}$ m^2

$I = 4$ A



(a) $H = NI/l = 200 \times 4 / 600 \times 10^{-3} = 1333$ A

(b) $B = \mu_o H = 4\pi \times 10^{-7} \times 1333 = 0.001675$ T $= 1675\ \mu$T

(c) Total Flux $\Phi = BA = 1675 \times 10^{-6} \times 500 \times 10^{-6}$

$= 0.8375\ \mu$Wb

Problem No. 2

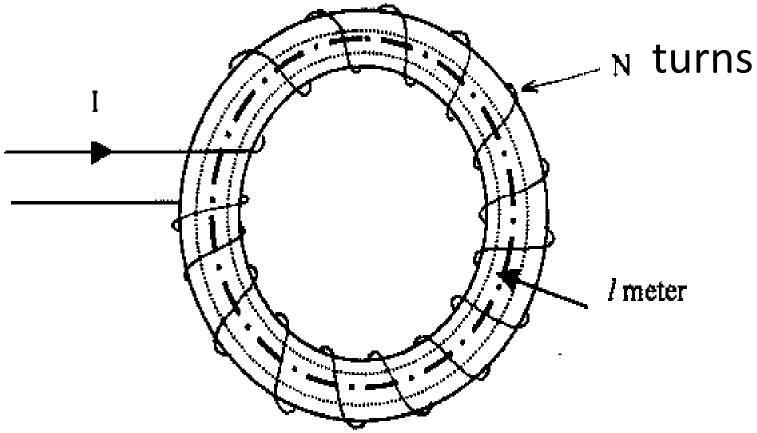
A mild steel ring, having a cross-section area of 500 mm^2 and a mean circumference of 400 mm is wound uniformly by a coil of 200 turns. Assume that μ_r = 380. Calculate

(a) reluctance of the ring and

(b) a current required to produce a flux of 800 μWb in the ring.

Solution

(a) $$B = \frac{\Phi}{A} = \frac{800\times10^{-6}}{500\times10^{-6}} = 1.6T$$



$$S = \frac{\ell}{\mu_r \mu_o A} = \frac{0.4}{380\times4\pi\times10^{-7}\times5\times10^{-4}}$$

$$= 1.667\times10^{6}[A/Wb]$$

Solution

(b)

$$\Phi = \frac{H\ell}{S} \longrightarrow H\ell = \Phi S$$

mmf $$H\ell = 800 \times 10^{-6} \times 1.667 \times 10^{6} = 1342[A] = NI$$

$$\therefore I = \frac{1342}{N} = \frac{1342}{200} = 6.7[A]$$

Problem No. 3

- Iron Ring of circular cross-sectional area of 3 cm^2 and mean diameter of 20 cm is wound with 500 turns of wire and carries a current of 2.09A to produce magnetic flux of 0.5mWb in the ring. Determine the permeability of the material.

Solution

The given values are :

$a = 3\ cm^2 = 3 \times 10^{-4}\ m^2,\quad d = 20\ cm,\quad N = 500,\quad I = 2\ A,\quad \phi = 0.5\ mWb$

Now, $\quad l = \pi \times d = \pi \times 20 = 62.8318\ cm = 0.628318\ m$

$$S = \frac{l}{\mu_0 \mu_r a} = \frac{0.628313}{4\pi \times 10^{-7} \times \mu_r \times 3 \times 10^{-4}} = \frac{1.6667 \times 10^9}{\mu_r} \quad \ldots (1)$$

$$f = \frac{M.M.F.}{S} = \frac{N I}{S}$$

$$\therefore \quad S = \frac{N I}{\phi} = \frac{500 \times 2}{0.5 \times 10^{-3}} = 2 \times 10^6\ AT/Wb \quad \ldots (2)$$

Equating equations (1) and (2),

$$\therefore \quad 2 \times 10^6 = \frac{1.6667 \times 10^9}{\mu_r}$$

$$\therefore \quad \mu_r = \mathbf{833.334}$$

Problem No. 4

A magnetic circuit comprises three parts in series, each of uniform cross-section area(c.s.a). They are :

(a)A length of 80mm and c.s.a 50 mm^2;

(b)A length of 60mm and c.s.a 90mm^2;

(c)An airgap of length 0.5mm and c.s.a 150 mm^2.

A coil of 4000 turns is wound on part (b), and the flux density in the airgap is 0.3T. Assuming that all the flux passes through the given circuit, and that the relative permeability m_r is 1300, estimate the coil current to produce such a flux density.

$$\Phi = B_C A_C = 0.3 \times 1.5 \times 10^{-4} = 0.45 \times 10^{-4} Wb$$

Mmf = F S = H *l* = N I

Material 'a' $$\Phi S_a = \Phi \frac{\ell_a}{\mu_r \mu_o A_a} = \frac{0.45 \times 10^{-4} \times 80 \times 10^{-3}}{1300 \times 4\pi \times 10^{-7} \times 50 \times 10^{-6}} = 44.1 At$$

Material 'b' $$\Phi S_b = \Phi \frac{\ell_b}{\mu_r \mu_o A_b} = \frac{0.45 \times 10^{-4} \times 60 \times 10^{-3}}{1300 \times 4\pi \times 10^{-7} \times 90 \times 10^{-6}} = 18.4 At$$

airgap $$\Phi S_c = \Phi \frac{\ell_c}{\mu_r \mu_o A_c} = \frac{0.45 \times 10^{-4} \times 0.5 \times 10^{-3}}{1 \times 4\pi \times 10^{-7} \times 150 \times 10^{-6}} = 119.3 At$$

Total mmf $$NI = \Phi S_a + \Phi S_b + \Phi S_c = 44.1 + 18.4 + 119.3 = 181.8 At$$

and $$I = \frac{181.8}{4000} = 45.4 \times 10^{-3} A = 45.4 mA$$