Basic Electrical Technology

2. Magnetic Circuits & Electromagnetism

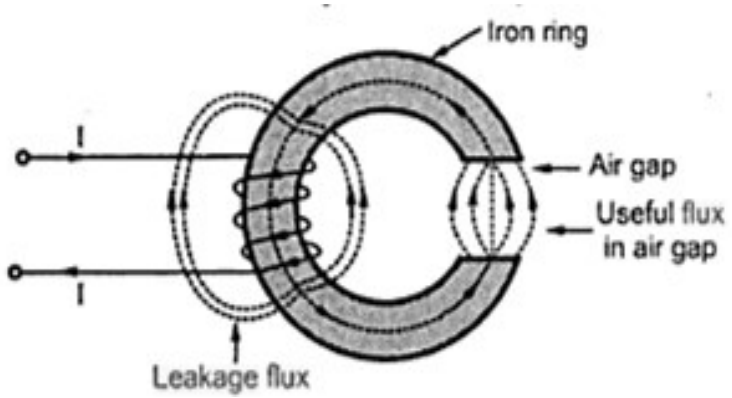
LECTURE 14 – 11 DEC 2021

Series Magnetic Circuits (contd…)

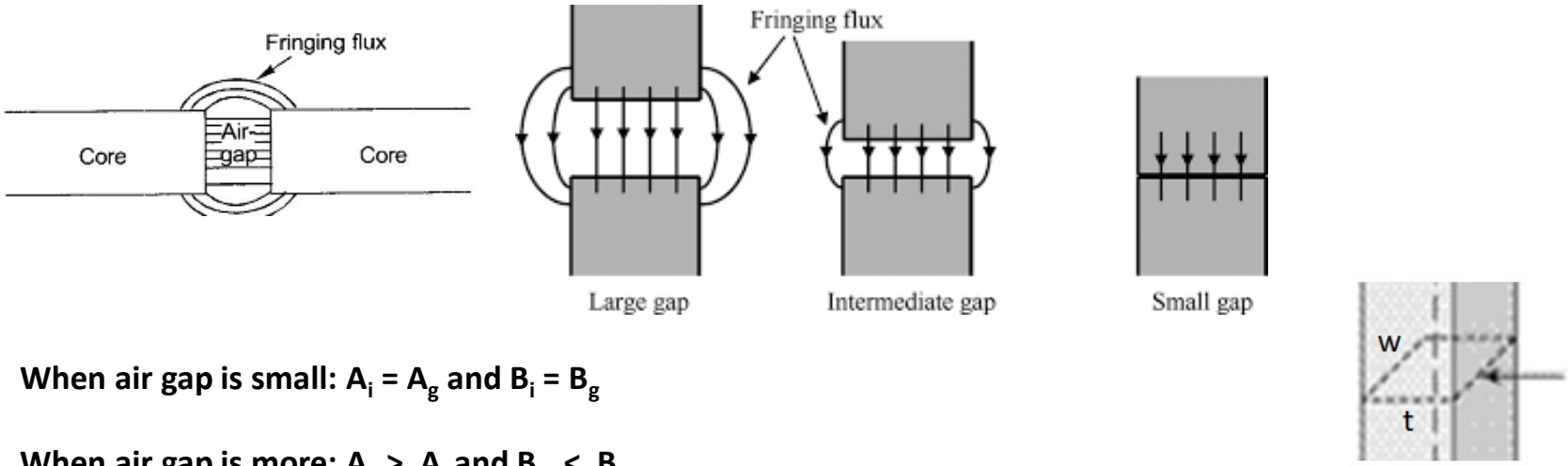
Useful & Leakage Flux

- **Magnetic leakage:**
  - The passage of magnetic flux outside the path along which it can do useful work
- Total flux of coil = Useful flux + Leakage flux
- **Leakage Coefficient**:

$$\lambda = \frac{\text{Total Flux of the Coil}}{\text{Useful Flux}} = \frac{\phi_{iron}}{\phi_{air-gap}} \approx 1.15 \text{ to } 1.25$$



Fringing



When air gap is small: $A_i = A_g$ and $B_i = B_g$

When air gap is more: $A_g > A_i$ and $B_g < B_i$

Fringing correction: Adding one gap length (L_g) in each of the two dimensions of the iron-core making up its area

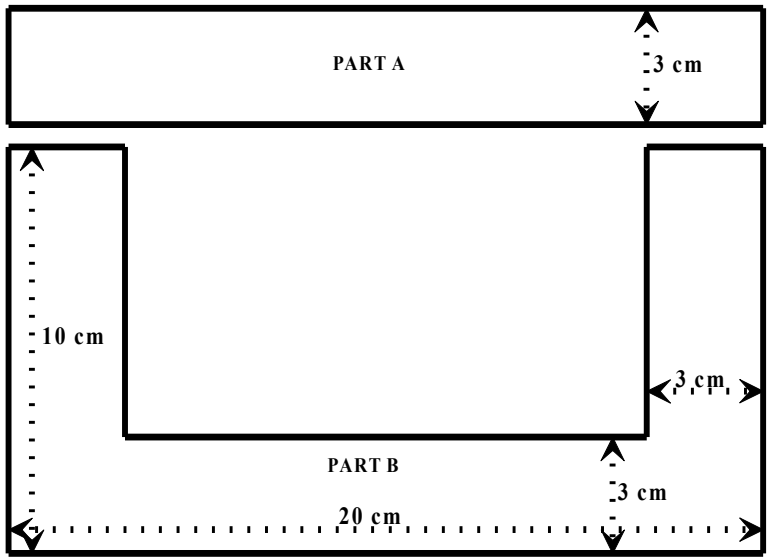
Core with rectangular cross-section: $A_i = w\ t$ With fringing correction: $A_g = (w + L_g)\ (t + L_g)$

Core with circular cross-section with diameter (d): $A_i = (\pi/4)\ d^2$ With fringing correction: $A_g = (\pi/4)\ (d + L_g)^2$

Illustration 3

The magnetic circuit shown in the figure is made of iron having a square cross-section of 3 cm side. It has two parts A and B, with relative permeabilities of 1000 and 1200 respectively, separated by two air gaps, each 2 mm wide. The part B is wound with a total of 1000 turns of wire on the two side limbs carrying a current of 2.5 A. Calculate

a) The reluctances of Part-A, Part-B & air gaps
b) the total reluctance
c) the mmf
d) the flux and the flux density



Hint:

Length of Part A = 1.5 + (20-1.5-1.5)+1.5 = 20cm

Length of Part B = (10-1.5)+(20-1.5-1.5)+(10-1.5) = 34 cm

Ans:

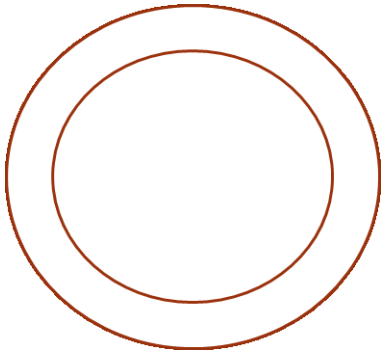
S_A = 176838.83AT/Wb,
S_B = 250521.67AT/Wb
S_g = 3536776.51AT/Wb
S_T = 3964137AT/Wb
mmf = 2500 AT
Φ = 0.63 mWb, B = 0.7 T

Illustration 4

A ring of cross sectional area 12 cm^2 has 3 parts made of following materials:

Part	Material	Length	Relative Permeability
A	Iron	25 cm	800
B	Steel	18 cm	1100
C	Air	2 mm	---

A coil of 660 turns carrying a current of 2.1 A is wound uniformly on the ring. Determine the flux density in the air gap. Assume no leakage and fringing effect.



Ans: 0.703 Wb/m^2

Illustration 5

An iron ring has mean circumferential length 50 cm and area of cross-section 4 cm^2. It is wound with 100 turns of wire. An air gap of 2 mm width is cut in the ring. Determine the current required in the coil to produce a flux of 0.48 mWb in the air gap. Assume leakage factor of 1.05. Assume the following data for magnetization of iron.

B (Wb/m2)	0.9	1.0	1.1	1.2	1.3
H (AT/m)	450	500	550	600	650

Ans: 22.236 A