University Mohamed Boudiaf of M'Sila
Faculty of Technology
Electrical Engineering Department
Option: ELT, ELM, ERE

Module: Basic Electrical Engineering 1
Level of study: 2nd year
Academic year: 2024-2025
Semester: 03

Series N 5: Magnetic Circuits

Exercise 01:

Consider the following magnetic circuit of fig.1: the relative permeability of the material is $\boldsymbol{\mu_r} = \mathbf{3000}$, with **100 turns**.

1. Give the equivalent circuit of this magnetic circuit and calculate:
   l: Length of flux path, **A**: Cross-sectional area.
   $\boldsymbol{\mathcal{R}}$: Magnetic reluctance.
2. What current I must be through the coil to have a flux $\boldsymbol{\phi = 1{,}3\ mwb}$ in the core.
3. Deduce its magnetic flux density $\boldsymbol{B}$

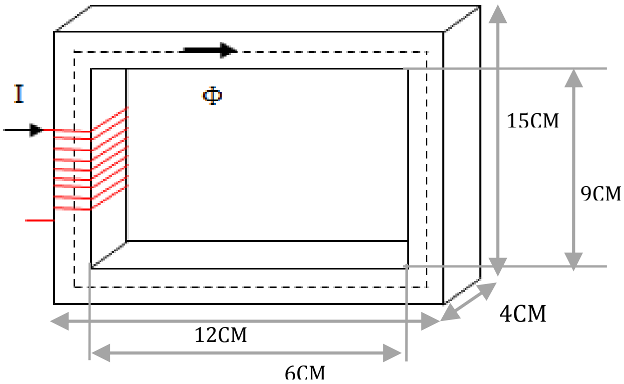
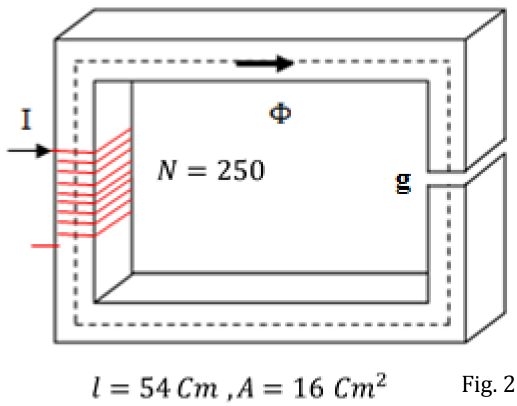


Fig. 1

Exercise 02:

Consider the magnetic circuit of fig.2: The permeability of the material is $\boldsymbol{\mu_r} = \mathbf{2500}$, and the air gap is **0.5 cm**.

1. Give the equivalent circuit of this circuit.
2. Calculate: $\boldsymbol{\mathcal{R}_i}$ the iron reluctance, $\boldsymbol{\mathcal{R}_g}$ the air gap reluctance and $\boldsymbol{\mathcal{R}_{eq}}$ the equivalent reluctance.
3. For $\boldsymbol{I = 2A}$, calculate the magnetic flux created in this circuit and deduce its corresponding magnetic density $\boldsymbol{B}$.



$l = 54\,Cm\ , A = 16\,Cm^2$ Fig. 2

Exercise 03:

Consider the ferromagnetic circuit shown in fig-3. What current must be sent into the coil to have: $\boldsymbol{\phi = 6.5\ mwb}$?

- ✓ When the relative permeability of the material is assumed to be constant $\mu_r = 5000$.
- ✓ When the magnetization curve of the material is as follows:

B(T)	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.25	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65	1.7
H(At/m)	52	58	65	76	90	110	132	380	600	900	1200	2000	3000	4500	6000	10^4	$1.4.10^4$

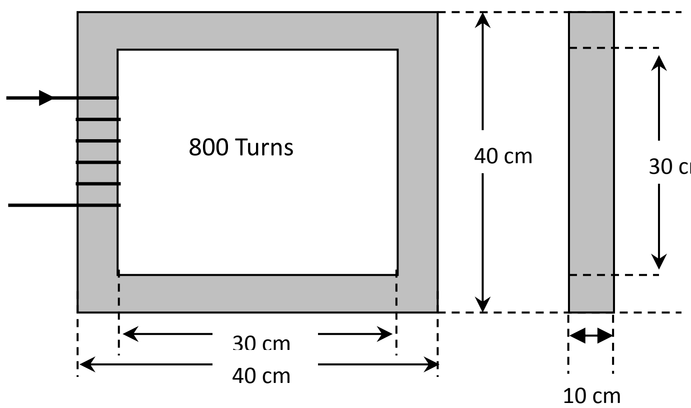


Fig.3

Exercise 04:

A magnetic core fig-4, whose magnetization curve is that of exercise 03, carries three coils, in accordance with the fig.4.

$n_1 = 2000\ ;\ i_1 = 0.5\ A$

$n_2 = 400\ ;\ \ i_2 = 1\ A$

$n_3 = 1000\ ;\ i_3 = ?\ A$

What current should be sent into the 3rd coil to have a flux $\boldsymbol{\phi = 1.5\ mwb}$ in the core?

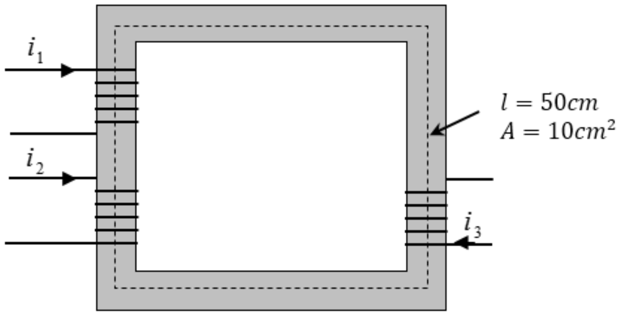


Fig.4

Exercise 05

The magnetic circuit shown in fig-5 is made of a material whose relative permeability varies according to the induction according to the following table:

B(T)	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2
$\mu_r = \frac{\mu}{\mu_0}$	1700	2000	2300	2500	2550	2400	2300	2100	2000	1500	1000

Calculate the current that must be sent into the **2000-turn** coil to have a magnetic flux density **1T** in branch AB.

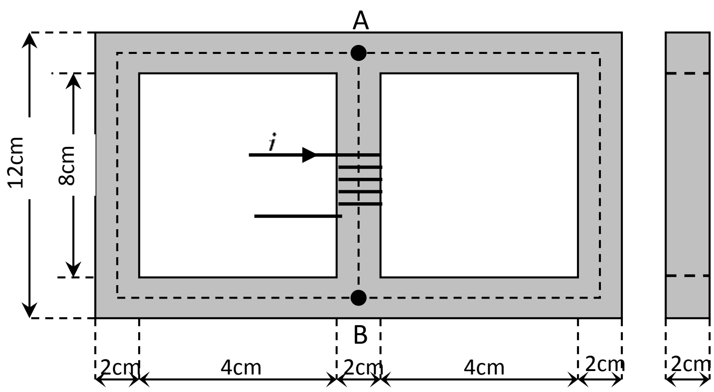


Fig.5

Exercise 06

A magnetic circuit with a single air gap is shown in Fig. 6. The core dimensions are:

Cross-sectional area $A = 1.8 \text{ x } 10^{-3}\ m^2$, Mean core length $l_c = 0.6\ m$

Gap length $g = 2.3 \text{ x } 10^{-3}\ m$, N = 83 turns

Assume that the core is of infinite permeability ($\mu \to \infty$) and neglect the effects of fringing fields at the air gap and leakage flux. Calculate :

(a) The reluctance of the core R_e and that of the gap R_g.

For a current of i = 1.5 A, calculate

(b) The total flux ϕ.

(c) The flux linkages λ of the coil, and (d) the coil inductance L.

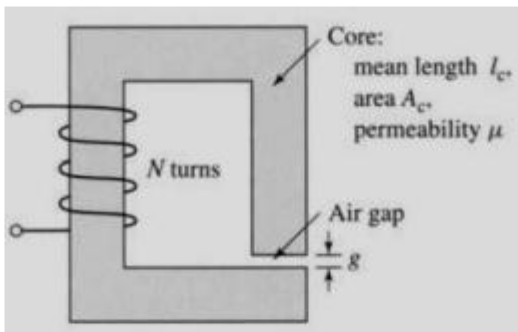


Fig.6