THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
Department of Electrical & Electronic Engineering

EEE 3352: Electromechanics & Electrical Machines

ASSIGNMENT 3: MAGNETIC CIRCUITS
(*Class Quiz - 02/09/2022*)
Time 1 1/2 hr

Part I – Multiple choice

1. What happens to the inductance presented by a coil wound on a uniform magnetic circuit if you double the … ?

$$L = \frac{N^2}{S} = \frac{N^2}{l/(\mu A)} = \frac{\mu A N^2}{l}$$

i) cross-sectional area of the magnetic circuit [2]
A. It remains the same. B. It halves. C. It doubles. D. It quadruples. E. I do not know.
[C]

ii) cross-sectional area of the coil copper conductor [2]
A. It remains the same. B. It halves. C. It doubles. D. It quadruples. E. I do not know.
[A]

iii) length of the magnetic circuit [2]
A. It remains the same. B. It halves. C. It doubles. D. It quadruples. E. I do not know.
[B]

iv) length of the coil copper conductor [3]
A. It remains the same. B. It halves. C. It doubles. D. It quadruples. E. I do not know.
[A]

v) relative permeability of the magnetic circuit iron [3]
A. It remains the same. B. It halves. C. It doubles. D. It quadruples. E. I do not know.
[C]

vi) number of turns of the coil [3]
A. It remains the same. B. It halves. C. It doubles. D. It quadruples. E. I do not know.
[D]

Part II – Numerical answers only

A circular magnetic circuit of iron with relative permeability of 1800 and of length of 50 cm and uniform cross-section area of 4 cm^2 is wound with a copper-conductor coil of 100 turns.

2. What is the reluctance, in A/Wb, presented by the magnetic circuit as seen by the coil? [A whole number, i.e., 0 decimal places] [10]
[552621]

$$A = "\pi r^2" = \frac{\pi}{4}\left(\frac{D_2}{2} - \frac{D_1}{2}\right)^2$$

$$S_{Fe} = \frac{l_{Fe}}{\mu_{Fe} A} = 552621 \text{ A/Wb}$$

Ans: 552621 A/Wb

3. With the information in Question 1, what is the inductance, in mH, presented by the coil? [A whole number, i.e., 0 decimal places] [10]

[18]

$$L = \frac{N^2}{S_{Fe}} = \ 0.018 \text{ H}$$

Ans: 18 mH

4. With the information in Question 1, what is the required mmf, in A, if the desired magnetic flux density in the magnetic circuit is 0.6 T. [A whole number, i.e., 0 decimal places] [10]

[133]

$$F = "\phi S" = BAS_{Fe} = \ 133 \text{ A}$$

Ans: 133 A

5. What is the dc current in the coil, in A, required to achieve the flux density desired in Question 10? [1 decimal place] [5]

[1.3]

$$"F = NI" \rightarrow I = \frac{F}{N} = 1.3 \text{ A}$$

Ans: 1.3 A

6.With the information of Question 1, a saw-cut is made through the cross-section of the magnetic to create an air-gap of 1 mm. What is the reluctance of the airgap, in A/Wb? [A whole number, i.e., 0 decimal places] [10]

[1989437]

$$S_g = \frac{l_g}{\mu A} = 1989437 \text{ A/Wb}$$

Ans: 22.8 nF

7. With the information of Question 1 and 6, what is the effective reluctance, in A/Wb, as seen by the coil? [A whole number, i.e., 0 decimal places] [10]

[2542058]

$$S_T = S_{Fe} + S_g = \ 2542058 \text{ A/Wb}$$

Ans: 22.8 nF

8. The coil wire of Question 1 is now known to have uniform diameter of 1mm, is of total length of 10 m and is made of copper with conductivity of 60 MS/m. What is the value of the series resisance, in Ω, in the equivalent circuit representation of copper loss of the inductor arrangement? [2 decimal places] [10]

[0.22]

$$R_{Cu} = \frac{1}{G_{Cu}} = \frac{l_{Cu}}{\sigma_{Cu} A_{Cu}} = \ 0.22 \ \Omega$$

Ans: 0.22 Ω

9. When the coil of Question 1 is connected to a 50-Hz ac voltage of 10 V, a current of 2.4 A flows with power consumption of 2 W. With the help of the result in Question 8, what could be the value of the parallel resisance, in Ω, in the equivalent circuit representation of iron loss of the inductor arrangement? [A whole number, 0 decimal places] [10]

[132]

$$P_{Loss} = P_{Cu} + P_{FE}$$

$$R_p = \frac{V^2}{P_{Fe}} = \ 132 \ \Omega$$

Ans: 132 Ω

10. For the situation described in Question 15, what is value of the peak magnetic flux density, in T, in the magnetic circuit? [1 decimal place] [10]

[1.1]

$$B_m = \frac{V}{4.44\, fNA} = 1.1 \text{ T}$$

Ans: 1.1 T

A Zulu
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