Tutorial Sheet -05 (Magnetic Circuit)

(Basic Electrical Engineering)

1. The magnetic circuit shown in Fig. 1 has dimensions $A_c = A_g = 9\text{cm}^2$, g = 0.050cm, l_c = 30 cm and N = 500 turns. Assume the value of the relative permeability μ_r = 70,000 for the core material. (a) Find the reluctance R_c of the core and R_g of the air gap. Also find the current i that should flow through coil to establish a flux density B_c = 1.0 T in the core. [Ans: R_c = 3785 AT/Wb, R_g = 442321.3 AT/Wb, i = 0.8A]

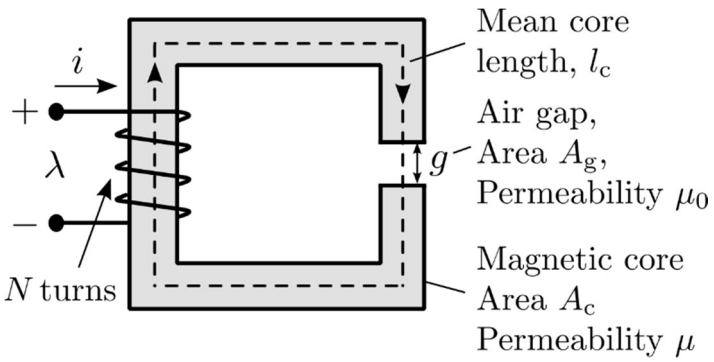

Fig. 1

2. A cast steel ring has a circular cross section 3 cm in diameter and mean circumference of 80 cm. The ring is uniformly wound with a coil of 600 turns which carries direct current of 0.9A. The coil produces a flux of 0.5 mWb in the core. (a) Find the relative permeability of the core material. (b) A saw cut of 2 mm is introduced in the ring. If the current remains the same what will be the value of the core flux? (c) What should be the current injected in the coil so that the flux in the core again becomes 0.5 mWb? [Ans: (a) 190, (b) 0.134 mWb, (c) 2.78A]

3. The magnetic circuit in Fig. 2 has a cast steel core with dimensions as shown. It is required to establish a flux of 0.8 mWb in the air gap of the central limb. Determine the mmf of the exciting coil if the core material has infinite relative permeability. Neglect fringing. [Ans: 1343.98 AT]

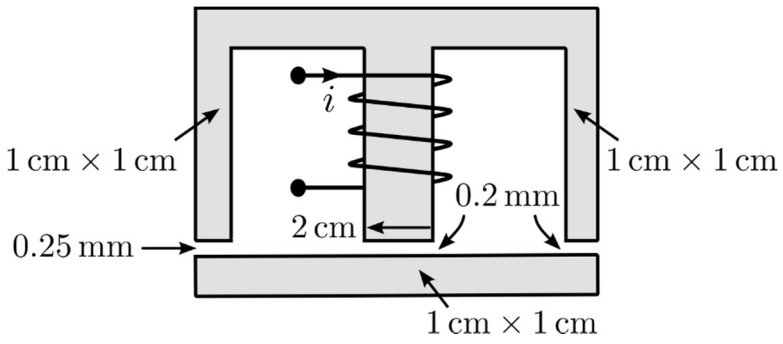

Fig. 2

4. In the magnetic circuit shown in Fig. 3, the area of cross section of the central limb is 12 cm^2 and that of each outer limb (A to B) is 6 cm^2. A coil current of 0.5A produces 0.5 mWb in the airgap. Find the relative permeability of the core material. [Ans: 7627.5]

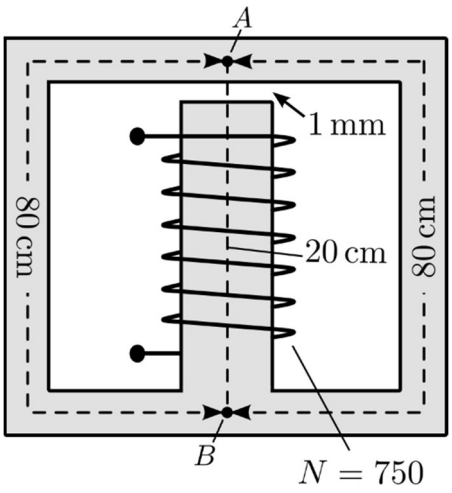

Fig. 3

5. The mean diameter of a steel ring is 50 cm and a flux density of 1.0 Wb/m^2 is produced by a field intensity of 40 AT/cm. If the area of cross section of the ring is 20cm^2 and if a 500 turn coil is wound around the ring (a) Find the inductance of the coil in Henry, (b) When an air gap of 1.0 cm is cut in the ring and the exciting current is changed to maintain a flux density of 1.0 Wb/m^2 then find the new inductance of the coil. Ignore the effect of leakage and fringing. [Ans: (a) 79.6 mH, (b) 35.2 mH]

6. For the magnetic circuit shown in Fig. 4 Find the self and mutual inductance between the two coils. The relative permeability of the core is 1600.

[Ans: L_1 = 0.73 H, L_2 = 3.55 H, M = 0.64 H]

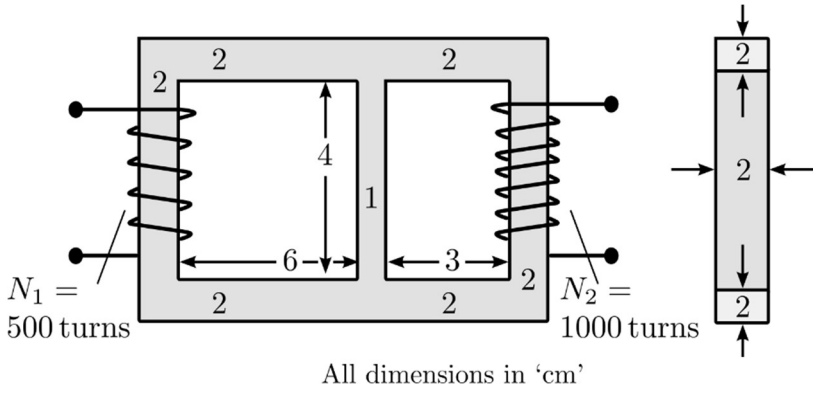

Fig. 4

7. . Find the two loop current phasors $\dot{I}_1$ and $\dot{I}_2$ in the circuit shown in Fig. 5.

[Ans: $\dot{I}_1 = 20.3\angle 3.5°\ A$ and $\dot{I}_2 = 8.69\angle 19°\ A$]

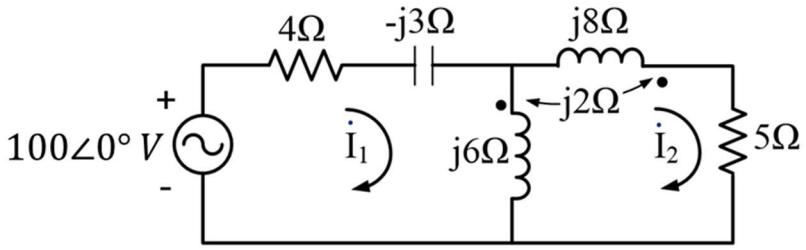

Fig. 5

8. A horse-shoe magnet as shown in Fig. 6 needs an excitation of 1800 AT to raise a soft iron armature when the gap is 1.25 mm. Each pole shoe has an area of 2 cm^2. (a) Find the attraction force on the armature assuming the core and the armature to have infinite permeability. (b) If the gap closes to 0.1 mm, find the force needed to pull the armature away, the excitation remaining constant.

[Ans: (a) 129 N, 410 N]

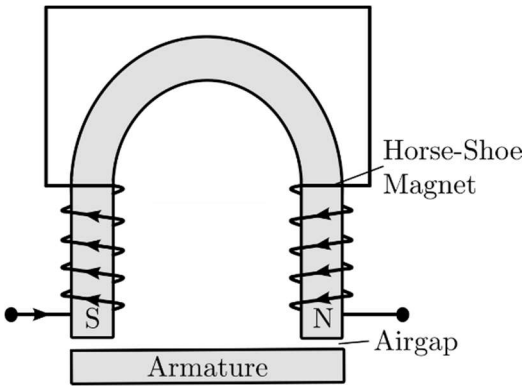

Fig. 6

9. The losses in a core carrying alternating flux can be expressed as

$$P_{core} = K_h f B_{max}^n + K_e f^2 B_{max}^2$$

Where '*f*' is the frequency of the alternating flux and B_{max} is the peak flux density in the core. The first term in the above equation represent hysteresis loss and the second term represents eddy current loss. The following data is obtained from a magnetic core.

Frequency	B_{max}	Core loss
50 Hz	1.2 T	115 W
30 Hz	1.2 T	60.36 W
30 Hz	1.4 T	87.24 W

Separate the hysteresis loss and eddy current loss in the core from this data for each reading.

Ans:

Frequency	B_{max}	Core loss	Hyst. loss	Eddy loss
50 Hz	1.2 T	115 W	79 W	36 W
30 Hz	1.2 T	60.36 W	47.4 W	12.96 W
30 Hz	1.4 T	87.24 W	69.6 W	17.64 W

10. Estimate the active cross-sectional area of the core of a 20 turn 1 phase inductor for a terminal voltage of 100 V at 50 Hz. The peak flux density is to be 1 T. [Ans: 225 cm^2]

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11. A single phase transformer has 400 primary and 1000 secondary turns. The net cross sectional area of the core is 60 cm2. If the primary winding is connected to a 500 V, 50 Hz single phase supply calculate (a) the peak flux density in the core, (b) The voltage induced in the secondary winding. Assume the transformer to be ideal.

[Ans: (a) 0.94 T, (b) 1250 V]

12. The no-load ratio of a single phase, 50 Hz transformer is 6000 / 250 V. Find the number of turns in each winding if the peak core flux is to be 0.06 Wb. [Ans: 480, 20]

13. A single phase 220 V / 110 V 50 Hz transformer draws 2 A magnetizing current from the 220 V 50 Hz source when on no load. Find the current supplied from the 220 V sources and the power factor when the 110V side supplies a load current of 10A at unity power factor. Neglect the core loss current and the series impedance drop in the transformer. [Ans: 5.385A, 0.928 lagging]

14. For the transformer shown in Fig. 7, N_{EF} = 600, N_{AB} =150 and N_{CD} =300 turns. Also the load resistances are R_{AB}= 30Ω and R_{CD}= 15Ω. The voltage applied to the primary is 16V sinusoidal. Considering the transformer to be ideal, calculate (a) Total load impedance reflected to the primary, (b) Total current drawn from the supply.

[Ans: (a) 53.3Ω, (b) 0.3A]

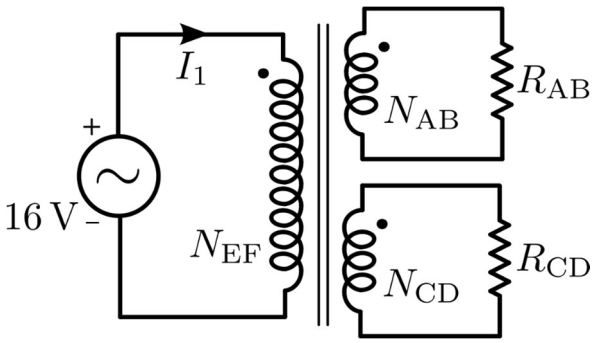

Fig. 7