In the name of Almighty

EE Course 25741
Energy Conversion 1

Assignment 1 – Magnetic Circuits

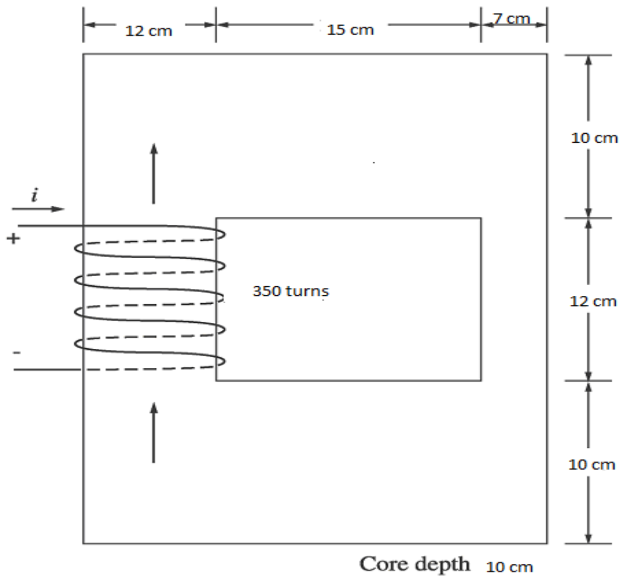
Due date: 1393/12/2

1 There is a coil with four hundred turns on one leg of the ferromagnetic core as shown below. The depth of the core is 10 cm. The other dimensions of the core are shown in this figure.

a- Find the value of current that will produce a flux of 0.008 Wb.

b- What is the flux density at the top of the core window? What is the flux density at the right leg of the core?

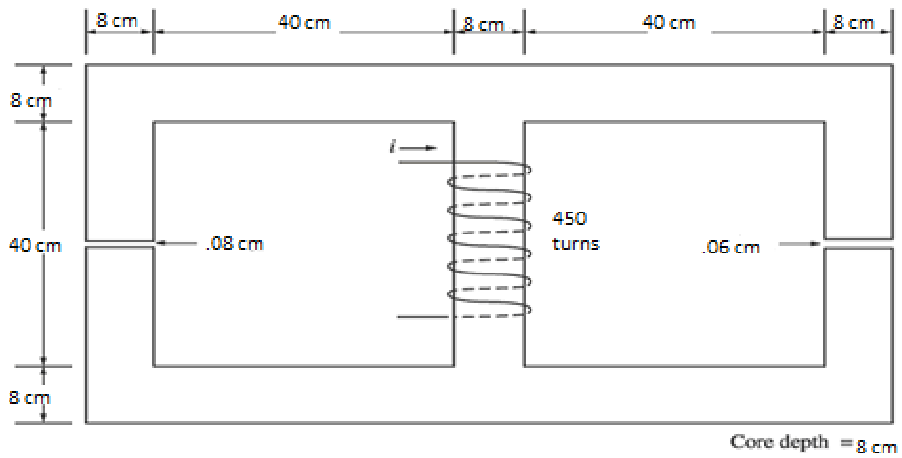
Assume the relative permeability of the core to be 2500.



2 A magnetic core with relative permeability of 2300 is shown in Figure below. The depth of the core is 8 cm. The air gaps on the left and right legs of the core are 0.08 and 0.06 cm, respectively. The effective area at the air gaps due to fringing effects is 5 percent larger than their physical size. A 450 turn coil is located on the center leg of the core. If a current of 1.5 A passes the coil,

a - What is the flux in each one of the three legs of the core?

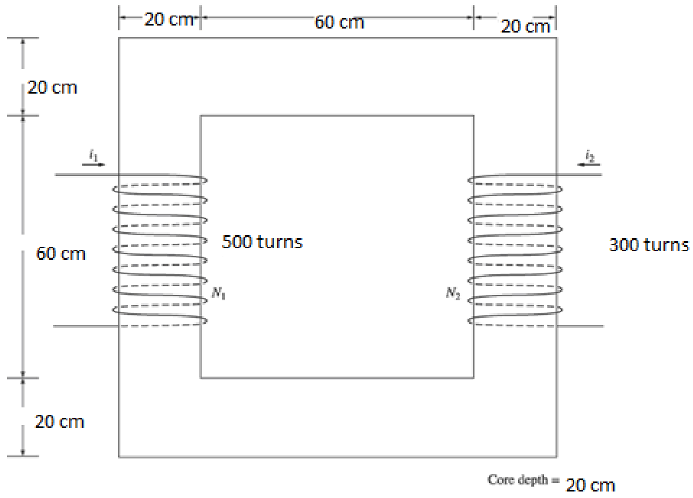
b - What is the flux density in each air gap?



3 On each leg of the core, in figure below, there is a coil. The winding on the left leg with 500 turns and the winding on right leg with 300 turns. The coils are

wound according to the direction shown in the figure. Having currents of $i_1 = 0.5A$ and $i_2 = 0.75A$ in the windings,

What would be the flux? (Assuming that relative permeability is 2000)

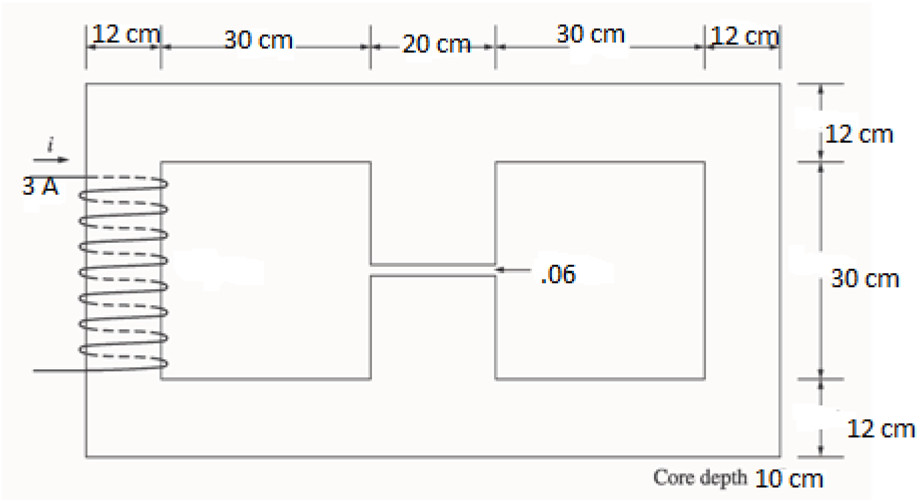


4 A core having three legs as shown in figure below, has a depth of 5 cm. there are 300 turns on the left-most leg. The relative permeability of core assumed constant and equal to 1500.

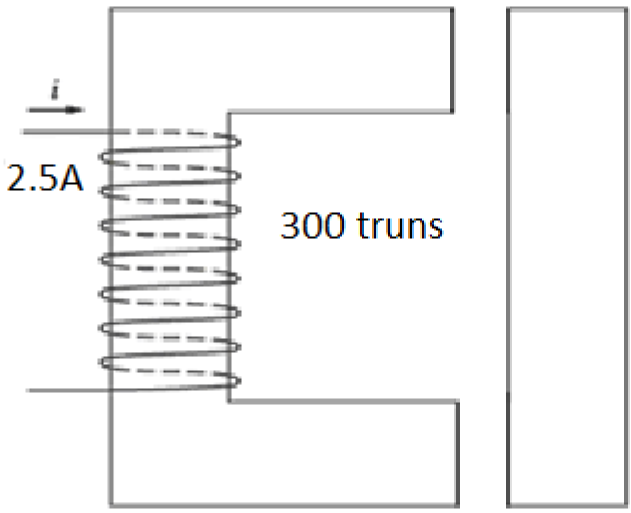
a- Determine the flux in each leg of the core

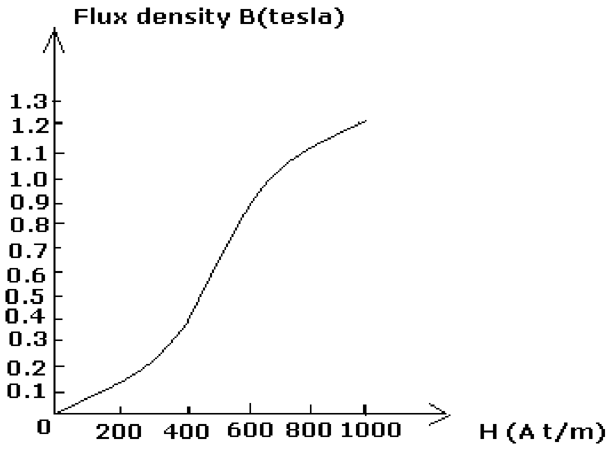
b- Determine the flux density in each leg of the core

Assume a four percent increase in effective area of air gap due to the fringing effects.



5 The magnetic system of figure below with 500 turns of winding on the core that is made of cast steel, has a magnetization curve (B-H) of next figure. A current of 4 A passes the coil, when each air gap length is 1 mm. The mean length of the core is 360 mm. Find the flux density in the air gap.



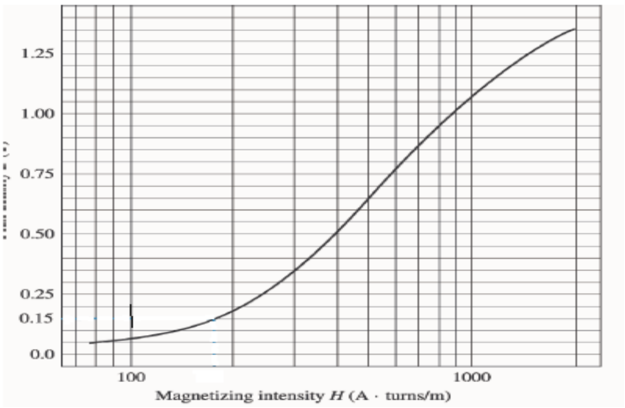


5 The core shown below of the third Question is made of steel whose magnetization curve is shown in figure below. The permeability is not constant in this problem.

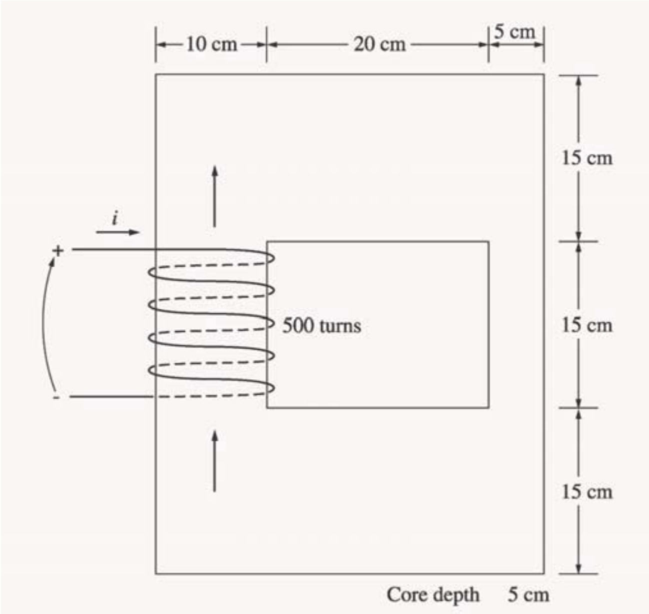
a- How much flux is produced in the core by current specified?

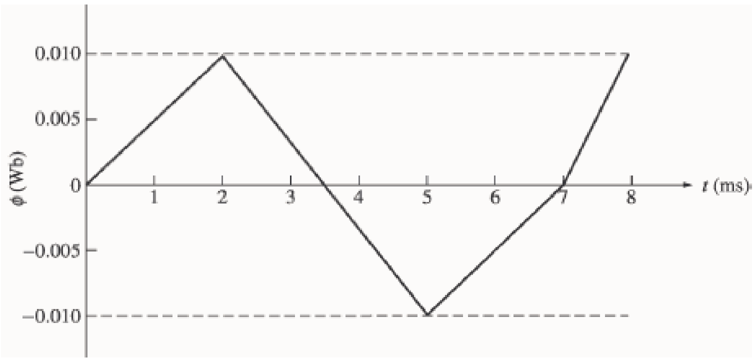
b- What is the relative permeability of this core under these conditions?

c- Was the assumption in the third Question that relative permeability was equal to a 1000 a good assumption for these conditions? Is it a good assumption in general?



6 The core shown below, has the flux φ shown in this figure below. Sketch the voltage present at the terminals of the coil.



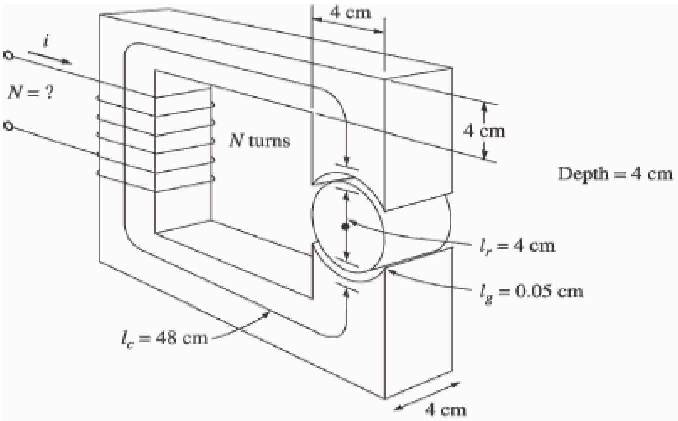


7 Figure below shows the core of a simple dc motor. The magnetization curve and relative permeability of this core is shown below. Assume the cross-sectional area of each air gap is 20 cm^2 and the width of each air gap is 0.05 cm. the effective diameter of rotor is 4 cm.

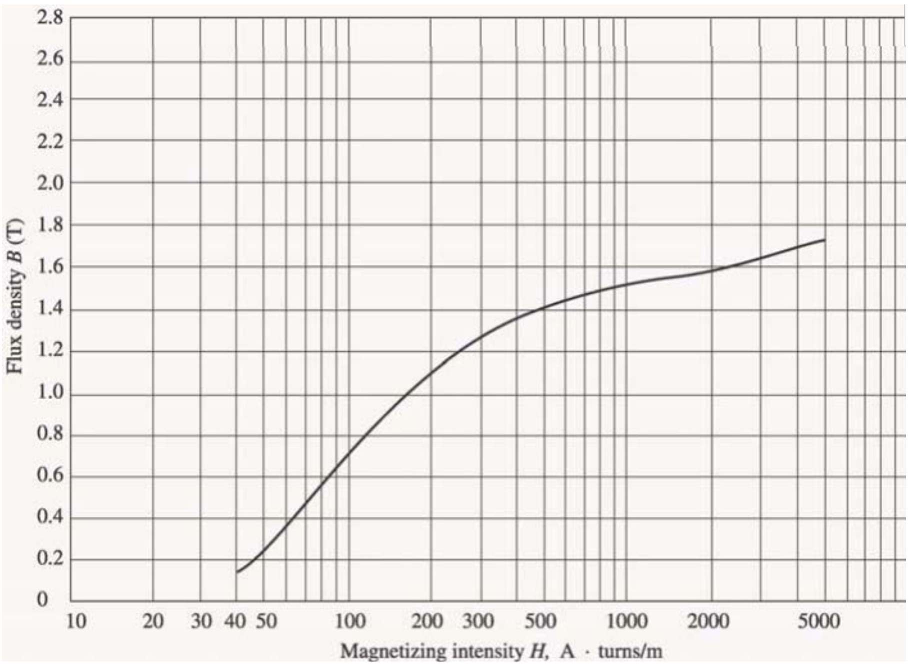
a- To build a machine with as great flux density as possible while avoiding excessive saturation in the core, what would be a reasonable maximum B for this core?

b- What would be the total flux in the core at that flux density of (a)?

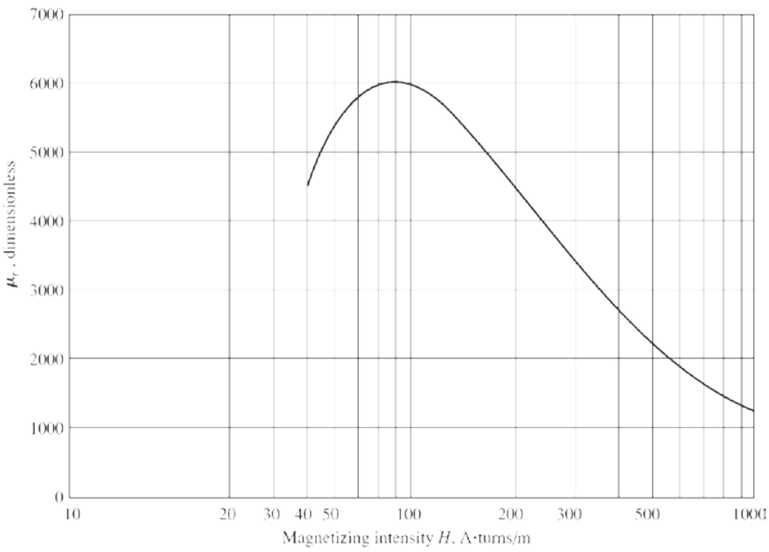
c- The maximum field current for this machine is 1 A. Select N to provide the desired flux density while not exceeding the maximum current.



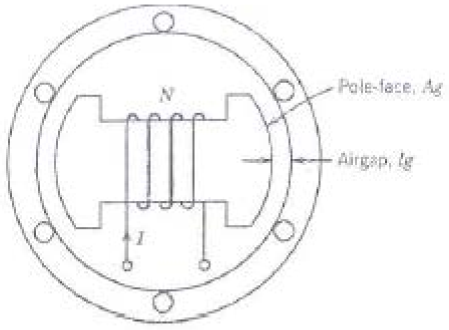
The magnetization curve for this core is shown below:



The relative permeability of this core is shown below:



9 A two-pole synchronous machine, as shown in figure below, has the following dimensions.



Each air gap length, l_g =20 mm
Cross-sectional area of pole face, Ag = 400 cm^2
I = 4A , N=300
μ = infinity
(a) Draw the magnetic equivalent circuit
(b) Find the flux density in the air gap

10 A proposed energy-storage mechanism consists of an air-core coil wound around the large toroidal form shown in figure below. There are N turns, each of circular cross section of radius a. The radius of the toroid is r, as measured to the center of each circular turn. The geometry of this device is such that the magnetic field can be considered to be zero everywhere outside the toroid.

Assuming that a<<r , the H field inside the torus can be considered to be directed around the torus and of uniform magnitude

$$H = Ni / (2\pi r)$$

(a) Calculate the coil inductance L
(b) the coil is to be charged to a magnetic flux density of 1.5 T. Calculate the total stored magnetic energy in the torus when B is achieved.
(c) If the coil is to be charged at a uniform rate, that is di/dt=constant, calculate the terminal voltage required to achieve the required B in 20 s. Assume the coil resistance to be negligible.