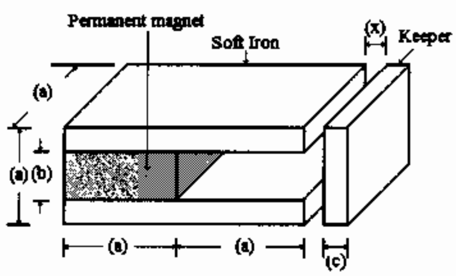
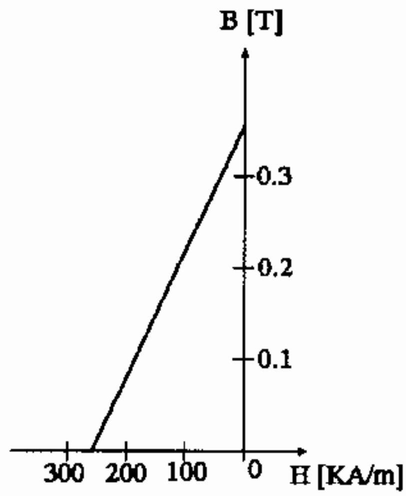
# FEA/ECE
# EECE370,
# ELECTRIC MACHINES AND POWER FUNDAMENTALS

## PROBLEMS ON ELECTROMAGNETIC CIRCUITS

**1.** Figure 1.1 shows a small assembly intended for use as a door holder. The keeper is attached to the door while the remainder is positioned on the door frame. The magnet used is ferrite D whose demagnetization curve is shown in Fig.1.2. The iron pieces are infinitely permeable and neither fringing nor leakage is accounted.

a. Draw the equivalent magnetic circuit.
b. Find the maximum permissible length of the air gap if a flux density of 0.6T is needed to provide the necessary force. Circuit dimensions are: a = 20 mm, b = 10 mm, and c = 5 mm *(1.57mm)*
c. Repeat "b" for the magnet lengths b = 5 and 2 mm. What do you conclude?




**2.** Given a cross- section of a rotating motor, Fig.2.1. The rotor has a radius of 120mm and an axial length of 20mm. Each pole covers an arc of 40° and is of the same axial length as the rotor. The air gap lengths are 1.5mm each. The motor core is made of material represented by the B-H curve of Fig.2.2. Each pole has a coil of 360 turns connected in series. Draw the equivalent magnetic circuit and determine:

a. The approximate reluctance of each air gap. *(712KA/Wb)*
b. The flux in each pole if the air gap flux density is 0.8T.
c. The current required in the coils to produce the flux of (b), if the core is infinitely permeable.(2.65A)
d. The flux density in the yoke whose outer radius is 210mm and its thickness is 25mm. *(1.34T)*
e. The current required for an air gap flux density of 0.8T if the yoke mmf is included but that of the poles and the rotor core is ignored.(2.98A)

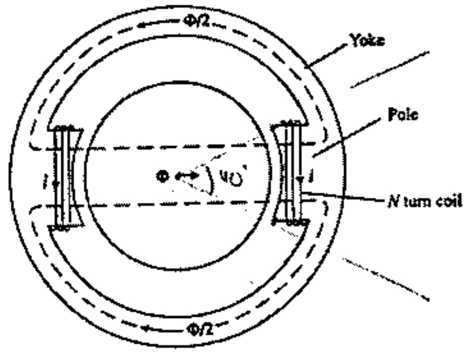



Fig 2.1

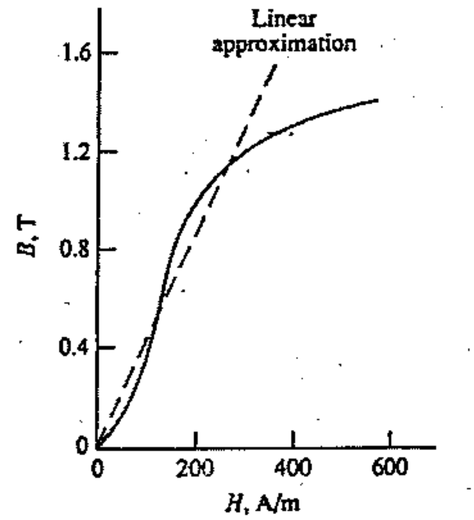



Fig 2.2

3. A given magnetic material has a total hysteresis loss of 260W when operated at a frequency of 30Hz and with a maximum flux density is 1.4T. What is the hysteresis loss when operating at 0.9T at 50Hz?
   Assume Steinmetz constant to be 1.8.

4. Figure 3.1 shows the configuration of an infinitely permeable magnetic core. The circuit parameters are as follows:

   $N_1 = N_2 = 300$turns  $I_1 = 5A$,  $I_2 = 8A$,
   $L_{g1} = 1cm$,  $l_{g2} = 1.5cm$,  $A_1 = 3cm^2$,  $A_2 = 2cm^2$.

   a. If coil 1 carries a current $I_1$ and coil 2 caries no current, calculate the flux densities inside the air gaps and the flux linkages of the 2 windings. *(0.19T, 0.12T)*
   b. Repeat 'a' if current in coil 1 is zero, and current in coil 2 is $I_2$.
   c. In which case is the circuit heavily saturated? Why?

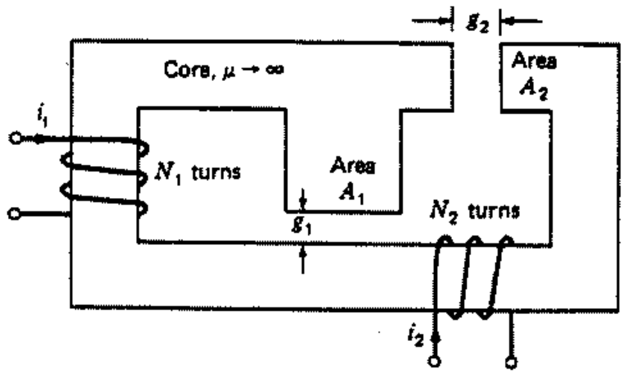
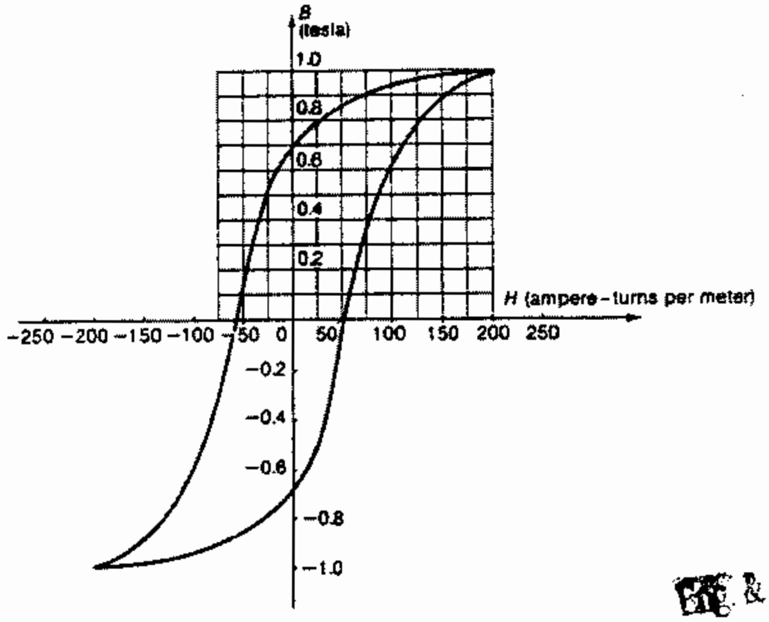



Fig 3.1

**5.** Estimate the hysteresis loss at 60 Hz for a toroidal core of 300- mm mean diameter and a square cross- sections of 50x50 mm. The corresponding hysteresis loop for the M-36 sheet is shown in Fig.4.1.*(30.44W)* .




Symmetrical hysteresis loop for M-36 electric sheet steel.

Fig 4.1