Tutorial Sheet – No. 1

(Revision of Magnetic Circuits and Inductance)

1 Two pieces of steel (μ_r = 800), both 20cm long have a magnetic flux density of 0.6T along their long axis. One piece has a rectangular cross-section (5cm × 5cm) and the other piece is a rod with a diameter of 5cm. Calculate the reluctance for each piece of steel and the magnetomotive force (mmf) along their lengths.

($7.96 \times 10^4 H^{-1}$; $1.01 \times 10^5 H^{-1}$; 119.4AT; 119.4AT)

2 If the two pieces of steel bar in question 1 are joined in series, what is the total reluctance and the magnetomotive force if the flux through them is 10×10^{-5} Webers?

($1.81 \times 10^5 H^{-1}$; 18.1AT)

3 If the two pieces of steel bar in question 1 are joined in parallel, what is the total reluctance and the magnetomotive force if the total flux through the system is 12×10^{-4} Webers?

($0.445 \times 10^5 H^{-1}$; 53.4AT)

4 An iron toroidal core of mean diameter 30cm and cross-sectional diameter 6cm has a coil of 100 turns wound on it. If the toroid is made up of four equal lengths of material with relative permeabilities (μ_r) of 80, 250, 600 and 1200 respectively, calculate the current in the coil required to establish a flux density of 1T in the core. What is the magnetomotive force across each section?

(35.6A; 2344AT; 750AT; 312.5AT; 156.3AT)

5 An iron toroidal core has a mean diameter 20cm, a cross-sectional area of $10cm^2$ and a relative permeability of 1000. If the current in a coil wound on the core to establish a flux density of 0.28T is 2.8A, calculate the number of turns on the coil and the self inductance.

(50 turns; 5mH)

6 An iron ring has a mean diameter of 10cm and a cross-sectional area of $10cm^2$. A coil having 250 turns is wound round it. Calculate the self-inductance of the coil if the relative permeability of the iron is 1000.

(0.25H)

7 A rectangular iron core, shown in figure 1 below, has a coil of 1000 turns wound on it. The mean length of each side of the core is 10cm and it has a cross-section of 2cm × 2cm. If the relative permeability of the iron is 1000, calculate the coil current required to establish a flux density of 1T in the core.

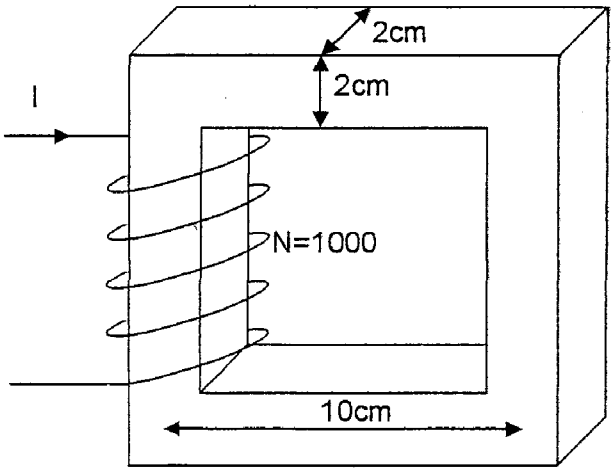

Figure 1

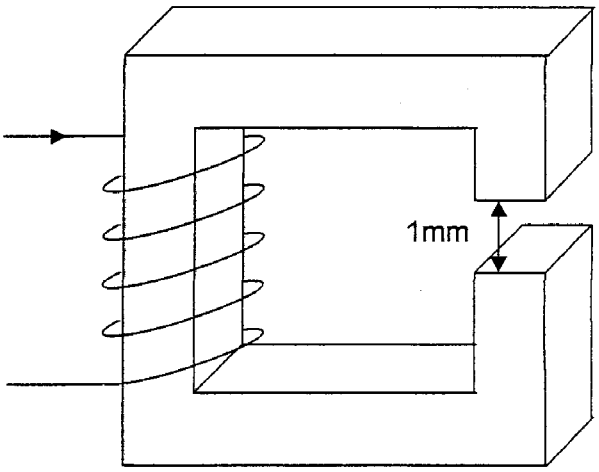

Figure 2

(0.32A)

8 The iron core in question 7 now has a 1mm wide slot cut through one of the sides as shown in figure 2 (not to scale). Calculate the new value of current required to maintain the flux density in the core at 1T. (Assume the area of the gap is equal to that of the iron).

(1.1A)

9 A plunger solenoid has the dimensions given in figure 3 below. If the coil has 1000 turns and a d.c. resistance of 120Ω, calculate the ratio of the powers dissipated in the coil when the plunger if fully in and fully out. The supply is 240Vrms, 50Hz and the relative permeability of core and plunger is 500.

(21.8:1)

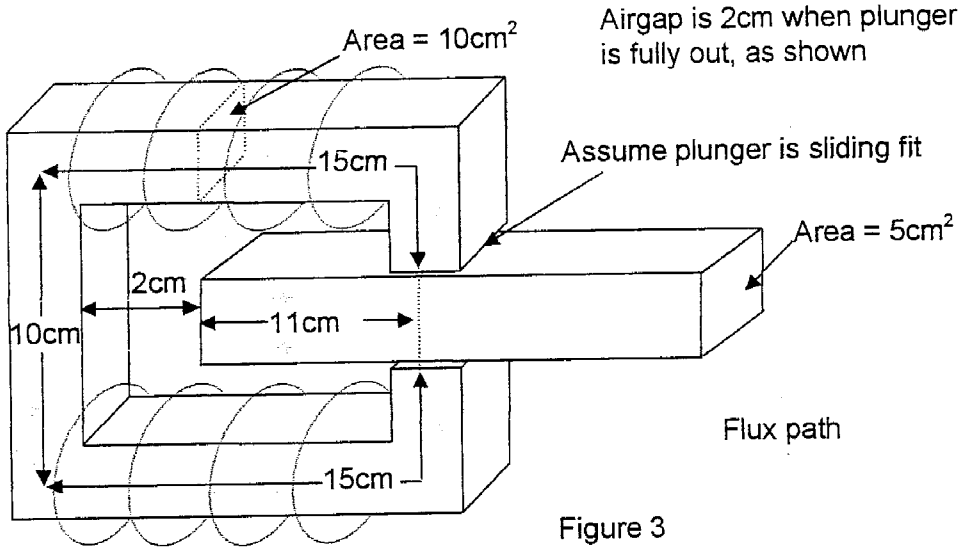

Figure 3