VE230 Homework 6

2021 Summer

P1 A toroidal iron core of relative permeability 3000 has a mean radius $R = 80(\text{ mm})$ and a circular cross section with radius $b = 25(\text{ mm})$. An air gap $\ell_g = 3(\text{ mm})$ exists, and a current I flows in a 500 -turn winding to produce a magnetic flux of $10^{-5}(\text{ Wb})$. (See Fig. 1.) Neglecting flux leakage and using mean path length, find

a) the reluctances of the air gap and of the iron core,

b) $\mathbf{B}_g$ and $\mathbf{H}_g$ in the air gap, and $\mathbf{B}_c$ and $\mathbf{H}_c$ in the iron core,

c) the required current I.

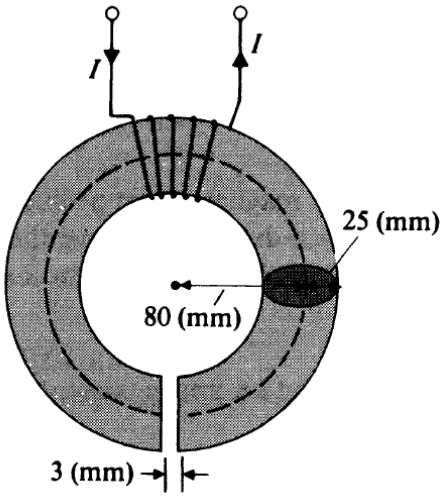

Figure 1: A toroidal iron core with air gap (Problem 1).

P2 Consider the magnetic circuit in Fig. $6-45$. A current of 3 (A) flows through 200 turns of wire on the center leg. Assuming the core to have a constant cross-sectional area of $10^{-3}\,(\text{m}^2)$ and a relative permeability of 5000:

a) Determine the magnetic flux in each leg.

b) Determine the magnetic field intensity in each leg of the core and in the air gap.

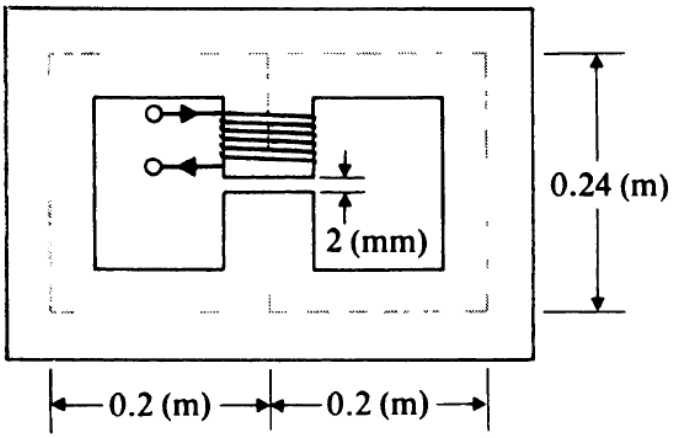

Figure 2: A magnetic circuit with air gap (Problem 2).

P3 What boundary conditions must the scalar magnetic potential V_m satisfy at an interface between two different magnetic media?

P4 Determine the mutual inductance between a very long, straight wire and a conducting circular loop, as shown in Fig. 3.

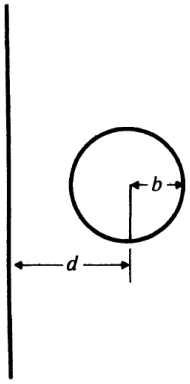

Figure 3: A long, straight wire and a conducting circular loop (Problems 4)

P5 The cross section of a long thin metal strip and a parallel wire is shown in Fig. 4. Equal and opposite currents I flow in the conductors. Find the force per unit length on the conductors.

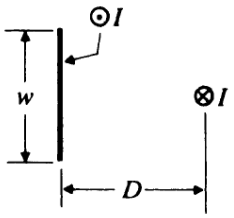

Figure 4: Cross section of parallel strip and wire conductor (Problems 5)

P6 One end of a long air-core coaxial transmission line having an inner conductor of radius a and an outer conductor of inner radius b is short-circuited by a thin, tight-fitting conducting washer. Find the magnitude and the direction of the magnetic force on the washer when a current I flows in the line.

P7 A current I flows in a long solenoid with n closely wound coil-turns per unit length. The cross-sectional area of its iron core, which has permeability μ, is S. Determine the force acting on the core if it is withdrawn to the position shown in Fig. 5.

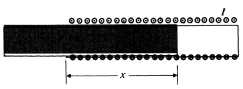

Figure 5: A long solenoid with iron core partially withdrawn (Problems 7)