UNIVERSIDADE da MADEIRA

Electromagnetism

Series of problems 8

1. A torus of 60 turns/ m carries on its wire a current of 5.00 A. Its core consists of iron, which has a permeability $\mu = 5000\mu_0$ under the conditions of this problem. Find H and B inside the core.

2. A long solenoid with 12 turns per centimeter has a cast iron core. When the current is 0.50 A, the magnetic field inside the core is 1.36 T. Find:

   (a) The magnetic field that would be produced within the solenoid if the nucleus did not exist.

   (b) The relative permeability of cast iron.

   (c) The magnetization within the core.

3. A magnetic field of 1.30 T is intended to be obtained from the iron core of a torus. The torus has an average radius of 10.0 cm and a magnetic permeability of $5000\mu_0$. What is the needed current, knowing that the torus has 470 turns of wire? (The thickness of the iron ring is small compared to 10 cm, so the field in the material is almost uniform.)

4. A torus with an average radius of $20,0$ cm and 630 turns is filled with a substance whose magnetic susceptibility χ is 100. The current in the turns is $3,00$ A. Find the magnitude of field $\mathbf{B}$ (assume it is uniform) within the torus.

5. Calculate the intensity of the magnetic field $\mathbf{H}$ of a magnetized substance in which the magnetization is 0.880×10^6 A/ m and the magnetic field has magnitude 4.40 T.

6. Calculate the energy associated with the magnetic field of a 200-loop solenoid in which a current of 1.75 A produces a flux of 3.70×10^{-4} Wb in each loop.

7. The magnetic field inside a superconducting solenoid is 4.50 T. The solenoid has an inner diameter of 6.20 cm and a length of 26.0 cm. Determine:

   (a) The density of magnetic energy in the field.

   (b) The energy stored in the magnetic field in the solenoid.

8. The magnetic field in the interstellar space of our galaxy has a magnitude of 10^{-10} T. How much energy is stored in this field in a 10 light − year edged cube? (For scale purposes, note that the nearest star is 4.3 light − years away and the radius of our galaxy is around 8×10^4 light − years.)

9. A given region of space contains a magnetic field of 200 G and an electric field of 2.5×10^6 N/ C. Find

   (a) The total energy density.

   (b) The energy in a cubic box on the side $l = 12$ cm.

Solutions:
1) $H = 300$ A/ m; $B = 1,88$ T; 2a) $B_0 = 7,54 \times 10^{-4}$ T; 2b) $\mu_r = 1800$; 2c) $M = 1,08 \times 10^6$ A/ m; 3) $I = 277$ mA; 4) $B = 0,191$ T; 5) $H = 2,62 \times 10^6$ A/ m; 6) $U_B = 0,0648$ J; 7a) $u_B = 8,06 \times 10^6$ J/ m^3; 7b) $U_B = 6,33$ kJ; 8) $U_B = 3 \times 10^{36}$ J; 9a) $u = 187$ J/ m^3; 9b) $U = 0,323$ J.