Homework Assignment #4 = magnetostatics
due Monday Sept 30 [ ANNOUNCEMENT: NO CLASS FRIDAY SEPT 27]

To aid in grading, for each problem draw a box around your final answers using red pencil.

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4-1. A doughnut-shaped soft iron ring (radii a and R >> a) with a small gap has a toroidal winding (N turns with current I). Assume the permeability is 3000 $\mu_0$ . Calculate $\vec{B}$ and $\vec{H}$ in the iron and in the air gap. You may make reasonable approximations.

4-2. (A) A long straight wire (radius a and length L ≫ a and permeability $\mu$) is placed in a uniform magnetic field $\vec{B}_0$ perpendicular to the wire. Calculate the magnetic induction inside the wire.
(B) Two long straight parallel wires ( one copper and one iron ) carry small equal currents I in a uniform magnetic field $\vec{B}_0$ perpendicular to the wires. The wires are far apart. Compare the strengths of the forces on the wires, numerically and accurately.

4.3. Prove: If two magnetic media are separated by a planar interface, then the angles between the normal to the interface and the B-fields on either side obey $\mu_2 \tan\theta_1 = \mu_1 \tan\theta_2$.

4-4. A straight wire in air, carrying current I, is parallel to a planar boundary of a medium with permeability $\mu$, at distance d from the plane. The permeability of the medium is $\mu$.
(A) Assume $\mu = \infty$ (ferromagnetic material). Find an image current that produces the correct B-field in the air.
(B) Assume $\mu = 0$ (superconductor). Find an image current that produces the correct B-field in the air.

4-5. Why is a superconductor a perfect diamagnet?

4-6. Calculate the diamagnetic susceptibility of neon at STP. Use this theoretical model: assume the 8 outer electrons travel on circular orbits with mean radius R = $0.4 \times 10^{-10}$ m.

4-7. Jackson Problem 5-21.

4-8. The figure shows two identical permanent magnets. Calculate the force on either magnet. HINT: You will need elliptic integral functions.

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