Physics 8100 - Electromagnetic Theory I

Fall 2017 **N. Dietz**

Assignment # 9 (due to Monday, December 04, 2017)

Problem 1 (14 points)

(a) Use the Biot-Savart Law to calculate the magnetic field produced by a straight, infinitely long wire which carries a current ***I***.

(b) Use the Biot-Savart Law to calculate the magnetic field produced by a circular current loop of radius ***A***. You only need to find the field along the axis of the loop.

Problem 2: (15 points)

Use Ampere's Law in integral form to find. The magnetic field in the following situations:

(a) A long cylinder of radius A carries an uniformly distributed current - distributed throughout its interior. Find the magnetic field inside and outside the cylinder.

(b) A long solenoid of radius A is constructed by wrapping wire around a cylinder, with N turns per unit length. If the wire carries a current I, find the magnetic field inside the solenoid.

(c) A thin conducting sheet, of thickness d, carries a current density $\mathbf{J} = J_0\, e_x$. Find the magnetic field just above the sheet.

Problem 3: (35 points)

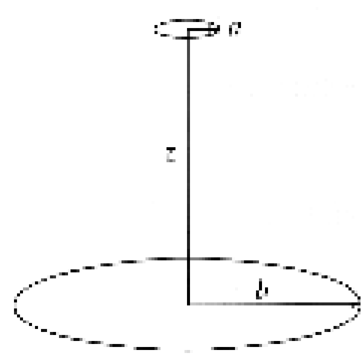
An alternating current $I = I_O \cdot \cos(\omega t)$ (amplitude 0.5A, frequency 60Hz) flows down a straight wire, which runs along the axis of a toriodal coil with rectangular cross section (inner radius 1 cm, outer radius 2 cm, height 1 cm, 1000 turns). The coil is connected to a 500 Ohm resistor.

a) In the quasistatic approximation, what emf is induced in the toroid? Find the current, $I_r(t)$, in the resistor.

b) Calculate the back emf in the coil, due to the current $I_r(t)$. What is the ratio of the amplitudes of the back emf and the "direct" emf in (a)?

Problem 4: (35 points)

A small loop of wire (radius a) lies a distance z above the center of a large loop (radius b), as shown in the Fig. on the side. The planes of the two loops are parallel, and perpendicular to the common axis.



a) Suppose current I flow in the big loop. Find the flux through the little loop. The little loop is so small that you can consider the field of the big loop to be essential constant

b) Suppose current I flow in the little loop. Find the flux through the big loop. The little loop is so small that you may treat it as a magnetic dipole.