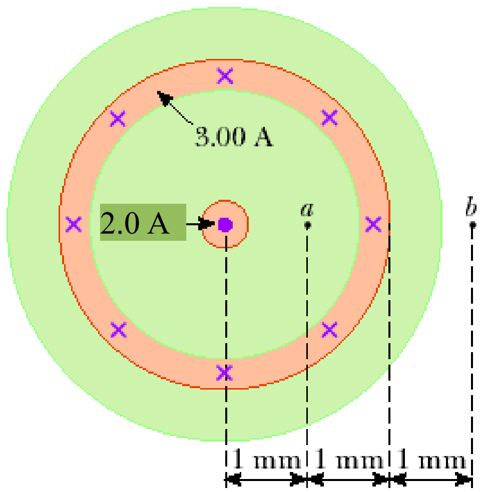
# Physics 2201 E&M
# Homework #14 – Due Tue. Feb. 9, 2016 by 3pm
# (hand in to drop box outside 3L24)

1. The figure below is a cross-sectional view of a coaxial cable. The center conductor is surrounded by a rubber layer, which is surrounded by an outer conductor, which is surrounded by another rubber layer. In a particular application, the current in the inner conductor is 2.00 A out of the page and the current in the outer conductor is 3.00 A into the page. Determine the magnitude and direction of the magnetic field at points *a* and *b*.




2. Consider a solenoid of length $L$ and radius $R$, containing $N$ closely spaced turns and carrying a steady current $I$. (a) In terms of these parameters, find the magnetic field at a point along the axis as a function of distance $a$ from the end of the solenoid. (b) Show that as $L$ becomes very long, $B$ approaches $\mu_0 NI/2L$ at each end of the solenoid. Consider the cases $a<0$, $0<a<L$, and $a>L$.

3. An 0.800-A current is charging a capacitor that has circular plates 18.0 cm in radius. If the plate separation is 1.50 mm, (a) what is the time rate of increase of electric field between the plates? (b) What is the magnetic field between the plates 12.00 cm from the center?

4. The magnetic moment of the Earth is approximately $8.20 \times 10^{22}$ A · m$^2$. (a) If this were caused by the complete magnetization of a huge iron deposit, how many unpaired electrons would this correspond to? (b) At two unpaired electrons per iron atom, how many kilograms of iron would this correspond to? (Iron has a density of 7900 kg/m$^3$, and approximately $8.50 \times 10^{28}$ iron atoms/m$^3$.)

5. We have seen that a long solenoid produces a uniform magnetic field directed along the axis of a cylindrical region. However, to produce a uniform magnetic field directed parallel to a *diameter* of a cylindrical region, one can use the *saddle coils* illustrated in the figure below. The loops are wrapped over a somewhat flattened tube. Assume the straight sections of wire are very long. The end view of the tube shows how the windings are applied. The overall current distribution is the superposition of two overlapping circular cylinders of uniformly distributed current, one toward you and one away from you. The current density $J$ is the same for each cylinder. The position of the axis of one cylinder is described by a position vector **a** relative to the other cylinder. Prove that the magnetic field inside the hollow tube is $\mu_0 J_a/2$ downward.

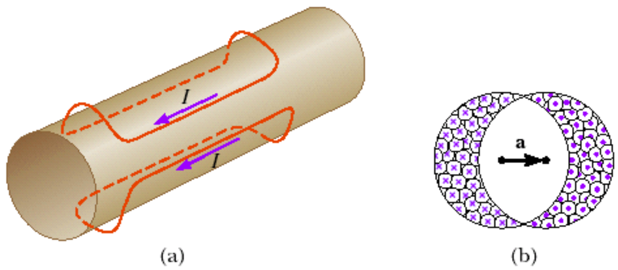



Figure for Problem 5: (a) General view of one turn of each saddle coil. (b) End view of the coils carrying current into the paper on the left and out of the paper on the right.