Name:

Physics 51
Homework #11
October 10, 2016

33-P8*, 33-E33, SUP18, SUP19

33-P8 Figure 33-53 shows a cross section of a long conductor of a type called a coaxial cable of radii a, b, and c. Equal but antiparallel, uniformly distributed currents i exist in the two conductors. Derive expressions for $B(r)$ in the ranges

(a) $r < c$,

(b) $c < r < b$,

(c) $b < r < a$, and

(d) $r > a$.

(e) Test these expressions for all the special cases that occur to you.

(f) Assume that $a = 2.0\,\text{cm}$, $b = 1.8\,\text{cm}$, $c = 0.40\,\text{cm}$, and $i = 120\,\text{A}$ and plot $B(r)$ over the range $0 < r < 3\,\text{cm}$.

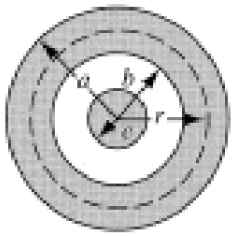

FIGURE 33-53. Exercise 33.

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SUP18 Consider an infinite slab of thickness **d** carrying a nonuniform current density (current per unit area) $\mathbf{j} = \mathbf{a}|\mathbf{z}|$ along the positive x-axis, where the slab is arranged parallel to the x-y plane, with the origin in its middle. Find the magnetic field everywhere (HINT: B must be zero on the x-y plane; why?).

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SUP19 An infinite long cylinder of insulating material of radius R carries a uniform charge density of ρ C/m^3. The cylinder is made to spin around its axis at angular velocity ω.

(a) Show that the magnitude of the current density inside the cylinder is $j(r) = \rho\omega r$.

(b) Using the previous result and Ampere's Law, determine the direction and magnitude of $\vec{B}$ at points inside ($r < R$) and outside ($r > R$) the cylinder. Make a sketch plot of $\vec{B}$ as a function of r.

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33-P8* A thin plastic disk of radius R has a charge q uniformly distributed over its surface. If the disk rotates at an angular frequency ω about its axis, show that the magnetic field at the center of the disk is

$$B = \frac{\mu_0 \omega q}{2\pi R}.$$

(Hint: The rotating disk is equivalent to an array of current loops.)

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