Name:

Physics 51
Homework #11
October 10, 2016

33-P8*, 33-E33, 10, 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 $0 < r < 3\,\text{cm}$.

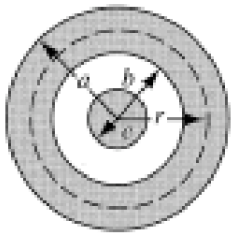

FIGURE 33-53. Exercise 33.

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33-E33 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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10 In a certain region there is a uniform current density of $15\,\mathrm{A/m^2}$ in the positive z direction. What is the value of $\oint \vec{\mathbf{B}} \cdot d\vec{\mathbf{s}}$ when the line integral is taken along the three straight-line segments from $(4d,\ 0,\ 0)$ to $(4d,\ 3d,\ 0)$ to $(0,\ 0,\ 0)$ to $(4d,\ 0,\ 0)$, where $d = 23\,\mathrm{cm}$.

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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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