Week 13, Session 1 Problems

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11/13

1 Finding Magnetic Fields: Ampere's Law and the Biot-Savart Law

1.1 Plane of Current

A flat sheet of metal of thickness t carries a uniform current density $\vec{j}$.

(a) Using Biot-Savart's Law, calculate the magnitude of the $\vec{B}$ field created at a point a distance y above the sheet, considering the infinite plane as a succession of infinite wires.

(b) Recalculate $\vec{B}$ using a faster method.

(Source: Bordel Fall 2013 Final, Problem 5)

1.2 Loops and Wires

A circular loop of radius R carries a steady current I_2 in a clockwise direction as shown on the top figure. The center of the loop is a distance $d > R$ above a long straight wire carrying current I_1.

(1) What is the direction and magnitude of the steady current I_1 in the wire if the magnetic field at the center of the loop is zero?

(2) Is the force between the ring and the wire zero, repulsive or attractive?

(Source: Corsini Spring 2015 Final, Problem 7)

1.3 Bent Wire

A long wire is bent into the hairpin-like shape.

(a) What is the direction of the magnetic field at the center of the half-circle of radius d?

(b) What is the magnitude of the magnetic field at that point?

(c) Suppose an electron is at point P and has a velocity v pointing into the page. What force does the magnetic field exert on it?

(Source: Lanzara Fall 2014 Final, Problem 2)

1.4 Spinning Charges

A hollow sphere of radius R and total charge Q is spinning along the z-axis with angular velocity ω. What is the magnetic field at the center of the sphere (magnitude and direction)? Express it in terms of Q, R, ω, and μ_0.

(Source: Speliotopoulos Fall 2014 Final, Problem 3)

1.5 Arc-ed Wire

A section of wire with current I running through it has an opening of angle θ_0 and radius a. What is the magnetic field (direction and magnitude) at the center of the opening?

(Source: Speliotopoulos Spring 2014 Final, Problem 2)