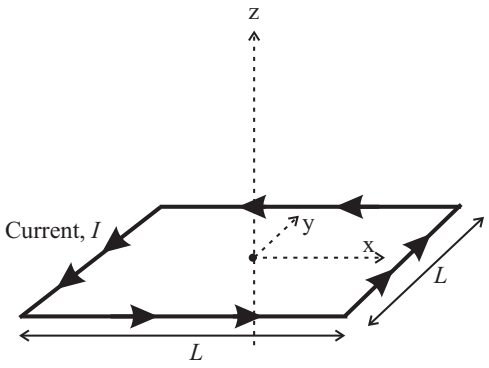
ECE 3025 Homework 10: Magnetostatics

1. A vortex of current is modeled by the following current density in space:

$$\vec{J}(x,y,z) = J_0\left[\frac{y}{\sqrt{x^2+y^2}}\hat{x} - \frac{x}{\sqrt{x^2+y^2}}\hat{y} + \hat{z}\right]$$

(a) How much current (C/s) is flowing through a disk-shaped area with radius R, centered on the origin in the xy-plane? (b) How much current (C/s) is flowing through a square of length L with one side resting flush against the z axis? (5 points)

2. A square loop of current with side lengths L lies on the xy-plane, centered on the origin. Given a line current I, what is the $\vec{H}$-field along the z-axis ($\vec{H}(0,0,z)$)? (10 points)



Here is an integral formula that might be useful:

$$\int \frac{du}{(a^2+u^2)^{3/2}} \quad = \quad \frac{u}{a^2\sqrt{a^2+u^2}} + C$$