

Intro to magnetic fields and Ampere's law

Reading assignment

Ulaby, 5-1, 5-2, 5-4

Connor and Salon VI-1 6 VI-13

Software

div_curl_example.m

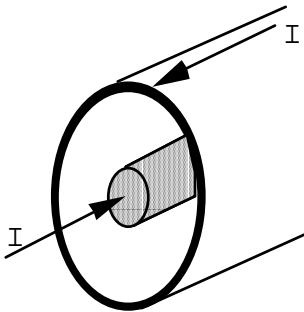
Problem 1 - Magnetic field properties

Run div_curl_example.m. Which of the fields shown are possible magnetic fields?
Which are possible electrostatic fields?

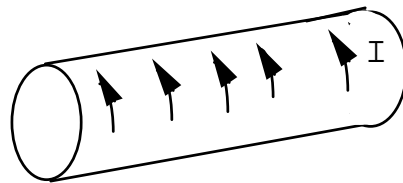
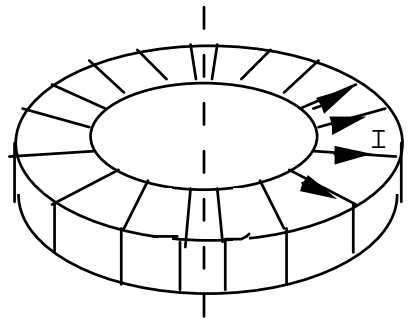
Problem 2 - Symmetry

Three standard geometries for analytical magnetostatic calculations are shown below.

- Use the right hand rule (thumb along the current direction, fingers for \mathbf{B}) and determine the direction of \mathbf{B} in each case.
- All 3 geometries can best be analyzed in cylindrical coordinates. For each, determine whether \mathbf{B} is a function of r , ϕ , and/or z . (Example from electric fields, \mathbf{E} of cylindrically symmetric charge is only a function of r .)

**Coaxial cable**

I is in z direction

**Solenoid**I is in ϕ direction**Toroid**

I wraps around core

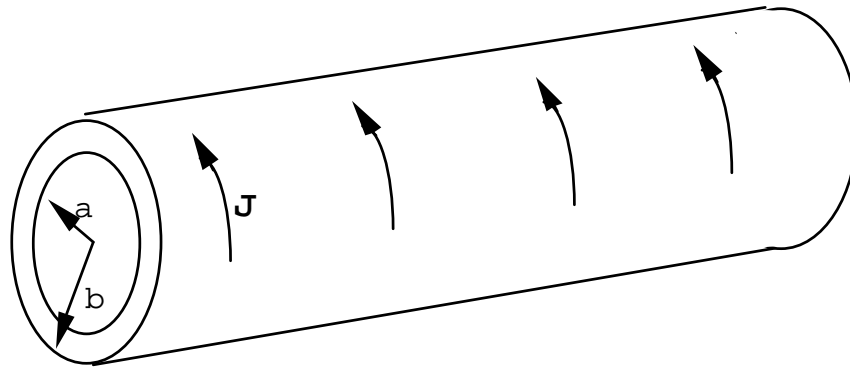
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Problem 3 - Ampere's Law

A long solenoid has a current density of $\mathbf{J} = J_0 \mathbf{a}_\phi$ for $a < r < b$ and is 0 everywhere else.

Ignore end effects.

- a. Find the magnetic flux density, \mathbf{B} for $r < a$. Be sure to sketch the line integral paths you use. Assume $\mathbf{B} = 0$ for $r > b$.



- b. Check your answer to part a. by evaluating $\nabla \cdot \mathbf{B}$ and $\nabla \times \mathbf{B}$.
- c. Find \mathbf{B} for $a < r < b$. Sketch the line integral path you use.
- d. Check your answer to part c. by evaluating $\nabla \cdot \mathbf{B}$ and $\nabla \times \mathbf{B}$.
- e. Plot B_z vs r .
- f. Show that $\mathbf{B} = 0$ for $r > b$.