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

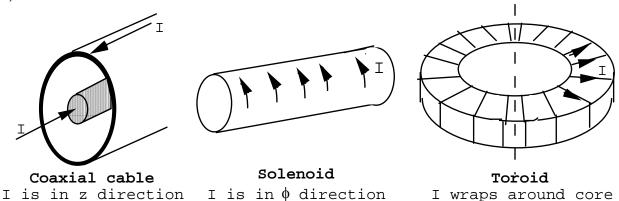
Run div_curl_example.m. Which of the fields shown are possible magnetostatic fields? Which are possible electrostatic fields?

Problem 2 - Symmetry

Three standard geometries for analytical magnetostatic calculations are shown below.

- a. Use the right hand rule (thumb along the current direction, fingers for **B**) and determine the direction of **B** in each case.
- b. All 3 geometries can best be analyzed in cylindrical coordinates. For each, determine whether **B** is a function of r, ϕ , and/or z.

(Example from electric fields, **E** of cylindrically symmetric charge is only a function of r.)

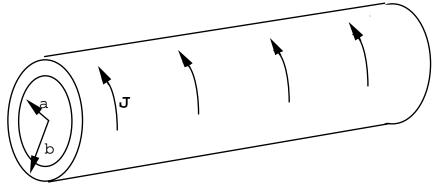


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Problem 3 - Ampere's Law

A long solenoid has a current density of $\mathbf{J} = \mathbf{J}_0 \mathbf{a}_{\phi}$ for $a < \mathbf{r} < b$ and is 0 everywhere else. Ignore end effects.

a. Find the magnetic flux density, **B** for r < a. Be sure to sketch the line integral paths you use. Assume **B** = 0 for r > b.



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