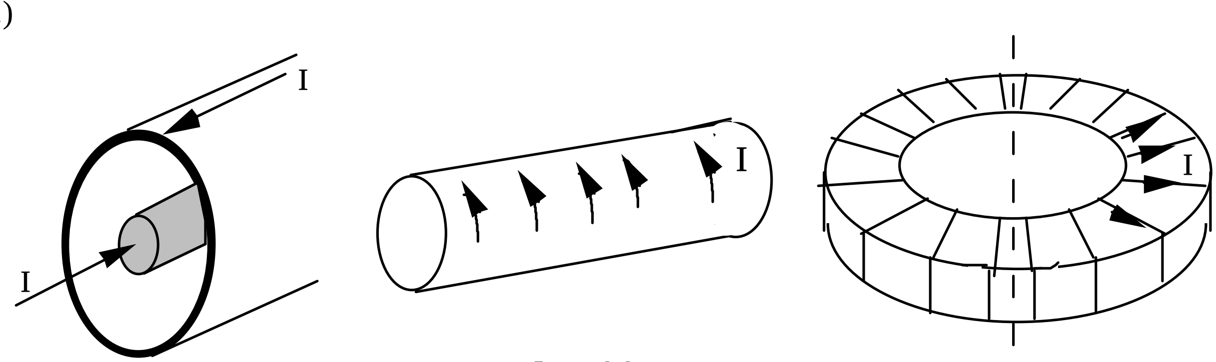
Intro to magnetic fields and Ampere's law

Reading assignment
Popović and Popović, Chapter 10
Connor and Salon VI-1 → 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.
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.)



Coaxial cable I is in z direction | **Solenoid** I is in ϕ direction | **Toroid** I wraps around core

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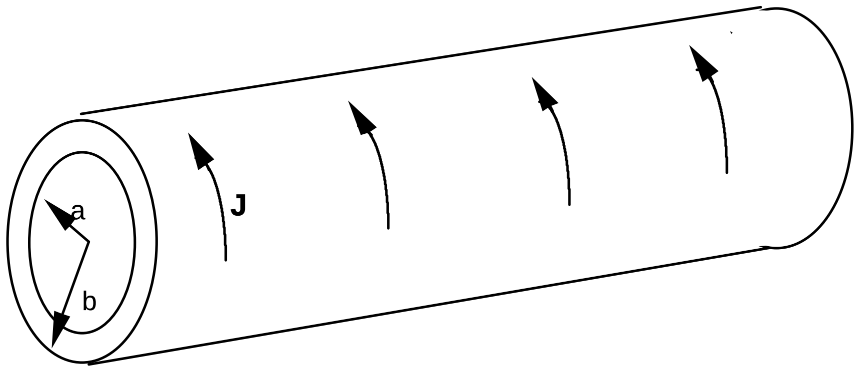
Problem 3 - Ampere's Law

A long solenoid has a current density of **J** = J_0 $\mathbf{a}_\varphi$ for *a* < 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 ∇•**B** and ∇x**B**.

c. Find **B** for *a* < r < *b* . Sketch the line integral path you use.

d. Check your answer to part c. by evaluating ∇•**B** and ∇x**B**.

e. Plot B_z vs r.

f. Show that **B** = 0 for r > *b* .