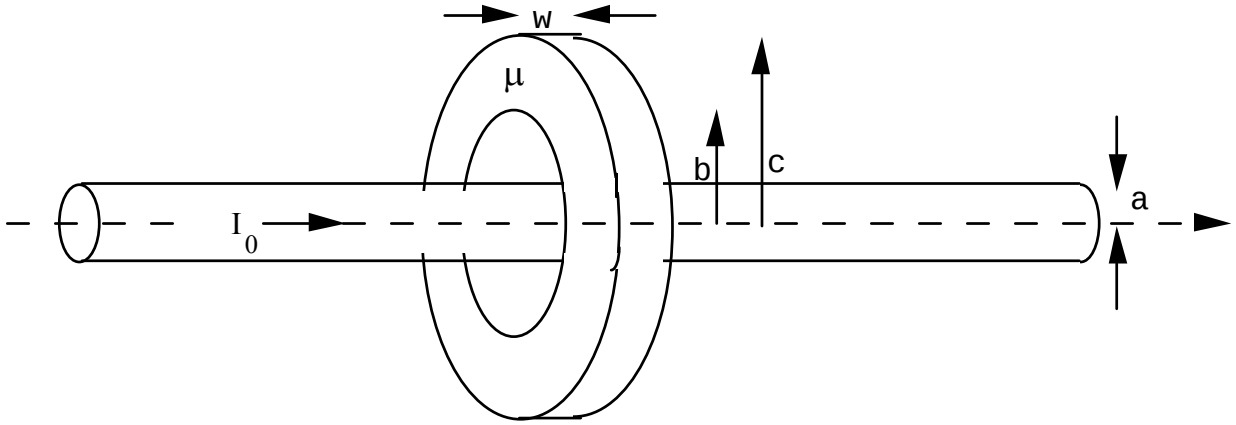
Magnetic materials

Reading assignment
Ulaby, 5-6, 5-7
Connor and Salon, VII-7 | VI-19

Problem 1 - magnetic materials - fixed μ

a. Calculate **B** and **H** for r > *a* in the figure below. State your answer for inside and outside the toroid separately.

b. Check that boundary conditions are satisfied.



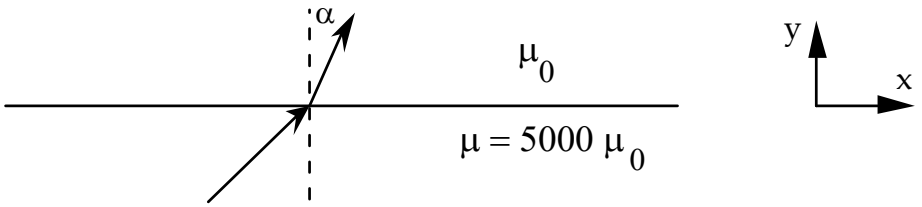
Problem 2 - boundary conditions

On the iron side of the iron-air boundary below, $\mathbf{B} = 0.1\,\mathbf{a}_x + 0.1\,\mathbf{a}_y$ Tesla.

What is **H** on the iron side?

What is **B** on the air side?

Approximately, what direction is **B** just outside the surface of a ferromagnet?



Problem 3 - Experiment

Make 4 coils of wire with at least 10 turns of magnet wire each. Two of the coils should be wrapped around a high μ toroid, while the other two should just have air in the center. Set the function generator to 5 V P-P at 1 MHz.

a. Connect the function generator output to one of the loops wrapped around the toroid.

1) Measure the emf induced around the other wire wrapped around the toroid. Move it to various locations.

2) Measure the emf induced around one of the air core coils at various locations.

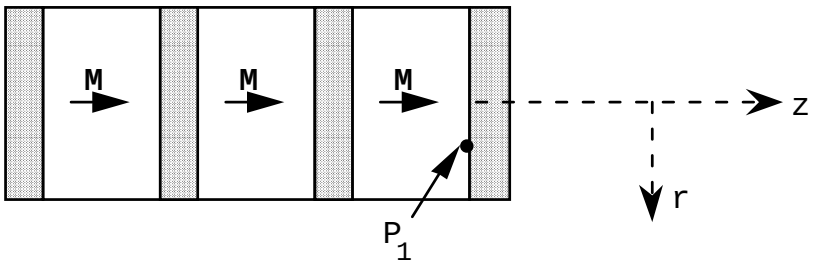
b. Connect the function generator to one of the air core coils and repeat.

Problem 4 - permanent magnets

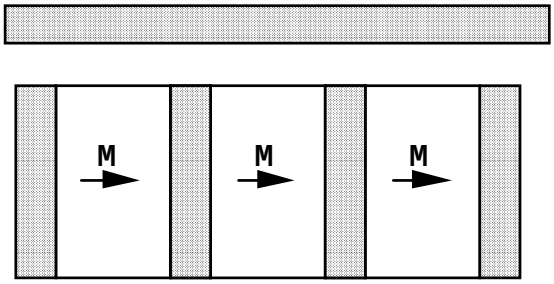
a. Sketch the magnetic flux density lines for the 3 cases shown below. The shaded regions are iron. Assume $\mu_r = 5000$. The clear regions are a permanent magnet with a magnetization, $\mathbf{M} = 4 \times 10^5$ A/m $\mathbf{a}_z$ that is independent of **H** (and $\therefore$, $\mathbf{B} \neq \mu \mathbf{H}$ in the permanent magnet). The surrounding area is air.

b. At point P_1 in Case 1, $\mathbf{B} = .196\,\mathbf{a}_r + .313\,\mathbf{a}_z$ on the iron side of the border. What is the value of **B** and **H** on both sides of the border?

Case 1



Case 2



Case 3