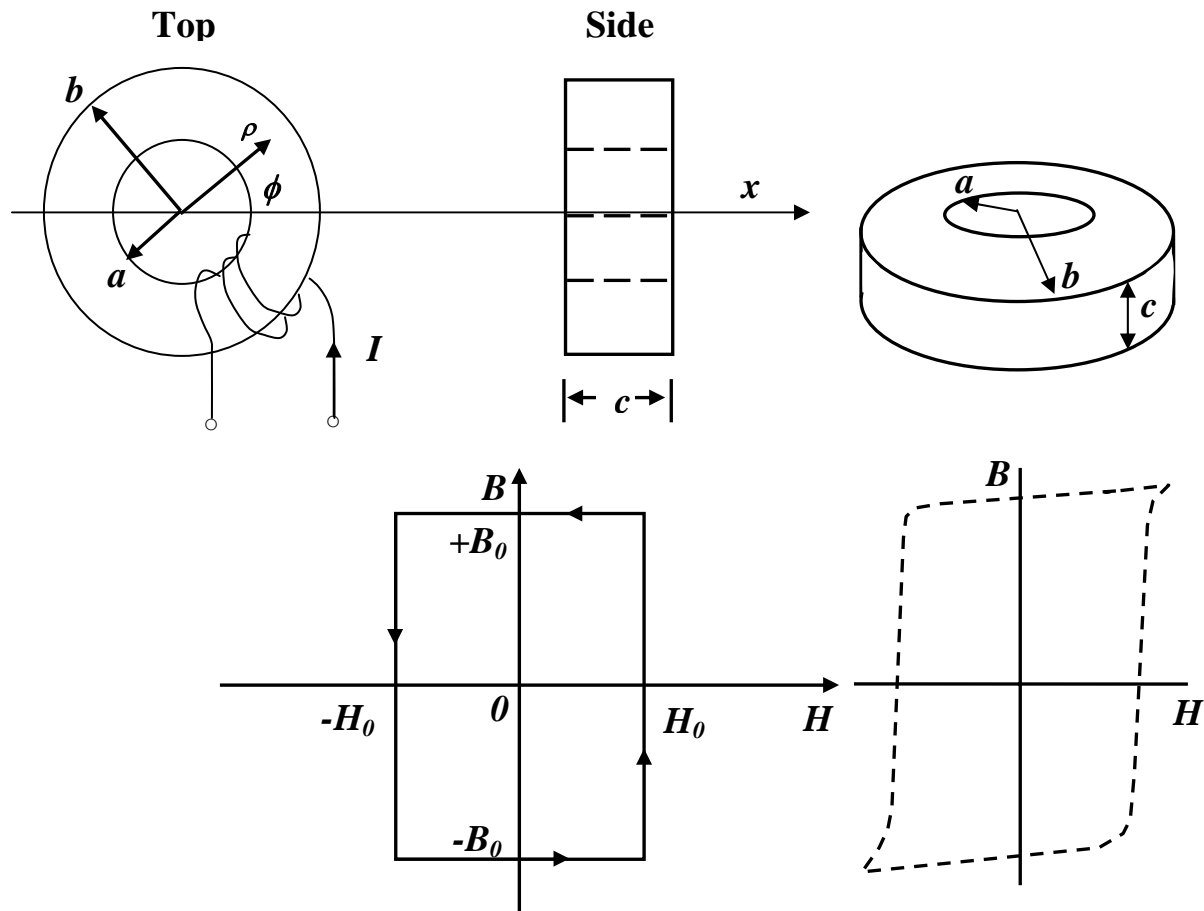7

Top   **Side**

A fine coil of wire with N turns is wound on a washer composed of a magnetic material, as sketched above. The inner and outer radii of the washer are a and b, respectively. The thickness of the washer is c. A current $I = 1$ amp is established in the wire.

The magnetic material is a special material that has a nearly rectangular hysteresis loop. An example of the **B** vs. **H** curve for such a material is shown on the right. We will approximate it in this problem by the rectangular hysteresis loop shown on the left for which the magnitudes of **B** and **H** are bounded by B_0 and H_0, respectively.

(a) Determine $H(\rho)$ at a point inside the washer at distance ρ from the center in terms of I and N.

(b) Determine the smallest value of N needed to produce $B = B_0$ at every point in the washer. We will call this the saturated state of the washer.

(c) What is the magnetization **M** in the washer after it has been saturated fully and the coil current, subsequently, reduced to zero? Give both magnitude and direction.

(d) The current in the wire is cycled from 1 amp to -1 amp and back to 1 amp. Calculate the energy dissipated in the saturated washer. Neglect the electrical resistance in the coil.