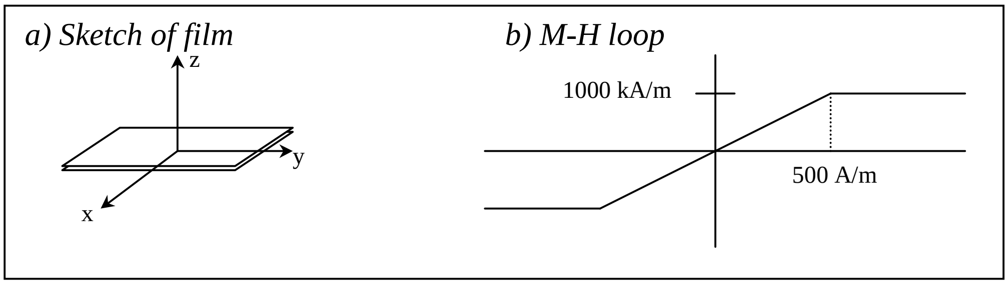
ECE 18-316
INTRO TO DATA STORAGE
FALL 98
<u>PROBLEM SET #3</u>

Due Friday, 9/18/98

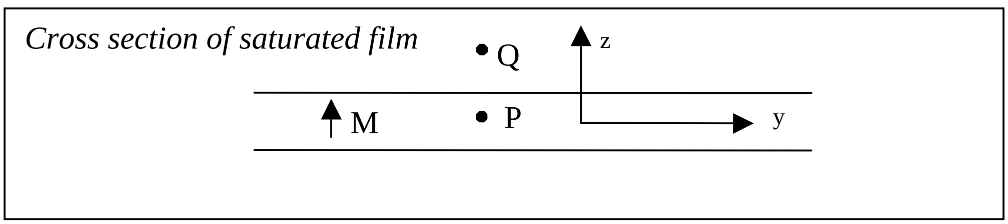
In Class or To Jie Zou Before Start of Lab Section (1:30 PM)

Late submissions will not get credit

1) Consider a thin film sample of material with its surface normal to the z-direction and infinite in extent in the x and y-directions. When a field are applied in the x-direction are the following M(H) loop is observed.



Consider now that a spatially uniform field is applied to the sample and the surrounding region sufficient to saturate it, as shown below.

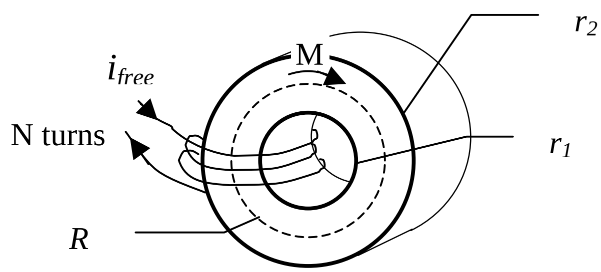


a) Give the value of M, H, and B at points P and Q for these cases.
b) What if the applied field is reduced to half of its value in a). Again give the values of M, H and B at points P and Q.

Make sure to specify units, and work in the SI system.

2) Consider a cylindrically magnetized core with the magnetization:

$$\bar{M} = M_0 \frac{r_1}{r}\left[\Theta(r - r_1) - \Theta(r - r_2)\right]\hat{\theta}$$



where $\hat{\theta}$ is a unit vector in the circumferential direction (everywhere perpendicular to the radial direction), and r is the coordinate in the radial direction. Note that the magnetic material extends from the inner radius of the core, r_1 to the outer radius, r_2.

a) Calculate the "magnetic" current density, j_{mag} everywhere in space, by taking a curl of the appropriate quantity in cylindrical coordinates.

b) Using the result in a) find the "magnetic" current, i_{mag}, within the line contour at radius, R, (shown as a dashed line in the diagram) by integrating over the appropriate area.

c) Combine the result in b) with amperes law and the definition of B to show the following result for this geometry (which is also true in the general case):

$$\oint_C \bar{B} \cdot d\bar{s} = \mu_0 \left(N i_{free} + i_{mag} \right)$$

where the line contour, C, over which the integration is done is, as above, the dashed line at radius, R, and $d\bar{s}$ is a differential element of the line contour, C.