ECE 18-316
INTRO TO DATA STORAGE
FALL 98
PROBLEM SET #9

Due Friday, 11/6/98

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

Late submissions will not get credit

Consider a comparison between a "shunt biased" MR head and a "soft-adjacent layer" (SAL) biased head. In the shunt-biased head, transverse biasing is achieved by current flowing in the MR stripe and a non-magnetic shunting layer. This offsets the center of the current form the center of the MR stripe. The output signal of this type of head is limited by the need to apply exactly the correct current to achieve the correct bias point. In the SAL head, the bias point is insensitive to current, so more current can be applied to the sensor (achieving a higher output). The only limit on current in the SAL head is the current density that the head can tolerate. In this problem, you will calculate the current in each head and the associated improvement in signal level that can be achieved with this new SAL design. You will also calculate what improvement in track density that can be obtained as a result of this increase.

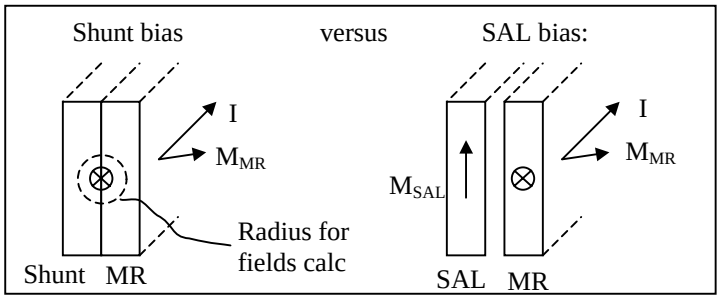
Assume the following

- Both heads have the same geometry, and all of the same physical properties.
- No current flows through the SAL.
- The bias field in the shunt biased head at the center of the MR can be calculated by treating the shunt/MR pair as wire with radius equal to half the MR thickness (as shown below)

***NOTE: ASSUME THIS FIELD IS INSIDE A PERMEABLE MATERIAL FOR CALCULATION ***

- The resistivity of the shunt layer is the same as the MR layer, but it does not vary with field
- The following problem properties apply

Sensor H_k	500 A/m
Sensor Ms	800 kA/m
Medium field	100 A/m
Sensor height	10 um
Sensor thickness	10 nm
Shunt thickness	10 nm
ρ_0	20 uOhm-cm
$\Delta\rho_0/\rho_0$	2%



1) Shunt biased head:
a) Estimate the current needed to achieve 45 degree bias in the shunt biased sensor
b) Calculate the resistance of the sensor at the bias current per um of trackwidth
c) Calculate the change in resistance with the addition of the medium field, per um of trackwidth
d) Calculate the signal, ΔV, for the application of the medium field, per um of trackwidth

2) SAL biased head:
a) Calculate the maximum current that can be applied to the sensor without exceeding a current density of 2×10^7 A/cm^2.
b) Calculate the signal, ΔV, for the application of the medium field, per um of trackwidth, assuming perfect biasing by the SAL.

3) System Improvements:
a) If a system needs the same total output voltage from either head, what is the ratio of the track density achievable with the shunt biased head to that achievable with the SAL head?