Indian Institute of Science

E9-251: Signal Processing for Data Recording Channels

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Home Work #1, Spring 2014

Late submission policy: Points scored = Correct points scored $\times e^{-d}$, d = # days late

Assigned date: Feb 3^{rd} 2014 **Due date:** Feb 20^{th} 2014.

PROBLEM 1: In this problem, you will build a simulator for the perpendicular recording channel. Assume that the transition response is $h(t) = A\tanh\left(\frac{2t}{0.579\pi PW_{50}}\right)$. In this case, PW_{50} is defined as the duration when the pulse $h(t)$ changes from $-\frac{A}{2}$ to $+\frac{A}{2}$. Define the channel bit density (cbd) as $\frac{PW_{50}}{T}$.

(1) Sketch $h(t)$, where, t is along the X-axis in nano-meter scale. Express $h(t)$ in terms of the user bit density (ubd) and code rate R. Study the effects of intersymbol-interference by varying ubd for a code rate $R = 0.75$.

(2) The readback signal suffers from jitter noise associated with the fluctuations in the position t and the pulse width PW_{50} as well as electronic noise from read heads. Define the signal-to-noise ratio (SNR) for this technology appropriately. Evaluate the SNR in terms of ubd, R and relevant noise statistics.

(3) Generate non return to zero (NRZ) bits and obtain the read back response along with noise and interference for cases where $ubd = \{1, 1.5, 2\}$. Assume that the code rate is $R = 0.75$. What do you conclude?

(4) Compute the time and statistical mean and autocorrelation for the read back signal. Is it ergodic in the mean and autocorrelation?

(5) Sketch the schematic of the read back signal generation process. Include all the signal and noise paths up to a first order approximation.

(75 pts.)

NOTE: Your solution should include the original Matlab code along with necessary mathematical derivations followed by experiments, observations and conclusions.

PROBLEM 2: Refer to the paper by Evans et al. "Thermally induced error: Density limit for magnetic data storage," in Appl. Phys. Lett., 100, 102402, 2012. The authors introduce an additional factor called 'thermal writability' to assess areal density gains.

(1) Sketch the areal density as a function of bit error rate (BER) during writing process for writing temperature $T_{wr} = 730K$ and curie temperature $T_c = 750K$.

(2) How do the areal densities in the previous part compare to the super paramagnetic limits?

(3) If the error mechanism is assumed purely due to the writing process, what is the classical capacity of the recording channel? (Hint: You may approximate this with the binary symmetric channel). Translate the capacity numbers to areal densities.

(25 pts.)