Indian Institute of Science

E9-252: Mathematical Methods and Techniques in Signal Processing

Instructor: Shayan G. Srinivasa

Home Work #1, Fall 2014

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

Assigned date: Aug 31^{st} 2014 **Due date:** Sep 16^{th} 2014 in class

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PROBLEM 1: What are the system modes for the noise free discrete signal $y[n] = n^a$, $n \geq 0$, a is any integer? (6 pts.)

PROBLEM 2: Problem 1.4.16 and 1.4.17 from the text Moon and Stirling. (10 pts.)

PROBLEM 3: Almost always, we need to truncate real numbers to integers when realizing algorithms in hardware. One such class of operations for truncation are the well known floor and ceil functions i.e., $f(x) = \lfloor x \rfloor$ and $c(x) = \lceil x \rceil$. For example, $f(2.5) = 2, c(2.5) = 3$. Suppose x is a random variable Gaussian distributed with mean 0 and variance σ^2. Determine the mean and variance of the random variables after the floor and ceil operations. (7 pts.)

PROBLEM 4: Problems 2.10.52, 2.12.57 and 2.12.63 from the text Moon and Stirling. (15 pts.)

PROBLEM 5: Three noise less signals $f_1(t)$, $f_2(t)$ and $f_3(t)$ as shown in the Figure 1 are emitted from a source with probabilities 0.2, 0.3 and 0.5 respectively.

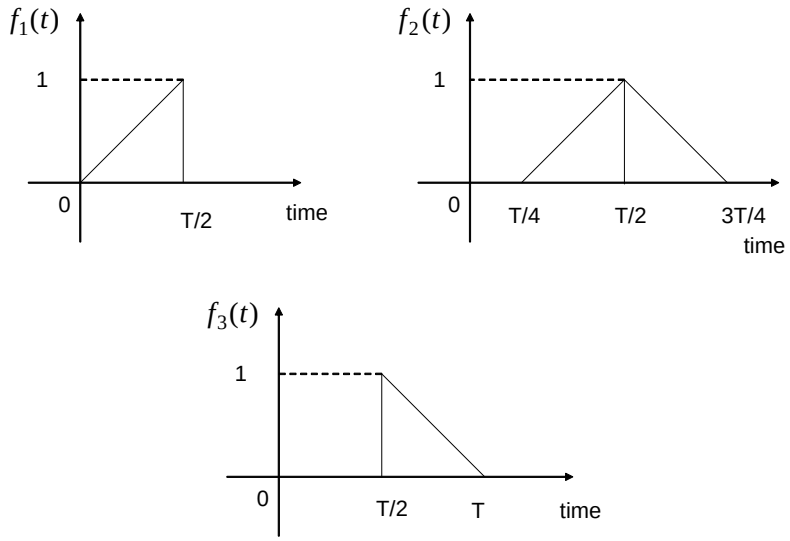

FIGURE 1. Three signals from a source.

(1) Represent the signals as vectors in an appropriate coordinate system. Evaluate the pairwise distance and angles between the signals. Intrepret your results qualitatively.
(2) Let us suppose that the signals are corrupted by additive noise with uniform distribution over the support of the signals during reception. Determine the optimal linear decision boundaries to minimize the probability of misclassifying the signals. Explicitly evaluate the probability of misclassification. (NOTE: If you find crunching of numerical values laborious, you are strongly encouraged to do this exercise via a computer program after you set up the equations. I am looking for the approach to this problem and your reasoning at every step.)

(12 pts.)