Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

6.341: Discrete-Time Signal Processing

Fall 2005

Problem Set 3

Quantization noise, Oversampled Noise Shaping

Issued: Tuesday September 20, 2005. **Due:** Tuesday September 27, 2005.

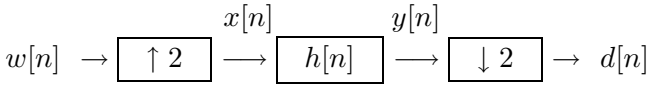
Reading: OSB Chapter 4 sections 4.8 and 4.9.
Note: The background exam is scheduled for September 22 The exam is officially from 11-12:30, but we have reserved from 11-1 to reduce time pressure somewhat. It is closed book.
No calculators and no notes of any kind are permitted.

Problem 3.1

Suppose a discrete-time filter has group delay $\tau(\omega)$. Does $\tau(\omega) > 0$ for all $\omega \in (-\pi, \pi)$ imply that the filter is necessarily causal? Clearly explain your reasoning.

Problem 3.2

In the system below, $w[n]$ is a real, zero-mean, white, wide-sense stationary random sequence with variance σ_w^2.



(a) Determine the autocorrelation of $x[n]$, *i.e.*, $R_{xx}[n, m] = \mathcal{E}(x[n]x[n+m])$, and state whether or not $x[n]$ is wide-sense stationary.

(b) Find an expression for the autocorrelation of $y[n]$ *i.e.*, $R_{yy}[n, m] = \mathcal{E}(y[n]y[n + m])$, in terms of σ_w^2 and $h[n]$ **for even values of** n. (For full credit, your expression should be in the simplest possible form.)

(c) Are there conditions on $h[n]$ which would ensure that $d[n]$ is wide-sense stationary? If yes, give the least restrictive such conditions.

Problem 3.3

OSB Problem 4.47

Problem 3.4

OSB Problem 4.57 a-c

Problem 3.5 (Optional)

OSB Problem 4.61