

University of Pennsylvania  
Department of Electrical and System Engineering  
Digital Signal Processing

## HW1: Discrete-time Signals and Systems

Thursday, January 19

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**Due:** Sunday, January 29, 11:59PM

- **Homework Problems:** All problems must be turned in and are not optional for full credit

1. Homework problems from the book: 2.23, 2.36, 2.54, 2.64, 2.76
2. Matlab problem: The M-point moving average (MA) filter is the filter of textbook Example 2.3 with  $M_1 = 0$  and  $M_2 = M - 1$ . Consider a signal  $\{s[n]\}$  corrupted by additive random noise  $\{w[n]\}$ . The resulting sequence is:  $x[n] = s[n] + w[n]$ , for all  $n$ . Useful MATLAB commands to look up: **wgn**, **randn**, **filter**, **conv**.
  - (a) Generate signal  $s[n] = 2n(0.9)^n$ , for  $n = 0, 1, \dots, 100$
  - (b) Generate independent Gaussian random noise with mean=0 and variance=1 ( $\mu_w = 0$ ,  $\sigma_w^2 = 1$ ),  $w[n]$ , for  $n = 0, 1, \dots, 100$ . Note noise power in decibels:  $dB = 10 \log_{10}(\text{Variance})$ .
  - (c) Plot the discrete-time signals (stem plot!)  $\{s[n]\}$ ,  $\{w[n]\}$ , and  $\{x[n]\}$ . Label all axes within MATLAB and submit code and plots with homework.
  - (d) Apply a 5-point moving MA filter to the sequence  $\{x[n]\}$  and generate the output sequence  $\{y[n]\}$ . Plot  $\{s[n]\}$  and  $\{y[n]\}$  on the same (labeled!) axes to observe the effect of filtering. Submit code and plot.
  - (e) Instead of noise, generate an interference frequency  $w_{int}[n] = \cos[2\pi fn]$ , for  $n = 0, 1, \dots, 100$  with  $f = 0.2$ . Filter  $x_{int}[n] = s[n] + w_{int}[n]$  with an M-point MA filter for  $M=4, 5$  and  $6$ . Plot and submit the results of each MA filter similar to part (d). Is the interference completely removed? Comment on your result.

- **Recommended Problems:** These are book problem recommended for practice and not to be turned in: 2.9, 2.18, 2.19, 2.22, 2.28, 2.56