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

HW1: Discrete-time Signals and Systems   Tuesday, January 23

Due: Sunday, February 4, 11:59PM

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

  1. Homework problems from the book: 2.23ab, 2.36ab, 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 $n = 0, 1, ..., 100$

     (b) Generate independent Gaussian random noise with mean=0 and variance=1 ($\mu_w = 0$, $\sigma_w^2 = 1$), $w[n]$, for $n = 0, 1, ..., 100$. Note noise power in decibels: $dB = 10 \log_{10}(Variance)$.

     (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 $w_{int}[n] = cos[2\pi f n]$, for $n = 0, 1, ..., 100$ 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, 2.23cd, 2.36c, 2.56