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

ESE531, Spring 2018 HW1: Discrete-time Sigs and Systems Tuesday, January 16

Due: Friday, January 26, 11:59PM

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

1. Homework problems from the book: 2.21, 2.23, 2.28, 2.36, 2.54, 2.64, 2.77
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 $w_{int}[n] = cos[2\pi fn]$, 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.