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

ESE531, Spring 2021 HW1: Discrete-time Sigs and Systems Monday, February 1

Due: Monday, February 8, 11:59PM

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

  1. List all available office hours and recitation times. For each, include the day of the week and time in the time zone of your choice. For your own knowledge, identify all the ones you are available to attend.
  2. Homework problems from the book: 2.23, 2.36, 2.54, 2.64, 2.76
  3. 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.