# EE3731C:
# Signal Processing Methods

Tutorial II-4

# Question #1

Consider a random process $x[n]$ generated by filtering a white noise that has has a zero mean and a unit variance with the system below:

$$H(z) = \frac{1}{z - 0.5}$$

Find the power spectrum of x[n].

# Question #2

Consider the random process $x[n]$ which has an autocorrelation function given by

$$R_x[k] = 17\delta[k] + 4\left(\delta[k-1] + \delta[k+1]\right)$$

i. Find a linear filter such that the output has the same autocorrelation function when the input is white noise of zero mean and unit variance.

ii. Find a whitening filter that converts $x[n]$ into white noise.

# Question #3

Let $S_s(\omega)$ denote the power spectral density of $s[n]$. Consider the situation in which we observe a realization of signal $s[n]$ in additive Gaussian noise $w[n]$, i.e.,

$$x[n] = s[n] + w[n]$$

Assume that the variance of $w[n]$ is 0.5 and $w[n]$ is independent of $s[n]$. Design an optimal Wiener filter for estimating $s[n]$ from the measured noisy signal $x[n]$. Express the filter in the frequency domain.

# Question #4

Consider the power spectral density function given by:

$$S_x\left(e^{j\omega}\right) = 5 + 4\cos(\omega)$$

i. Find the corresponding autocorrelation function of $x[n]$
ii. Find a linear filter whose output process has the same autocorrelation function when excited by white noise of zero mean and unit variance.
iii. What is the variance of the output process?