EE3731C:
Signal Processing Methods

Tutorial II-5

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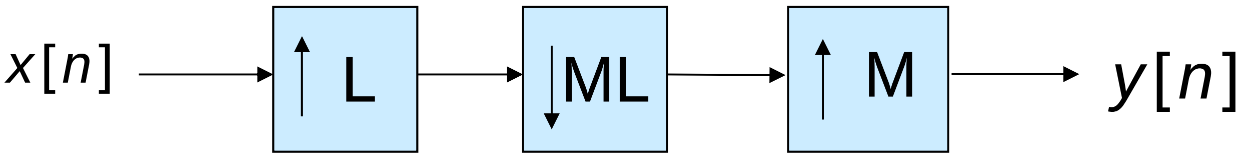
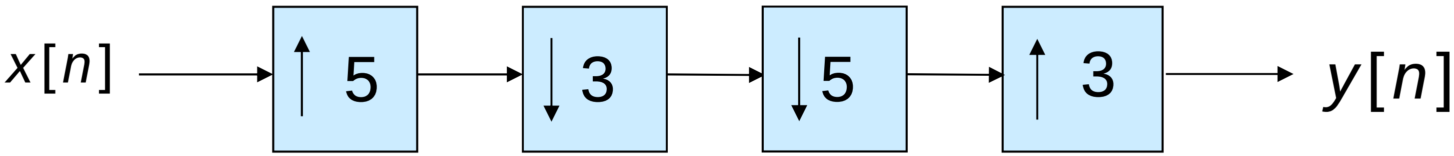
Question #1

Simplify the following multirate systems as much as you can.

i)

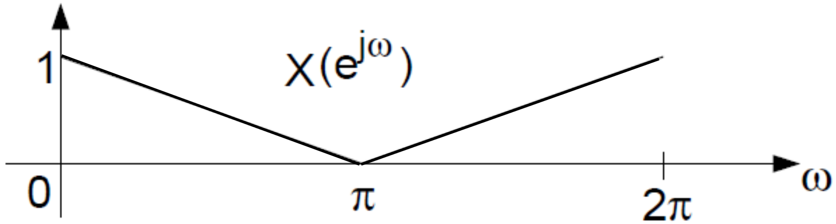


ii)



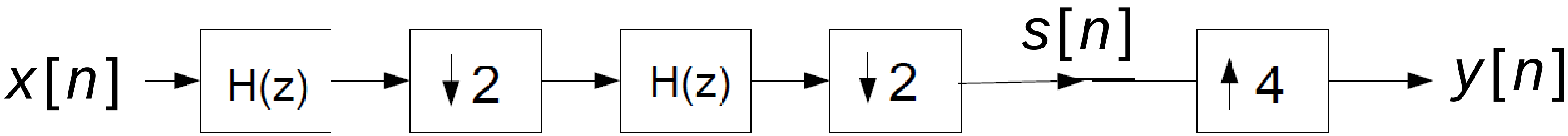
Question #2

Consider a sequence $x[n]$ whose Fourier transform is shown below.



The frequency response of the filter is

$$H\left(e^{j\omega}\right)=\begin{cases}1 & |\omega|<\pi/2\\ 0 & \pi/2\le|\omega|\le\pi\end{cases}$$



Plot $Y(e^{j\omega})$ and $S(e^{j\omega})$

Question #3

Let θ denote a random variable that is uniformly distributed on the interval from 0 to 2π, and let $e[n]$ be a sequence of zero-mean random variables that are uncorrelated with each other and also uncorrelated with θ (i.e., $e[n]$ represents white noise). The signal is given by:

$$x[n] = A\cos(\omega_0 n + \theta) + e[n],$$

where A and ω_0 are known constant values.

Determine the mean and autocorrelation functions of $x[n]$.

Question #4

A zero mean noise process $x[n]$ has the following autocorrelation function

$$R_x(m) = \left(\frac{1}{2}\right)^{|m|}$$

We process $x[n]$ with a linear time-invariant system that satisfies the following difference equation:

$$y[n] = x[n+1] + x[n-1]$$

What is the power spectral density of $y[n]$?