Midterm 2 Review Problems

EECS123: Digital Signal Processing

Prof. Ramchandran
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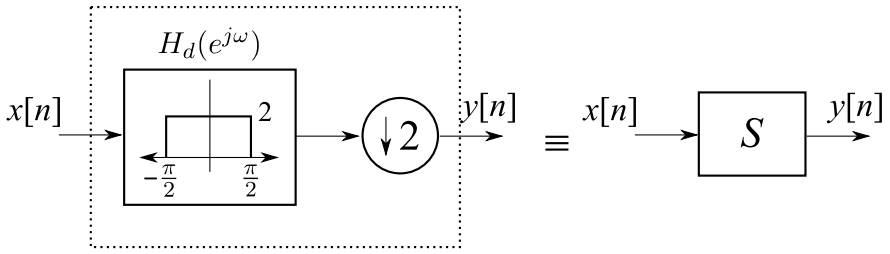
Multirate and filter banks

- Problem 4.51 from OSB.
- Problem 4.52 from OSB.
- Problem 4.53 from OSB.
- Consider the system S shown in the figure below:



  Let $X_d(e^{j0}) = 1$ and let $X_d(e^{j\omega})$ be continuous (smooth) at $\omega = 0$. What is the output when $x[n]$ is passed through an "infinite number of system S put in serial"? Can you interpret your answer using the noble identities?

Spectral analysis

- You are told that $y[n] = (ap^n + bq^n)u[n]$. Let $y[0:3] = \{5, 6, 0, -36\}$. Find a, b, p, q using the annihilation filter method.
- A signal of interest $y[n] = (ap^n + bq^n)u[n]$ cannot be observed directly. As a constraint, you can only see $y[n]$ after it passes through a filter $h[n] = e^{-n^2}$. Let $x[n] = y[n] * h[n]$, then $x[n]$ is observed. How many samples of $x[n]$ are needed to find the values of a, b, p, q?

FIR Filter design

- Problem 5.41 from OSB.
- Problem 7.33 from OSB.
- Problem 7.36 from OSB.
- Problem 7.48 from OSB.

IIR Filter design

1. (a) Use the bilinear transform method, with the analog prototype filter $H_a(s) = \frac{b}{b+s}$, to design a digital low-pass filter with 3 dB cutoff frequency $\omega_c = \frac{\pi}{2}$. Specify $H(z)$ explicitly. How does the constant b affects your answer?

   (b) Sketch $|H_d(e^{j\omega})|$ for the filter designed in part (a) over the interval $0 \leq \omega \leq \pi$.