

Tik-61.140 Signal Processing Systems

1. mid term exam, Mon 6.3.2000 16-19 C,D

You may use a mathematical reference book and a graphical calculator. Some formulae on the other side of the paper.

1. (6p) Let us examine a system S , which is defined with a block diagram below.

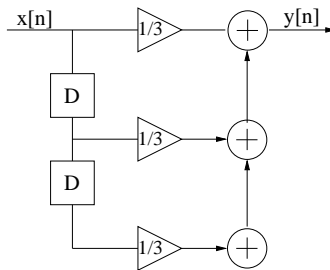


Figure 1: A block diagram of the system S

- Is the system LTI (linear and time-invariant)? Explain or calculate.
 - What is the impulse response $h[n]$ of the system?
 - Draw a sequence $x[n] = \cos(\pi n/2)$.
 - The sequence $x[n]$ from c) is fed into the system. Draw the output $y[n]$. Suppose that the system is in rest in the beginning, in other words, memory values are zero.
2. (6p) Let us examine a system S , which is given by a difference equation ($a > 0$ is a real number constant)

$$S : y[n] + ay[n - 1] = x[n]$$

- Draw a block diagram of the system.
 - What is the impulse response $h[n]$ of the system? Write $h[n]$ using the step function $u[n]$. ($u[n] = 1$, when $n \geq 0$ and $u[n] = 0$, when $n < 0$)
 - With which values of a is the system stable?
 - Is the system causal? Explain or calculate.
3. (6p) Let us examine a system given in the figure below, where

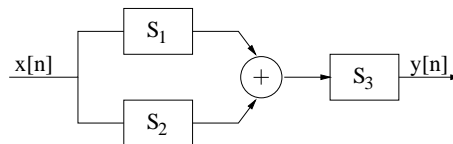


Figure 2: The system in problem 3

$$\begin{aligned} S_1 & : y[n] = 2x[n] + x[n - 1] - 4x[n - 2] \\ S_2 & : y[n] = -x[n - 1] + 2x[n - 2] \\ S_3 & : y[n] = -x[n - 1] + 2x[n - 2] + 2x[n - 3] - x[n - 4] \end{aligned}$$

- What is the impulse response $h_{12}[n]$ of the parallel system (S_1, S_2) ?
- What is the impulse response $h[n]$ of the whole system? Draw $h[n]$ and write $h[n]$ using impulse function $\delta[n]$. ($\delta[n] = 1$, when $n = 0$, $\delta[n] = 0$, else).
- What is the frequency response $H(e^{j\omega})$ of the system? (Hint: $\delta[n - n_0] \leftrightarrow e^{-j\omega n_0}$)
- Express the absolute value $|H(e^{j\omega})|$ of the transfer function $H(e^{j\omega})$ of c) with sine functions using Euler's formula.