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.

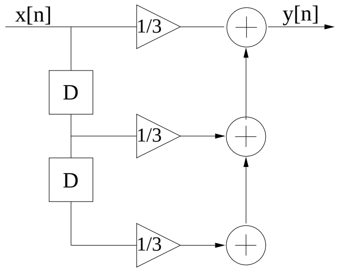

Figure 1: A block diagram of the system S

a) Is the system LTI (linear and time-invariant)? Explain or calculate.

b) What is the impulse response $h[n]$ of the system?

c) Draw a sequence $x[n] = cos(\pi n/2)$.

d) 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)

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

a) Draw a block diagram of the system.

b) 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 $n < 0$)

c) With which values of a is the system stable?

d) Is the system causal? Explain or calculate.

3. (6p) Let us examine a system given in the figure below, where

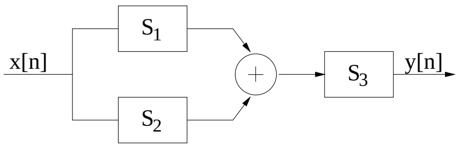

Figure 2: The system in problem 3

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

a) What is the impulse response $h_{12}[n]$ of the parallel system (S_1, S_2)?

b) What is the impulse response $h[n]$ of the whole system? Draw $h[n]$ <u>and</u> write $h[n]$ using impulse function $\delta[n]$. ($\delta[n] = 1,$ when $n = 0,$ $\delta[n] = 0,$ else).

c) What is the frequence response $H(e^{j\omega})$ of the system? (Hint: $\delta[n - n_0] \leftrightarrow e^{-j\omega n_0}$)

d) 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.