Problem Set #1

EEEC20034 - Introduction to Digital Signal Processing

NYCU

Problem 1

Determine the output of a linear time-invariant system if the impulse response $h[n]$ and the input $x[n]$ are as follows:

(a) $x[n] = u[n]$ and $h[n] = \alpha^n u[-n-1]$, with $\alpha > 1$.

(b) $x[n] = u[n-4]$ and $h[n] = 2^n u[-n-1]$.

(c) $x[n] = u[n]$ and $h[n] = (0.5)2^n u[-n]$.

(d) $h[n] = 2^n u[-n-1]$ and $x[n] = u[n] - u[n-10]$.

Use your knowledge of linearity and time invariance to minimize the work in Parts (b)-(d).

Problem 2

Consider the system illustrated in Fig. 4. The output of an LTI system with an impulse response $h[n] = (\frac{1}{4})^n u[n+10]$ is multiplied by a unit step function $u[n]$ to yield the output of the overall system. Answer each of the following questions, and briefly justify your answers:

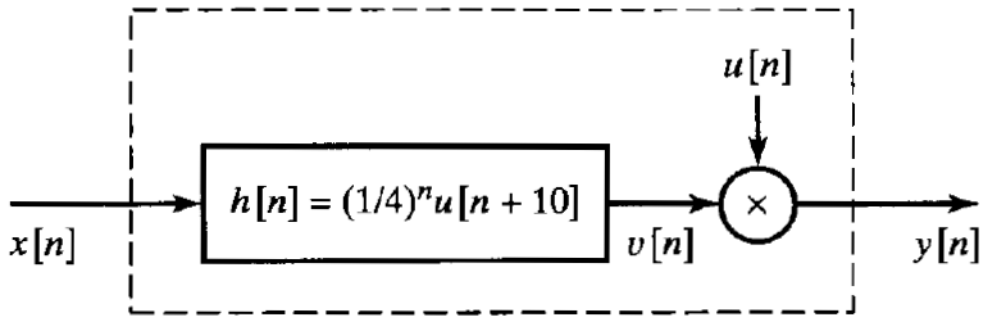

Figure 1

(a) Is the overall system LTI?

(b) Is the overall system causal?

(c) Is the overall system stable in the BIBO sense?

Problem 3

Determine which of the following signals is periodic. If a signal is periodic, determine its period.

(a) $x[n] = e^{j(2\pi n/5)}$

(b) $x[n] = sin(\pi n/19)$

(c) $x[n] = ne^{j\pi n}$

(d) $x[n] = e^{jn}$

Problem 4

For each of the following systems, determine whether the system is (1) stable, (2) causal, (3) linear, and (4) time invariant.

(a) $T(x[n]) = (cos\pi n)x[n]$

(b) $T(x[n]) = x[n^2]$

(c) $T(x[n]) = x[n]\sum_{k=0}^{\infty}\delta[n-k]$

(d) $T(x[n]) = \sum_{k=n-1}^{\infty}x[k]$