Assignment 2

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Question $2.15a$**) :** Consider the system illustrated in figure given below . 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 the following question, and briefly justify your answer:

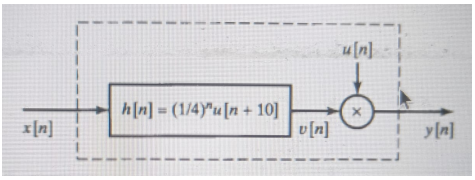

Fig. 1. Framework from input to output of a system

a) Is the overall system LTI?

SOLUTION:

Linear time-invariant system is a system that produces an output signal from any input signal subject to the constraints of linearity and time-invariance.

Linearity: A system is linear, if it only consists of linear operations, such as: scaling, time-shift, summations of scaled and time-shifted input signals.

Time invariance: A system is time invariant if a time shift in the input signal results in an identical time shift in the output signal.That is, if $y[n]$ is the output of a discrete time , time invariant system when $x[n]$ is the input , then $y[n-n_0]$ is the output when $x[n-n_0]$ is applied .

Properties of LTI system:

$$y[n] = \sum_{-\infty}^{\infty} x[k]h[n-k] \text{(discrete LTI)}$$

$$y[n] = \int_{-\infty}^{\infty} x[k]h[n-k] \text{(continuous LTI)}$$

$\boldsymbol{h[n]}$ is the response of the Linear system to the shifted unit impulse $\boldsymbol{\delta[n-k]}$.

where

$$\boldsymbol{\delta[n-k]} = \begin{cases} \boldsymbol{1, n=k} \\ \boldsymbol{0}, \text{else} \end{cases} \tag{1}$$

$\therefore$ The given system is not an LTI system since inputs $\boldsymbol{\delta[n]}$ and $\boldsymbol{\delta[n-1]}$ violate **TI**.