Signals and Systems (CT 203)

Tutorial Sheet-06 DA-IICT, Gandhinagar.

1. If the systems shown in Fig. 1(a) and Fig. 1(b) are equivalent, find $h(n)$.

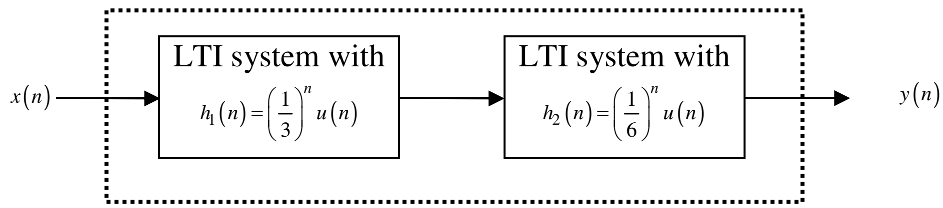

Fig. 1(a)

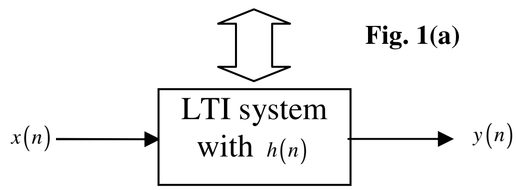

Fig. 1(b)

2. Check whether each of the following systems is *stable* and *causal* using condition on impulse response of the system.

   (a) Ideal Delay System, $y(n) = T\{x(n)\} = x(n - n_d)$

   (b) Accumulator System, $y(n) = T\{x(n)\} = \sum_{k=-\infty}^{n} x(k)$

   (c) Forward Difference system, $y(n) = T\{x(n)\} = x(n+1) - x(n)$

   (d) Backward Difference system, $y(n) = T\{x(n)\} = x(n) - x(n-1)$

3. Prove the following

   a) $x(t) = x(t) * \delta(t)$

   b) $\delta(t) = \delta(t) * \delta(t)$

   c) $\delta(t) = \delta(t) * \delta(t) * \delta(t)$

   d) $\delta(t) = \delta(t) * \delta(t) * \delta(t) .... * \delta(t)$

Imagine that $x_1(t) = \delta(t)$, $x_2(t) = \delta(t) * \delta(t)$,.. $x_n(t) = \delta(t) * \delta(t) * .... * \delta(t)$ are applied as input signals to an LTI system which is modeled by the linear differential equation is

$$\frac{dy(t)}{dt} + 3y(t) = x(t)$$

whose solution is given by $y(t)=e^{-3t}x(t)$ as shown in Fig.2. Analyze and comment on the nature output of LTI systems and hence importance of impulse excitation or impulse response in LTI system theory.

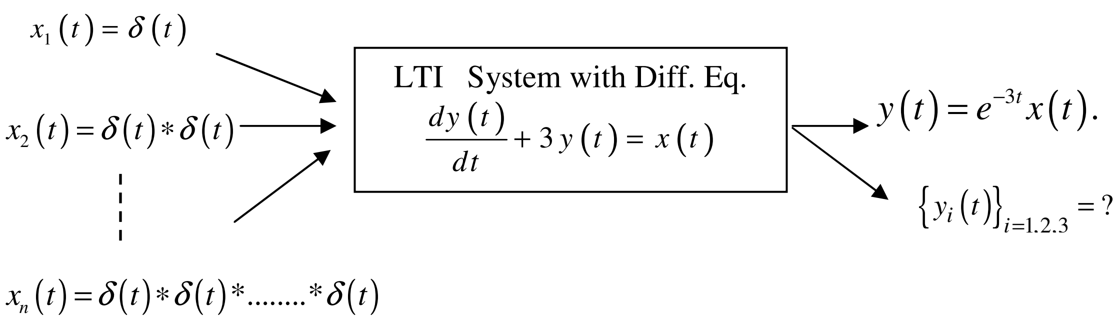

Fig.2. Understanding importance of impulse response of an LTI System

4. Find the *autocorrelation* function, $r_{xx}(l)$, for the sequence, $x(n)=\{..,1,2,3,4,1,2,3,4,1,2,3,4,..\}$. Observe your result carefully. Can you comment on any pattern/trend in your answer? If yes, can you determine the period of $x(n)$?

5. Find the *cross-correlation* sequence, $r_{xy}(l)$ of $x(n)=\left\{....,0,0,2,-1,3,7,\underset{\uparrow}{1},2,-3,0,0,...\right\}$ and $y(n)=\left\{....,0,0,1,-1,2,-2,\underset{\uparrow}{4},1,-2,5,0,0,...\right\}$.

6. Prove that $r_{xy}(l)=r_{yx}(-l)$. What is inference from this result?