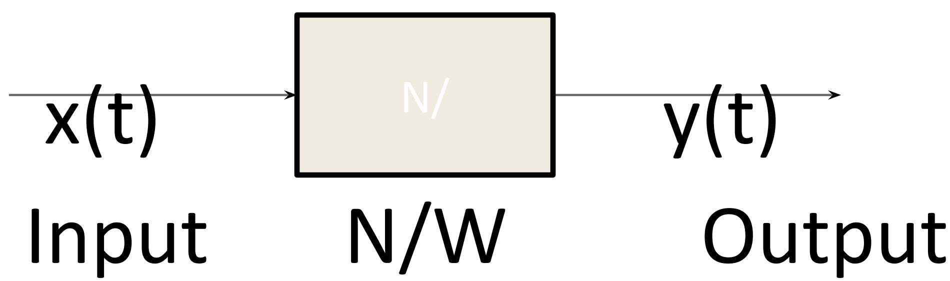
Network Analysis and Synthesis

1. Network Analysis.
2. Network Synthesis.



Linear Bilateral Network

1. Linear Network

Superposition theorem is applicable:

   (i) Additivity.

   (ii) Homogeneity.

2. Bilateral Network.

Reciprocity theorem is applicable.

Linear Time invariant system

1. Linear System:

   If for a system following equation is true;

   $\mathrm{T}[ax_1(t) + bx_2(t)] = ay_1(t) + by_2(t)$

   then the system will be termed as Linear system.

2. Time Invariant System:

   In this system; If $T[x(t)] = y(t) then$

   $T[x(t-\tau)] = \mathrm{y}(\mathrm{t}-\tau)$

LTI system cont.----

- Normally any random input signal can be expressed as a time Integral of scaled delayed unit impulses;

Means mathematically; if x(t)=0 for t<0 then;

$$x(\mathrm{t}) = \int_0^t x(\tau)\delta(t-\tau)d\tau$$

Here $\delta(t)$ is unit impulse signal defined as;

$$\delta(t) = \begin{cases} 1, t = 0 \\ 0, t \neq 0 \end{cases}$$

LTI system cont.----

- $x(\tau)$ is specific value of x(t) at t= τ,(a constant.) and $\delta(t-\tau)$ is delayed Unit impulse signal.

Hence we can say that above representation of x(t) is actually linear combination of delayed unit impulses.

LTI system cont.----

- If input x(t) is applied to LTI system then by applying linearity and time-invariance properties the output of the system y(t) will be given by;

$$y(t) = \int_0^t x(\tau)g(t-\tau)d\tau$$

Here g(t) is the output of the system for unit impulse signal $\delta(t)$, known as unit impulse response.

Above equation is known as Linear Convolution Integral representing Input-output relation of a LTI system.

LTI system cont.----

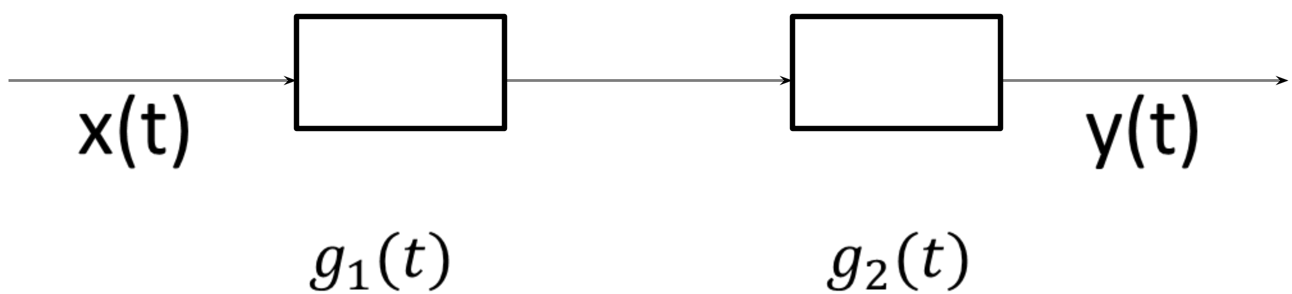
- LTI systems or networks are most important class of the systems as it shows 100% Fidelity towards complex exponentials. This makes the analysis of the systems very simple in frequency (Laplace) domain. We can explain 100% Fidelity as; for a sinusoidal input signal $x(t) = Asin\omega t$, if we get output of the system,

  $\mathrm{y}(t) = Bsin(\omega t + \emptyset)$ then the system shows 100% Fidelity for sinusoidal signals.

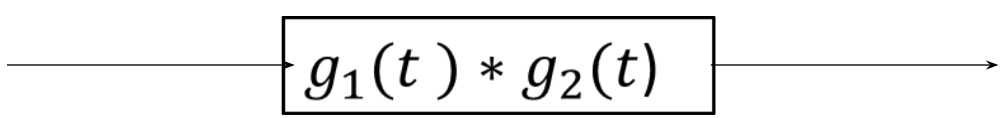
LTI system cont.----

- Interconnection of LTI systems;

1. Series Cascading:

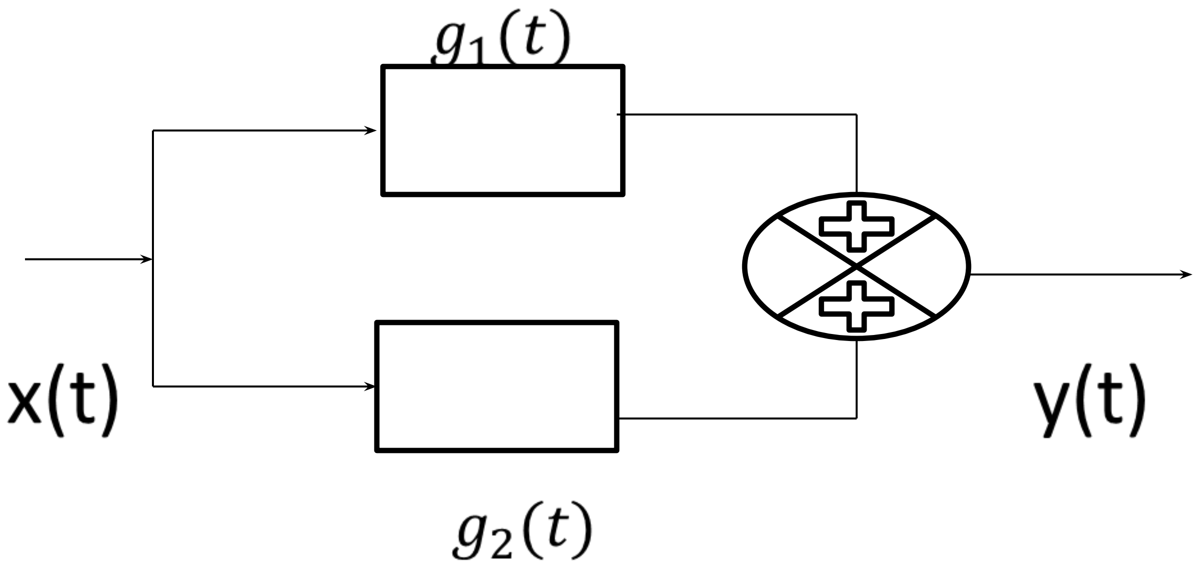


is equivalent to; (* denotes Linear convolution)



LTI system cont.----

- Parallel Interconnection:



equivalent unit impulse response will be; $g_1(t) + \; g_2(t)$

LTI system cont.----

- In LTI systems ;

  y(t) = x(t) * g(t) = g(t) * x(t) i.e.,

$$y(t) = \int_0^t x(\tau)g(t-\tau)d\tau = \int_0^t g(\tau)x(t-\tau)d\tau$$

Also one can show that linear convolution is distributive;

$$x(t) * [y(t) + z(t)] = x(t) * y(t) + x(t) * z(t)$$