SIGNALS & SYSTEMS

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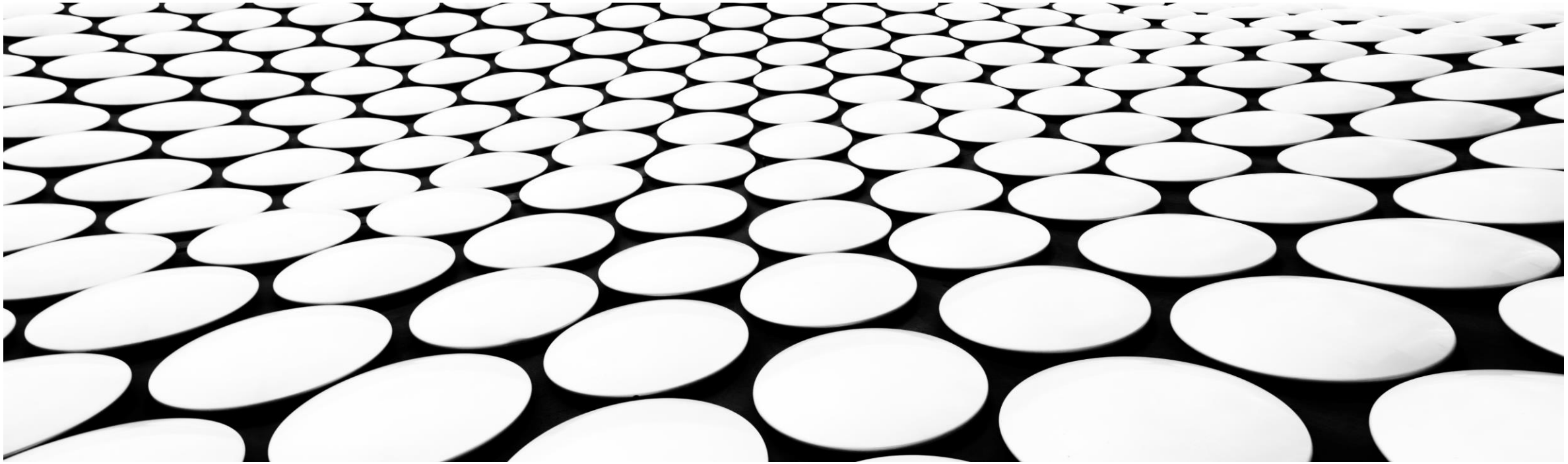
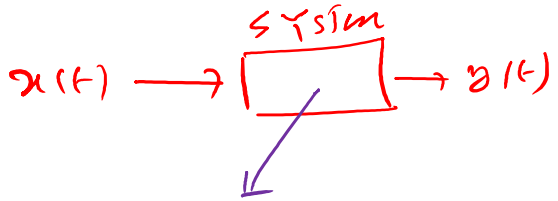


Response of LTI continuous system using convolution:-

$y(t) \longrightarrow x(t)$

$x(t)$ → arbitrary i/p to the system



$h(t)$ = impulse response of the system

$$y(t) = x(t) * h(t)$$

$$y(t) = \int_{-\infty}^{\infty} x(\lambda)\, h(t-\lambda)\, d\lambda$$

or,

$$y(t) = \int_{-\infty}^{\infty} x(\tau)\, h(t-\tau)\, d\tau$$

$$x(t) = \int_{-\infty}^{\infty} x(\lambda)\,\delta(t-\lambda)\,d\lambda$$ → as an integral impulses.

$\delta(t-\lambda)$ — delayed impulse response.

Let $y(t)$ be the response of system H for an i/p $x(t)$

$$\therefore y(t) = H\{x(t)\}$$

$$y(t) = H\left[\int_{-\infty}^{\infty} x(\lambda)\,\delta(t-\lambda)\,d\lambda\right]$$

$$= \int_{-\infty}^{\infty} H[x(\lambda)\,\delta(t-\lambda)]\,d\lambda$$

In linear system, system and integration operation can be interchanged

$$y(t) = \int_{-\infty}^{\infty} x(\lambda)\, H[\delta(t-\lambda)]\, d\lambda$$ → The system H is a fn of t and not a function of λ.

i/p → $\delta(t)$ → unit response → $h(t)$

response of $\delta(t)$

$$h(t) = H[\delta(t)]$$

$$\Rightarrow H[\delta(t-\lambda)] = h(t-\lambda)$$

$$y(t) = \int_{-\infty}^{\infty} x(\lambda)\, h(t-\lambda)\, d\lambda$$

properties of convolution:-

Commutative property $\Rightarrow x_1(t) * x_2(t) = x_2(t) * x_1(t)$

Associative property $\Rightarrow [x_1(t) * x_2(t)] * x_3(t) = x_1(t) * [x_2(t) * x_3(t)]$

Distributive property $\Rightarrow x_1(t) * [x_2(t) + x_3(t)] = x_1(t) * x_2(t) + x_1(t) * x_3(t)$

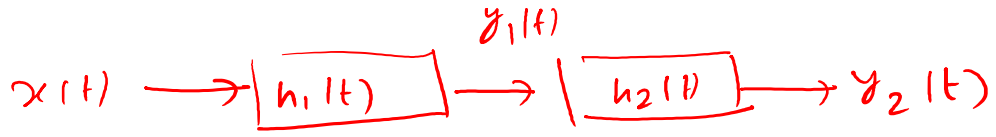
Interconnections of continuous time systems:-

Two basic ways to interconnect smaller continuous time systems to form a large system.

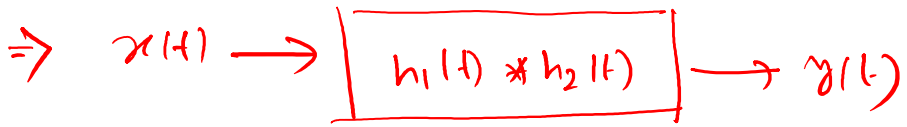
1) Cascade connected systems.

2) parallel connected system

Cascade connected system:-

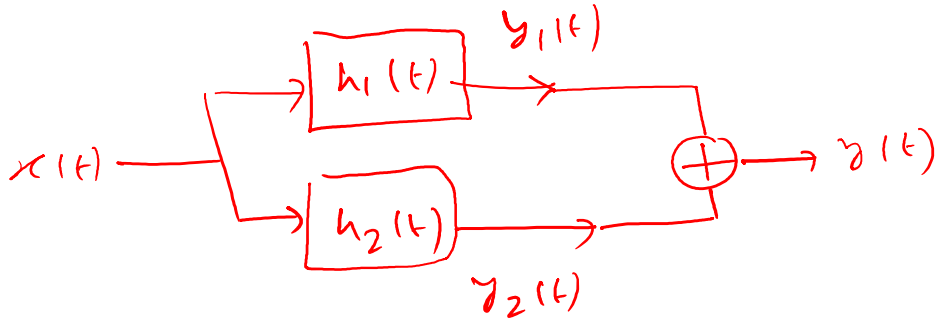


You can consider $y_2(t)$ as $y(t)$ final op

$\Rightarrow$ 

Convolution of individual impulse responses of system.

Parallel connected continuous time system:-



Overall system response is given as the sum of individual impulse response

$\Rightarrow$ $x(t) \longrightarrow \boxed{h_1(t) + h_2(t)} \longrightarrow y(t)$