DATE: SUBJECT:

Systems

the relationship between the input & output

$x(t) \longrightarrow$ [system] $\longrightarrow y(t)$

input output

ex:

- $y(t) = x^2(t)$
- $y(t) = abs(x(t))$
- $y(t) = \int_{-\infty}^{t} x(\tau)\, d\tau$
- $y[n] = 5\,x[n]$

Properties of systems

$x(t) \longrightarrow$ [S] $\longrightarrow y(t)$

* Memory

$y(t) = x^2(t)$ without memory

$y(t) = x(t-1)$ memory

$y(t) = x(t) * (t-1)$ without memory

$y[n] = [n-2]\, x[n-5]$ memory

$y(t) = (t+1)x(t)$ without

$y[n] = x[-n]$ memory

$y(t) = t\,x(t+1)$ memory

$y[n] = x[n+5]$ memory

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

Invertibilty

$x(t) \longrightarrow \boxed{\text{system1}} \longrightarrow y(t) \longrightarrow \boxed{\text{system2}} \longrightarrow x(t)$

* From knowing the output, we can get the input back.

$y(t) = x^2(t)$ — not inverting because we can't exaclty tell what the input was. $y(t) = 9$
$x_2(t) = \pm 3$? I don't know. we lost some info.

$y(t) = 3x(t)$ — invertable

$y(t) = \cos(t)\, x(t)$ — not inverting because when $\cos(\frac{\pi}{2}) = 0$, we don't know whether $t = \frac{\pi}{2}$ or the $x(t)$ was zero.
(Some times we lose some information)

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Causality

$$x(t) \longrightarrow \boxed{\text{system}} \longrightarrow y(t)$$

↓ depends only in the Current or past signal not the Future.

$y(t) = (t+5)\,x(t)$	Causal	"Current"
$y[n] = [n+10]\,x[n-10]$	Causal	"Past"
$y(t) = \cos(t+5)\,x(t+10)$	Not Causal	"future"
$y[n] = x[-n]$	Not Causal	"Sometimes future"
$y(t) = \int_{-\infty}^{\infty} x(\tau)\,d\tau$	Not Causal	"sometimes Future"

Stability

$x(t) \rightarrow \boxed{S} \rightarrow y(t)$

$y(t) \rightarrow \infty$ $x(t)$ is finite

unstable

- Stable system $\rightarrow$ output is finite when input is finite
- BIBO = Bounded input Bounded output
  FIFO
- when input is ∞ $\rightarrow$ never study stability "abnormal"

$y(t) = x^2(t) \rightarrow$ stable

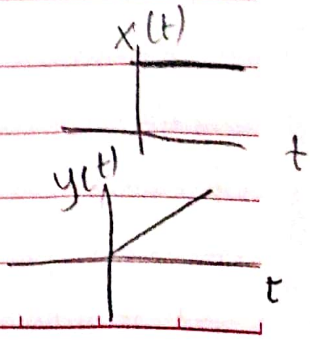
$y(t) = e^{x(t)} \rightarrow$ stable

$y(t) = t\,x(t) \rightarrow$ unstable " when $t=\infty$ "

$y(t) = \cos(t)\,x(t) \rightarrow$ stable " $-1 : 1$ "

$y(t) = \tan(t)\,x(t) \rightarrow$ unstable " ∞ "

$y(t) = \tan(x(t)) \rightarrow$ unstable



Time invarience

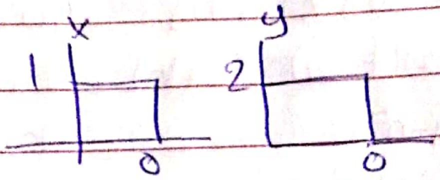
$x(t) \to \boxed{sys} \to y(t)$

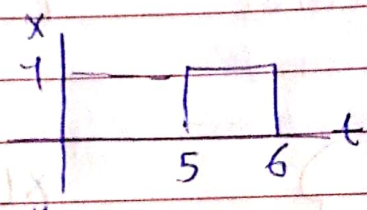
When the relationship doesn't vary with time

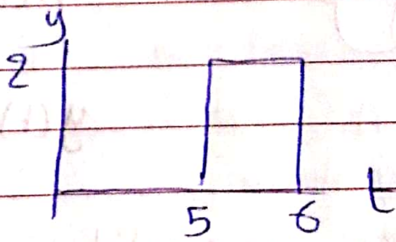
$x(t) \longrightarrow y(t)$

$x(t-t_0) \longrightarrow y(t-t_0)$

$y(t) = 2x(t)$

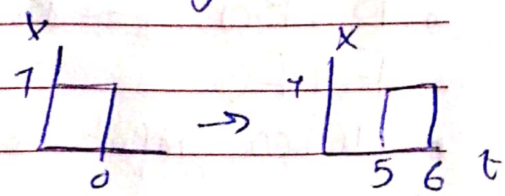


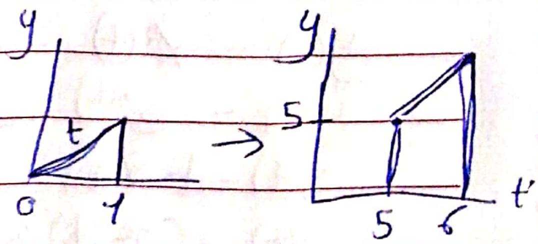




$y(t) = y(t-5)$, The same Performance at any time

$y(t) = t\,(x(t))$, NOT TI





not time invariant