

# TE201416: SINYAL DAN SISTEM

## SISTEM

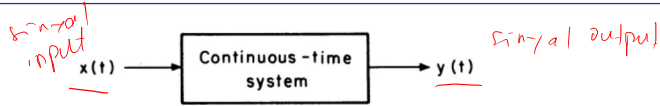


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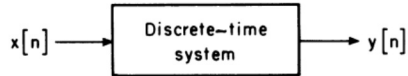
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Februari 26, 2020

# Definisi Sistem

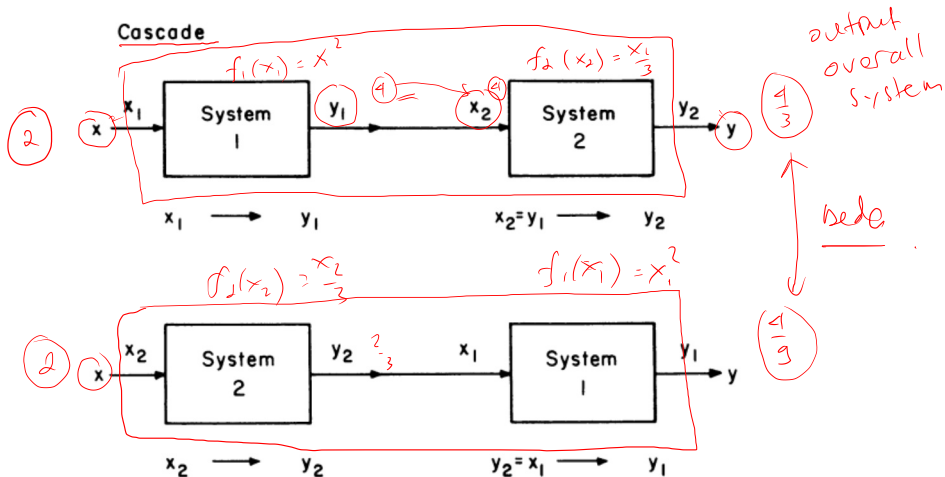


$$x(t) \longrightarrow y(t)$$



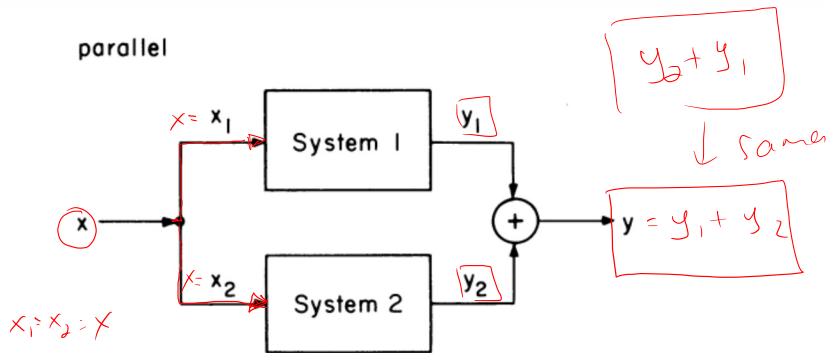
$$x[n] \longrightarrow y[n]$$

# Interkoneksi Antar Sistem



# Interkoneksi Antar Sistem

parallel

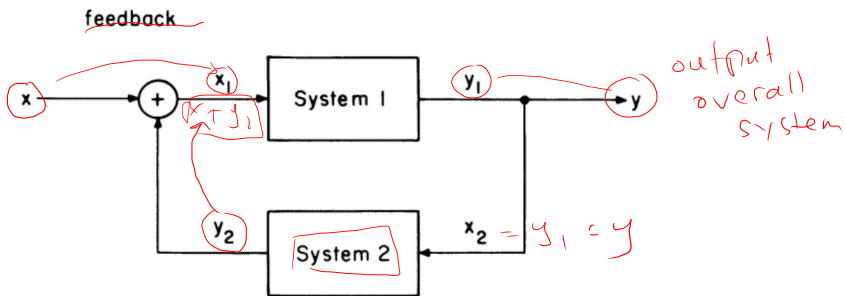


$$x_1 = x_2 = x$$

$$x_1 = x_2 = x$$

$$y = y_1 + y_2$$

# Interkoneksi Antar Sistem



$$x_1 = x + y_2$$

$$y = y_1$$

$$x_2 = y_1$$

# Karakteristik Sistem

## ① MEMORYLESS

$$y(t) @ t=t_0 \leftarrow x(t) @ t=t_0$$

$$y[n] @ n=n_0 \leftarrow x[n] @ n=n_0$$

### Examples

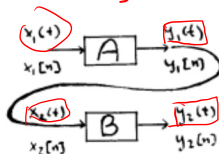
yes  $y(t) = x^2(t)$  Squarer  
 $y[n] = x^2[n]$

No  $y(t) = \int_{-\infty}^t x^2(\tau) d\tau$

Unit delay  
 $y[n] = x[n-1]$

## ② INVERTIBILITY

$$B = A^{-1}$$



$$x_2 = y_1$$

If  $\exists$  = Inverse of A

Then  $y_2 = x_1$   
Identity

System A:

$$y_1(t) = \int_{-\infty}^t x_1(\tau) d\tau$$

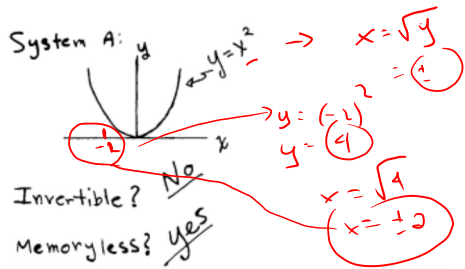
Integrator

System A<sup>-1</sup>:

$$y_2(t) = \frac{dx_1(t)}{dt}$$

differentiator

invertibility?



# Karakteristik Sistem

## ③ Causality

output at any time  
depends only on input  
prior or equal to that  
time

or:

system can't anticipate  
"future" inputs

or:

$$x_1(t) \rightarrow y_1(t) \quad \checkmark$$

$$x_2(t) \rightarrow y_2(t) \quad \checkmark$$

If:

$$x_1(t) = x_2(t) \quad t < t_0$$

Then:

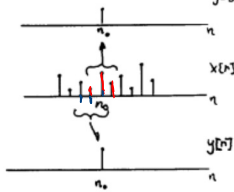
$$y_1(t) = y_2(t) \quad t < t_0$$

Same for discrete  
Time

Example:

$$y[n] = \frac{1}{3} \{x[n-1] + x[n] + x[n+1]\}$$

not  
Moving  
Average  
 $y[n]$



$$y[n] = \frac{1}{3} \{x[n-2] + x[n-1] + x[n]\}$$

causal

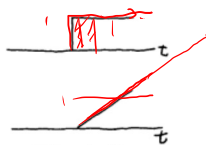
Stability

$\Rightarrow$  For every bounded  
input the output is  
bounded

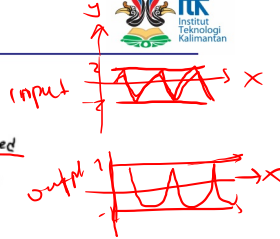
Example

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

not  
Stable



Stable?



# Karakteristik Sistem

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## Time Invariance

C-T;

$$x(t) \rightarrow y(t)$$

Then

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

D-T;

$$x[n] \rightarrow y[n]$$

Then

$$x[n-n_0] \rightarrow y[n-n_0]$$

## Example

$$y[n] = \sum_{k=-\infty}^n x[k]$$

Accumulation

$$y[n] = x(-\infty) + \dots + x[n]$$

Time Invariant? No

## Example

$$y(t) = \sin(t)x(t)$$

$$x(t) \rightarrow (\sin t)x(t)$$

$$x(t-t_0) \rightarrow (\sin t)x(t-t_0)$$

≠

$$y(t-t_0) = \sin(t-t_0)x(t-t_0)$$

Time Invariant? No

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## Linearity

C.T & D.T

$$x_1(t) \rightarrow y_1(t)$$

$$x_2(t) \rightarrow y_2(t)$$

Then:

$$ax_1(t) + bx_2(t) \rightarrow ay_1(t) + by_2(t)$$

## Examples

$$y(t) = \int_{-\infty}^t x(\tau) d\tau \quad \text{yes}$$

$$y[n] = 2x[n] + 3 \quad \text{No But}$$

$$y[n] = x^2[n] \quad \text{Not}$$

kombinasi linear  
thd input  
↓  
output  
kombinasi  
linear

increment  
linear