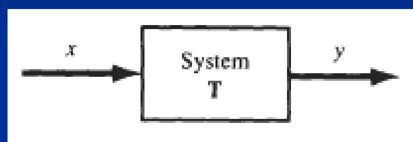
# Sistem

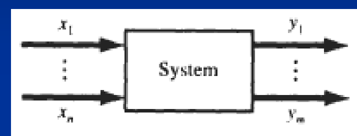
Dr. Risanuri Hidayat

## System

- System adalah
  - Interkoneksi dari komponen-komponen dengan terminal-terminal (masukan dan keluaran) materi, energi, atau informasi yang di dalamnya terdapat proses-proses tertentu
- Contoh system
  - Rangkaian elektronika
  - Robot
  - Pabrik/Industri
  - dll

## single or multiple

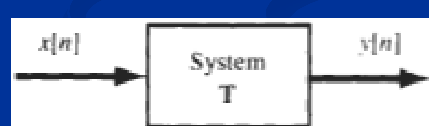



- System with single or multiple input and output signals.

## Continuous and Discrete Systems

- If the input and output signals x and y are continuous-time signals, then the system is called a ***continuous-time system***
- If the input and output signals are discrete-time signals or sequences, then the system is called a ***discrete-time system***

## Systems with Memory and without Memory

- **A** system is said to be ***memory-less*** if the output at any time depends on only the input at that same time.
- Otherwise, the system is said to have ***memory.*** An example of a memoryless system is a resistor R

$$y(t) = Rx(t)$$

•An example of a system with memory is a capacitor

$$y(t) = \frac{1}{C}\int_{-\infty}^{t} x(\tau)\,d\tau$$

## Causal and Non-causal Systems

- A system is called ***causal*** if its output ***y ( t )*** at an arbitrary time $t = t_0$, depends on only the input ***x ( t )*** for $t <= t_o$. That is, the output of a causal system at the present time depends on only the present and/or past values of the input, not on its future values.
- **A** system is called ***noncausal*** if it is not causal. Examples of noncausal systems are

$$y(t) = x(t+1)$$

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

all memory-less systems are causal, but not vice versa.

# Linear and Nonlinear Systems

- If the operator T satisfies the following two conditions, then T is called a linear operator and the system represented by a linear operator T is called a linear system:
  - ***Additivity,*** Given that $T\,x_1 = y_1$ and $T\,x_2 = y_2$

    $T(x_1 + x_2) = T\,x_1 + T\,x_2 = y_1 + y_2$
  - ***Scaling,*** for any signals x and any scalar a.

    $T\{ax\} = a\,T\,x = ay$

# Time-Invariant and Time-Varying Systems

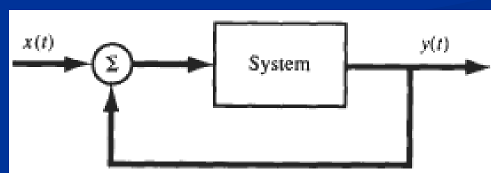
- A system is called time-invariant if a time shift (delay or advance) in the input signal causes the same time shift in the output signal.
- Thus, for a continuous-time system, the system is time-invariant if

$$\mathbf{T}\{x(t-\tau)\} = y(t-\tau)$$

**Linear Time-Invariant Systems**. If the system is linear and also time-invariant, then it is called a linear rime-invariant (LTI) system.

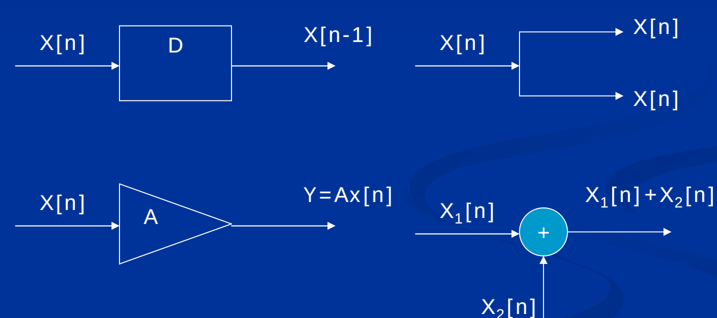
# Feedback Systems

- A special class of systems of great importance consists of systems having ***feedback.***
- In a ***feedback system,*** the output signal is fed back and added to the input to the system




# Penggambaran Sistem

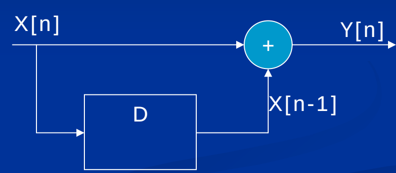
- Penggambaran sistem



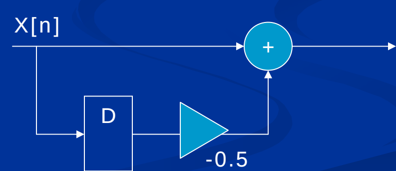
# Penggambaran Sistem

- Contoh

  y[n]=x[n]+x[n-1]




  y[n]=x[n]-0.5x[n-1]




# Penggambaran Sistem

- Integral

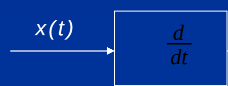

$$Y(t) = \int_{-\infty}^{t} x(p)dp$$

  • Diskret Integral / Summation


$$Y[n] = \sum_{k=-\infty}^{n} X[k]$$

# Penggambaran Sistem

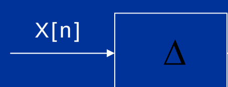
- Differensial




$$Y(t) = \frac{x(t+h) - x(t)}{h}$$

$$atau = \frac{x(t) - x(t-h)}{h}$$

- Differensial diskret / Differences



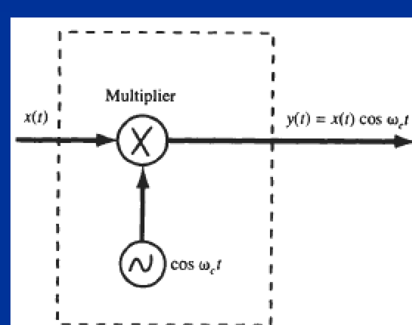

$$Y[n] = X[n] - X[n-1]$$

$$Y[n] = X[n+1] - X[n]$$

# Example

- Consider the system shown in Figure. Determine whether it is
  - (a) memoryless,
  - ***( b )*** causal,
  - ***( c )*** linear,
  - ***( d )*** time-invariant, or
  - ***( e )*** stable.

$$y(t) = \mathbf{T}\{x(t)\} = x(t)\cos\omega_c t$$



# Example

- (a) Since the value of the output ***y ( t )*** depends on only the **present values** of the input ***x ( t ) ,*** the system is memoryless.
- (b) Since the output ***y ( t )*** does not depend on the future values of the input ***x(t),*** the system is causal.
- (c) Let ***x ( t ) = a1 x ( t ) + a2 x ( t ) .*** Then

  ***y ( t ) = T { x ( t ) } = [ a 1 x 1 ( t ) + a 2 x 2 ( t ) ]*** cos ***wt***

  = ***a 1 x1 ( t )*** cos ***wt*** + ***a 2 x 2 ( t )*** cos ***wt***

  = a***1 y1 ( t ) + a2 y 2 ( t )***

  Thus, the superposition property is satisfied and the system is linear.

# Example

- *(d)* Let *y1(t)* be the output produced by the shifted input *x1(t) =x(t -to)*. Then

  *y 1 ( t ) = T { x ( t - t o ) ) = x ( t -* to)cos *wct*

  But

  $$y(t - t_0) = x(t - t_0)\cos\omega_c(t - t_0) \neq y_1(t)$$

  Hence, the system is not time-invariant.
- ***( e )*** Since cos ***w,t <=*** 1, we have

  $$|y(t)| = |x(t)\cos\omega_c t| \leq |x(t)|$$

- Thus, if the input *x ( t )* is bounded, then the output *y(t)* is also bounded and the system is stable.