CM03-220913화

2022년 9월 13일 화요일 10:50

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Announcements

1. HW#1 is not yet assigned. It will be available from the PLMS soon.

Overview

1. Signals and Systems
2. Linear Time-Invariant (LTI) Systems
3. Fourier Series **Representation** of Periodic Signals
4. Continuous-time Fourier Transform (CTFT)
5. Discrete-time Fourier Transform (DTFT)
6. Time and Frequency **Characterization** of Signals and Systems
9. Laplace Transform
10. Z-transform
7. Sampling
8. Communication Systems

Review

1. A system is a mapping rule from an input to an output.
   - A source has only an output. A sink has only an input.
2. A input or an output is called a signal.
3. a block diagram: system, source, sink, input, output, signal
4. As a signal, we use a mathematical entity such as
   - a real-valued/complex-valued scalar
   - a vector
   - a matrix
   - a tensor
   - a sequence of
     - scalars
     - vectors
     - matrices
     - tensors

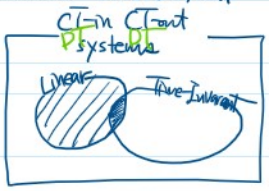
   =a scalar/vector/matrix/tensor-valued discrete-time signal =
   - a scalar/vector/matrix/tensor-valued function of a continuous parameter = a continuous-time signal = a waveform
   - a polynomial
   - a graph
   - a scalar/vector field, etc.
5. a DT signal and a CT signal
   - x = 0 vs x[n] = 0

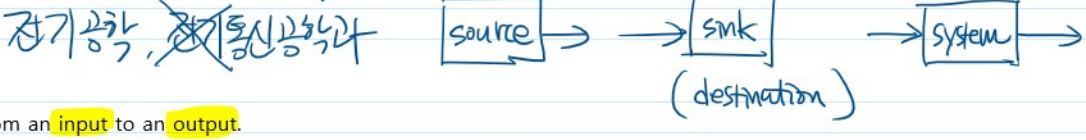
Caution

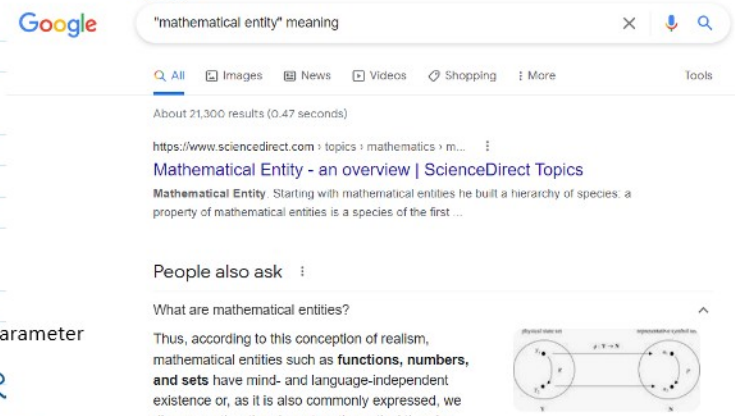
1. a function and its graph
   a. a discrete-time signal and the stem function in the MATLAB
2. a discrete-time signal vs a digital signal

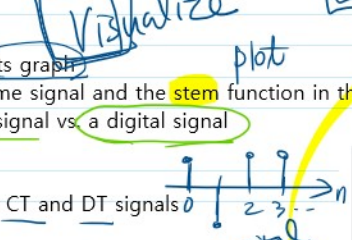
Preview

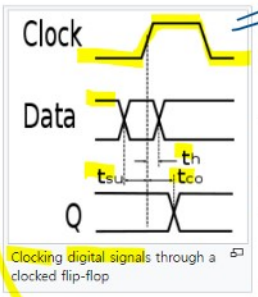
1. classifications of CT and DT signals
2. a system
   - a CT system
   - a DT system



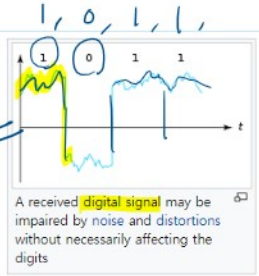




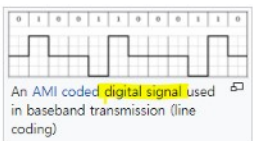


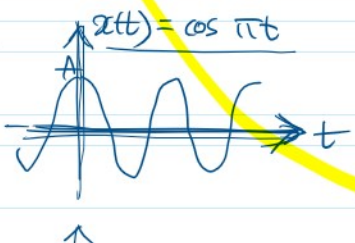


Clocking digital signals through a clocked flip-flop



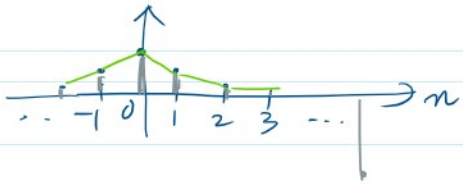
A received digital signal may be impaired by noise and distortions without necessarily affecting the digits


An AMI coded digital signal used in baseband transmission (line coding)

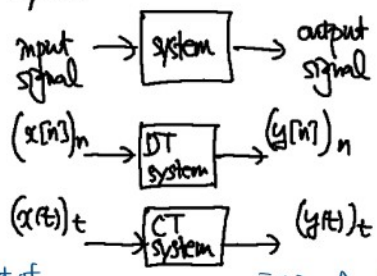


$g: \mathbb{Z} \to \mathbb{Z}$

$g[n] = \left(\frac{1}{2}\right)^{-|n|}$

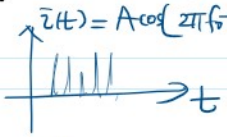


- system



set of all s. EECE 233 22-2

$x(t) = A\cos(2\pi f_0 t)$



classification

aperiodic

all CT signals

periodic signals

non-periodic aperiodic

dichotomy

binary

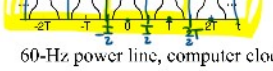
modeling

Signals with symmetry

- Periodic signals

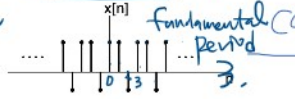
CT $x(t) = x(t+T)$, $\forall t \in \mathbb{R}$

T is a period. 2T, ...



Ex. 60-Hz power line, computer clock, etc.

DT $x[n] = x[n+N]$, $\forall n \in \mathbb{Z}$



fundamental period

capital N

cap N

Def. "A CT signal $x(t)$ is periodic" if $\exists T > 0$ s.t. $x(t) = x(t+T)$, $\forall t$

Lemma.

If $T > 0$ is a period of $x(t)$, then mT " also a period for all $m \in \mathbb{N}$.

Def. For a periodic $x(t)$, the minimum period is called the fundamental period.

Example

cos wot

"period" — existence, uniqueness

Fundamental Period

$x(t) = \begin{cases} 1, & \text{for } t \in \mathbb{Q} \\ 0, & \text{for } t \notin \mathbb{Q} \end{cases}$

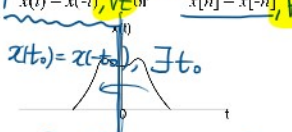
Cantor Dini ...

Signals with symmetry (continued)

- Even and odd signals

Even $x(t) = x(-t)$, $\forall t$ or $x[n] = x[-n]$, $\forall n$

$t \in (-\infty, \infty)$

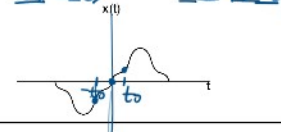


$x(t_0) = x(-t_0)$, $\exists t_0$

Odd $x(t) = -x(-t)$ or $x[n] = -x[-n]$, then

$x(0) = 0$

or $x[0] = 0$



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for sufficiently large t

$\lim_{t \to \infty}$

for sufficiently small x

$\lim_{x \to 0}$

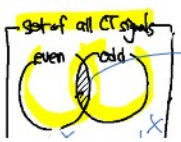
$x(t) = 0$, $\forall t$ $\quad$ $x(t) = A\cos(2\pi f_0 t)$ TO

$f(x) = f_e(x) + f_o(x)$, $\forall x$

where

Signals with symmetry (continued)

- Any signals can be expressed as a sum of *Even* and *Odd* signals. That is,



$x(t) = 0$, $\forall t \in \mathbb{R}$

$f(x) = f_e(x) + f_o(x)$, $\forall x$

where

$f_e(x) \triangleq \frac{f(x)+f(-x)}{2}$

"sub" subscript 이것처럼

$f_o(x) = \frac{f(x)-f(-x)}{2}$

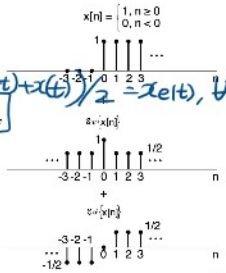
Signals with symmetry (continued)

- Any signals can be expressed as a sum of *Even* and *Odd* signals. That is:

$$x(t) = x_{even}(t) + x_{odd}(t),$$

where $x_e(-t) = (x(-t)+x(t))/2 = x_e(t), \forall t$

$$x_{even}(t) = [x(t) + x(-t)]/2,$$
$$x_{odd}(t) = [x(t) - x(-t)]/2.$$



Ex. DT unit-step function.

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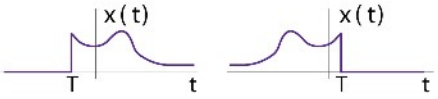
Right- and Left-Sided Signals

A right-sided signal is zero for $t < T$ and a left-sided signal is zero for $t > T$, where T can be positive or negative.



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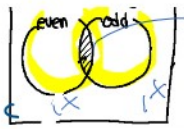

$x(t) = 0, \forall t \in \mathbb{R}$

Claim. Any CT signal $x(t)$ can be represented as

$x(t) = x_e(t) + x_o(t)$

where $x_e(t) = x_e(-t), \forall t$ & $x_o(t) = -x_o(-t), \forall t$.

$x_e(t) \triangleq \frac{x(t)+x(-t)}{2}$, $x_o(t) \triangleq \frac{x(t)-x(-t)}{2}$

Claim. $x(t) = x_{CS}(t) + x_{CAS}(t)$. Q. How?

Conjugate symmetric

" anti-symmetric

$x_{CS}(t) = x_{CS}^*(-t), \forall t$

$x_{CAS}(t) = -x_{CAS}^*(-t), \forall t$

cf) $A = \frac{A+A^T}{2} + \frac{A-A^T}{2}$ when A is square.

$A = \frac{A+A^H}{2} + \frac{A-A^H}{2}$