

CM03 230912T

Announcements

1. 지난 강의 수정 사항

N/A

2. LN#1 and #2 are updated. Please reload them.

3. HW

- HW02 will be assigned soon. Due will be next Tuesday. For details, check the PLMS class homepage.
 - Upper- and lower-case Greek letters

4. 강의 자료

- Handouts and annotated pdfs are downloadable from the non-PLMS class homepage at <http://cisl.postech.ac.kr/class/eece233/schedule.html>.
- Recorded CMs are available from cisl.postech [YouTube channel](#). Please place clickable time stamps.

5. 출석

- 수강변경기간(2023. 9. 4(월) ~ 9. 13(수)) 중의 수업, 중간 및 기말 시험일을 포함하여 전체 Class Meeting (CM) 약 30회중 1/4이하의 무단 결석(지각 2회 = 1회 무단 결석)은 성적에 영향을 주지 않습니다.
- CM01, 02 출결상태에 대해 전자출결시스템(<https://wpse.postech.ac.kr/eams/login>)에 수정입력해 놓았습니다. 정정사항이 있는 학생은 사유를 제출해 주세요. 첫날 강의에서 설명했듯, 앞으로는 따로 공지가 없어도 각 수강생이 직접 시스템 입력 상태를 확인하고 정정사항을 사유와 함께 알려 주셔야 합니다.

6. 관련 개설과목 23-2학기

EECE233 [신호 및 시스템](#)

EECE341 [정보통신공학 개론](#)

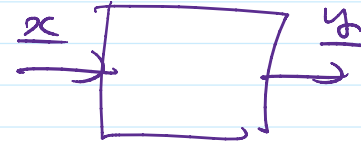
EECE443/NGCN302 [통신 및 네트워크 실험](#)

CSED 221 컴퓨터 SW 시스템 개론

CSED 331 알고리즘

MATH 203 응용선형대수

$$\underline{y} = A \underline{x}$$



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신규게시물

- 공지사항
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- 식단 | 교통 | 편의시설

업무활용자료

- 규정/지침
- 청탁금지법
- 서식
- 현황
- 매뉴얼
- 프로세스

회의자료

- 일반회의
- 교수회의
- 주임 교수간담회
- 대학평의원회
- 교수평의회

문의응답

교내회보

공지사향 > 교내회보

부서(학과) 단위의 공식적인 내용을 구성원에게 안내하는 게시판입니다
This bulletin board informs university members of official departmental (team) news

전체 일반 학사 연구 세미나/강연

[프린트] [스크랩] [목록]

제목 : [학사] 산학장학생 연계 차세대통신 및 네트워크 융합부전공생 모집 재안내 (Announcement on submission of NGCN Minor Petitions)

작성자 : 전자컴퓨터융합공학부 행정팀/전자컴퓨터융합공학부 등록일 : 1 일전 조회수 : 63

첨부파일 : 차세대통신 및 융합부전공 신청 양식.docx [Download] [Preview]

*This announcement only applies to undergraduate students. Please note that this announcement will be offered only Korean.

산학장학생 연계

차세대통신 및 네트워크 융합부전공생 모집 안내

(Announcement on submission of Next Generation Communications and Network Minor Petitions)

1. 차세대통신 및 네트워크 융합부전공 소개

4차 산업시대의 근간이 되는 5G, 6G 이동통신 및 네트워크 분야의 급속한 발전에 따라 하드웨어와 소프트웨어 지식과 소양을 모두 갖춘 융합형 인재의 양성이 요구됩니다. 삼성전자(DX부문: 네트워크 사업부)는 차세대통신 분야에 대한 관심을 바탕으로 대학과의 협력을 통해 차세대통신 분야에 대한 인재를 양성하기 위하여 산학장학생을 선발합니다. 이번에는 차세대통신 및 네트워크 융합부전공생 모집을 위한 것입니다. 모집 대상은 2024년 2학기 입학 예정인 고등학교 졸업 또는 동등한 학력자를 대상으로 하며, 모집 분야는 차세대통신 및 네트워크 융합부전공입니다. 모집 인원수는 총 10명이며, 모집 마감일은 2024년 1월 15일까지입니다. 자세한 내용은 첨부된 신청 양식을 참조하십시오.

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감사나눔/봉사
동호회 동아리
버룩시장
카툰 분실/습득
부서게시판
자유토론

1. 석·박사과정 및 개편된 융합전공 소개

4차 산업시대의 근간이 되는 5G, 6G 이동통신 및 네트워크 분야의 급속한 발전에 따라 하드웨어와 소프트웨어 지식과 소양을 모두 갖춘 융합형 인재의 양성이 요구됩니다. 삼성전자(DX부문: 네트워크 사업부, 삼성리서치, MX사업부)의 지원을 받아 전자전기공학과와 컴퓨터공학과와의 해당 교과목을 기반으로 맞춤형 필수 개론 과목, 선택 실험 과목을 추가 개설하여 학문적 수월성과 기업의 요구 사항에 부응하는 성공적인 산학연계 융합교육의 모델을 제시, 운영하고자 합니다.

2. 융합부전공 신청방법

- 1) 융합부전공 신청학과와 전공과목 일부를 한 학기 전 미리 이수
- 2) 융합부전공 신청: **첨부된 신청 양식 작성 후**

차세대 통신 및 네트워크 융합부전공 행정팀(jk02140@postech.ac.kr)으로 메일 전달

* 첨부 양식 내 '**본인 서명 및 지도교수 서명**' 작성 후 신청 가능
산학 장학생 신청은 매년 3월과 9월 중에 있습니다.

융합부전공 신청기간 : 9/1(금) ~ 9/13(수)

***융합부전공은 전공무관 신청가능**

***산학장학 선발기간은 상이하니 아래의 선발 프로세스 참고**

7. Overview (The numbers are the chapter numbers of the textbook)

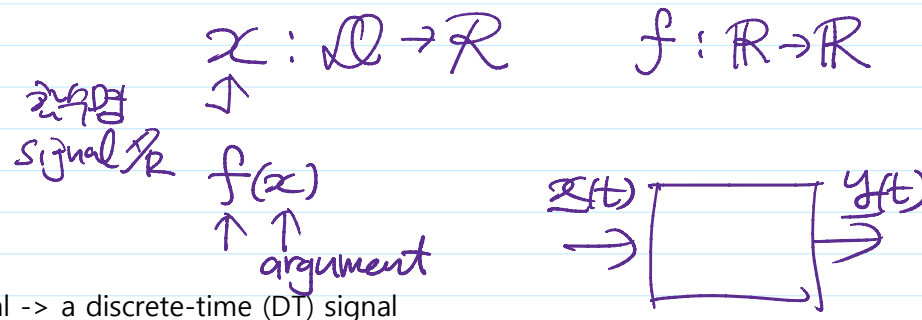
1. Signals and Systems
2. Linear Time-Invariant Systems
3. Fourier Series Representation of Periodic Signals
4. Continuous-time Fourier Transform
5. Discrete-time Fourier Transform
6. Time and Frequency Characterization of Signals and Systems
9. Laplace Transform
10. Z-transform
7. Sampling
8. Communication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

8. Review

- A **system** is a mapping rule from a domain to a range.

○ The domain is a set of every admissible input signal.

- 0-D: a scalar
- 1-D: a vector
- 2-D: a matrix
- 3-D: a tensor
- 1-D: a sequence of scalars -> a discrete-parameter signal -> a discrete-time (DT) signal



- 1-D: a waveform or a function $\rightarrow$ a continuous-parameter signal $\rightarrow$ a continuous-time (CT) signals
- 1-D or 2-D: a sequence of $M \times 1$ vectors
- 1-D or 3-D: a sequence of $M \times N$ matrices
- n-D: field
- polynomial
- graph etc.

$G(E, V)$

manifold

- The range is the set that includes the set of possible output signals.
- Any set can be a domain.
- Among every possible pair of a domain and a range, we mainly consider in this course 4 combinations:
 - a CT system: a CT signal goes in and a CT signal comes out
 - a DT system: a DT signal goes in and a DT signal comes out
 - a CT/DT converter: a CT signal goes in and a DT signal comes out
 - a DT/CT converter: a DT signal goes in and a CT signal comes out

EECE233 Signals and Systems

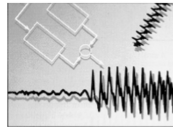
Lecture Note #1

Prof. Joon Ho Cho

(Slides thanks to Qing Hu*, D. Boning, D. Freeman, T. Weiss, J. White, and A. Willsky)

- 1) Administrative details
- 2) Signals

* These lecture notes are based on the lecture notes used in 6.003 taught by Prof. Qing Hu at M.I.T. These notes are adopted for EECE233 under the permission of Prof. Qing Hu.



1

Signals and Systems

EECE233 is about using mathematical techniques to help analyze and synthesize systems which process signals.

- Signals are variables that carry information.
- Systems process input signals to produce output signals.

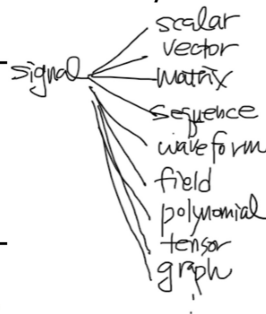
Today: Signals, next lecture: Systems.

2

Examples of signals

- Electrical signals --- voltages and currents in a circuit
- Acoustic signals --- audio or speech signals (analog or digital)
- Video signals --- intensity variations in an image (e.g. a CAT scan)
- Biological signals --- sequence of bases in a gene
⋮
- In EECE233, we will treat **noise** as unwanted signals

3

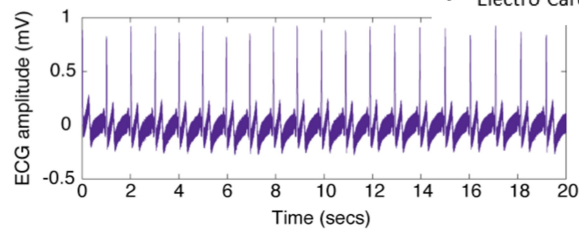


Signal Classification

Type of Independent Variable

Time is often the independent variable. Example: the electrical activity of the heart recorded with chest electrodes — the electrocardiogram (ECG or EKG).

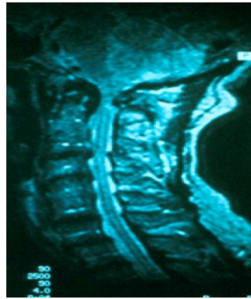
- Electro Cardio Gram 심전도



4

The variables can also be spatial

Eg. Cervical MRI



In this example, the signal is the intensity as a function of the spatial variables x and y .

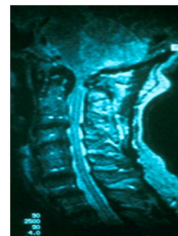
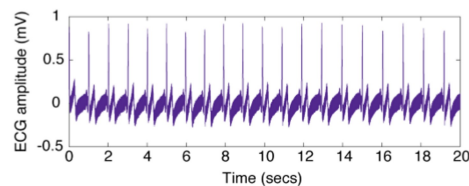
- cervical: 목의
- The left signal can be modeled as, e.g.,
 $x: \{1, 2, \dots, 800\} \times \{1, 2, \dots, 600\} \rightarrow [0, 1]$
Since the domain is 2-D, this signal is a 2-D signal.

5

$$\mathbb{R}^2 \Rightarrow (0,0)$$
$$\mathbb{R} \times \mathbb{R}$$

Independent Variable Dimensionality

An independent variable can be 1-D (t in the EKG) or 2-D (x, y in an image).

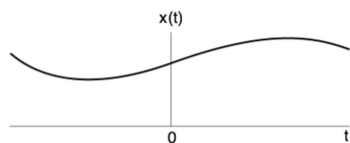


In EECE233, focus on 1-D for mathematical simplicity but the results can be extended to 2-D or even higher dimensions. Also, we will use a generic time t for the independent variable, whether it is time or space.

6

↙
(✓)

Continuous-time (CT) Signals



- Most of the signals in the physical world are well modeled by CT signals, where the time scale is infinitesimally fine, so are the spatial scales. E.g. voltage & current, pressure, temperature, velocity, etc.

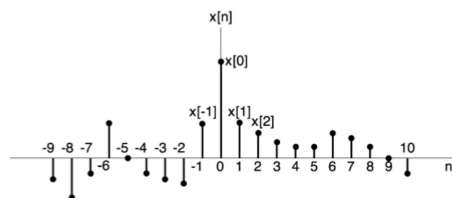
↙ $t \in \mathbb{R}$

$x(t), y[n]$
↘ $n \in \mathbb{Z}$

↘ x
 x_t, y_n
↑ subscript

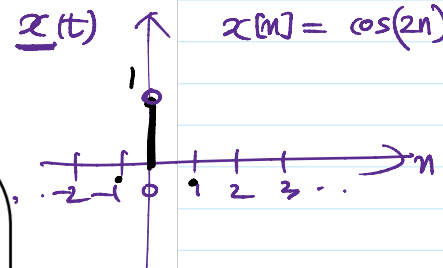
Discrete-time (DT) Signals

- $x[n]$, n — integer, time varies discretely



- Examples of DT signals in nature:
 - DNA base sequence
 - Population of the n th generation of certain species

- Notation in EECE233: $x(t)$ — CT, $x[n]$ — DT



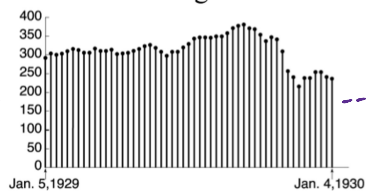
$x: \mathbb{Z} \rightarrow \mathbb{R}$
 $x[n] = \cos(2n)$

plot
stem

Many human-made Signals are DT

DIA

Ex.#1 Weekly Dow-Jones
industrial average



Ex.#2 digital image



Ex.#3. ticking clock

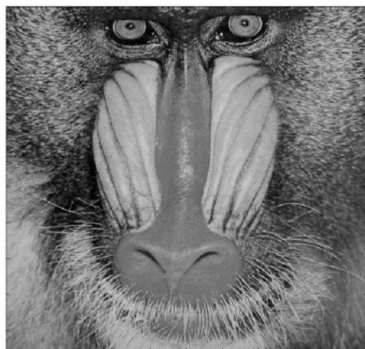
⋮

Why DT? — Can be processed by modern digital computers
and digital signal processors (DSPs).

9

Mandrill Example

Unblurred Image & No Noise

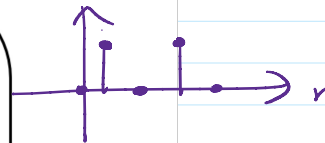
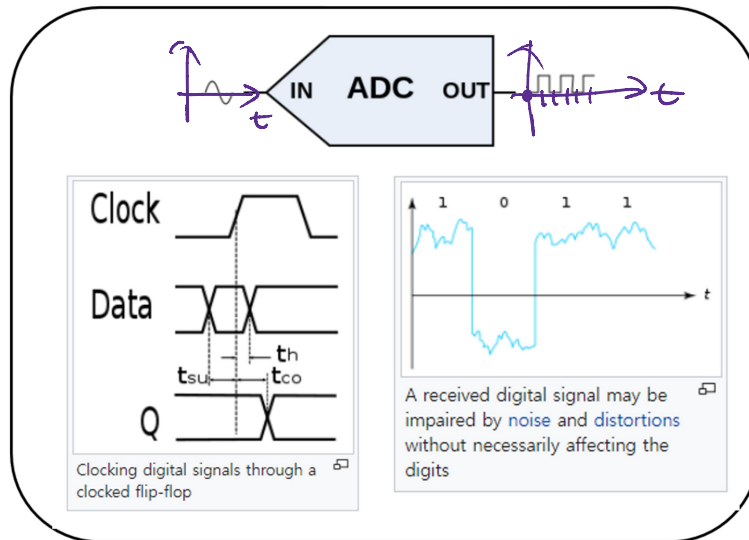


10

- a scalar: a 0-D signal because $x: \{1\} \rightarrow \mathbb{R}$
- a vector: a 1-D signal because $x: \{1, \dots, 300\} \rightarrow \mathbb{R}$
- a matrix: a 2-D signal because $x: \{1, \dots, M\} \times \{1, \dots, N\} \rightarrow \mathbb{R}$
- a 60 FPS BW video of 600x300 pixels
 - ◆ a (2-D matrix-valued) 1-D signal $X[n]$ because $x: \mathbb{Z} \rightarrow$ a set of 1-bit 600x300 BW images
 - ◆ a (scalar-valued) 3-D signal $X_n[k, l]$ because $x: \mathbb{Z} \times \{1, \dots, 300\} \times \{1, \dots, 600\} \rightarrow \{0, 1\}$

$$X[n] \in \mathbb{R}^{600 \times 300}$$

11



12

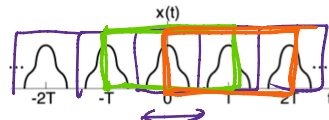
Signals with symmetry

- Periodic signals

CT

$$x(t) = x(t + T) \text{ for all } t.$$

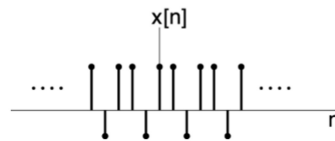
definition, existence, uniqueness; a, an, the
정의, 존재성, 유일성



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

DT

$$x[n] = x[n + N] \text{ for all } n.$$



13 a nonl positive # T.

Def. A CT signal $x(t)$ is periodic, if there exists $T > 0$ s. t. $x(t) = x(t+T)$, for all t .

Lemma. If periodic, then there exists $T > 0$ s. t. $x(t) = x(t+nT)$, for all t and all integer n .
 $t \in [0, T)$

Def. For a periodic signal, the smallest period is called the fundamental period, if exists.

Lemma. For a periodic signal with fundamental period T_0 , any period is an integer multiple of T_0 .

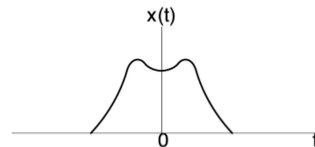
Signals with symmetry (continued)

- Even and odd signals

Even

$$x(t) = x(-t) \quad \text{or} \quad x[n] = x[-n]$$

짝우,
우함수

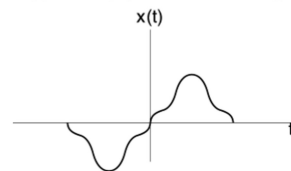


Odd

$$x(t) = -x(-t) \quad \text{or} \quad x[n] = -x[-n]$$

$$x(0) = 0$$

or $x[0] = 0$

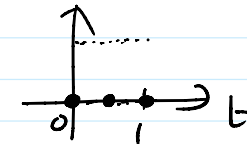


The zero function is even and odd at the same time.

the set of all CT signals
the subset of all periodic signals

the set of all DT signals

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



(가장) 1/2, 1/3, 1/4, ...