



Medical Communication System

نظم اتصالات طبية

Signals and System

Third Stage

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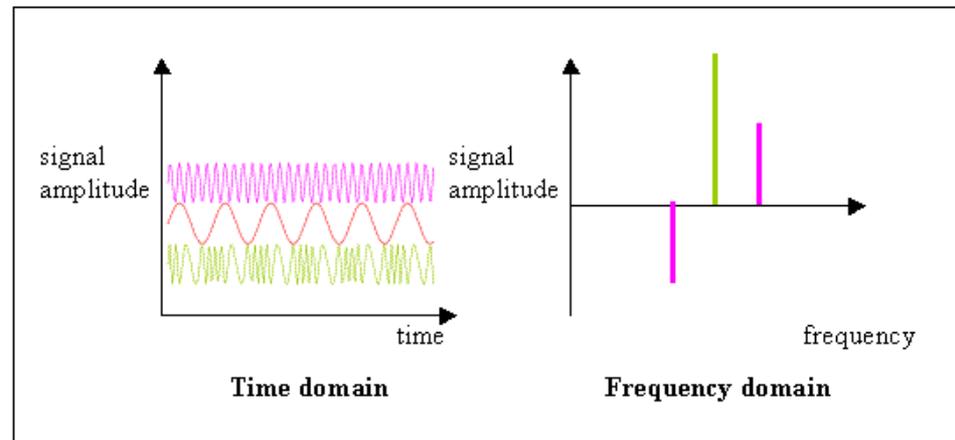
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Introduction



The goal of this lecture is to introduce the fundamental concepts of signals and systems, providing a solid foundation for future topics. In this lecture, we will explore these concepts in detail.

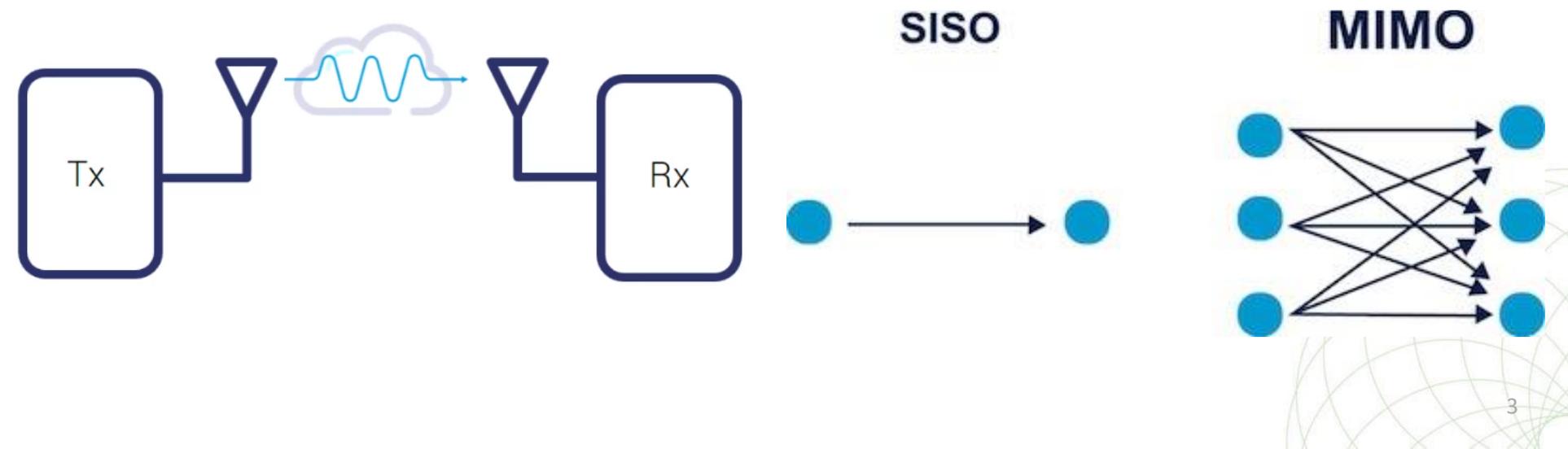
- **Signals** are an essential part of our daily lives. Any entity that conveys information is considered a signal. A signal is defined as a physical quantity that changes over time, space, or any other independent variable. Signals can be represented in two primary domains:
 - **Time Domain:** Representation of a signal as it varies with time.
 - **Frequency Domain:** Representation of a signal in terms of its frequency components.



Introduction



- **A system** is defined as a collection of elements or fundamental blocks that are connected and work together to produce an output based on an input signal. Systems can be classified as:
- **Single-Input Single-Output (SISO)** systems: Systems with one input and one output.
- **Multi-Input Multi-Output (MIMO)** systems: Systems with multiple inputs and outputs.



Introduction



The Communication Process:

The process of communication involves three key steps:

- ❖ **Generation of Signal:** Creation of the initial signal to be transmitted.
- ❖ **Transmission of Signal:** Sending the signal through a medium (e.g., air, cable).
- ❖ **Reception of Signal:** Receiving and interpreting the transmitted signal at the destination.



Classification of Signals



There are several classes of signals. Anyway, we shall consider the following classes, which are required in next lectures.

- Continuous-Time and Discrete-Time Signals.
- Analog and Digital Signals.
- Periodic and Non periodic Signals.
- Even and Odd Signals.
- Energy and power signals

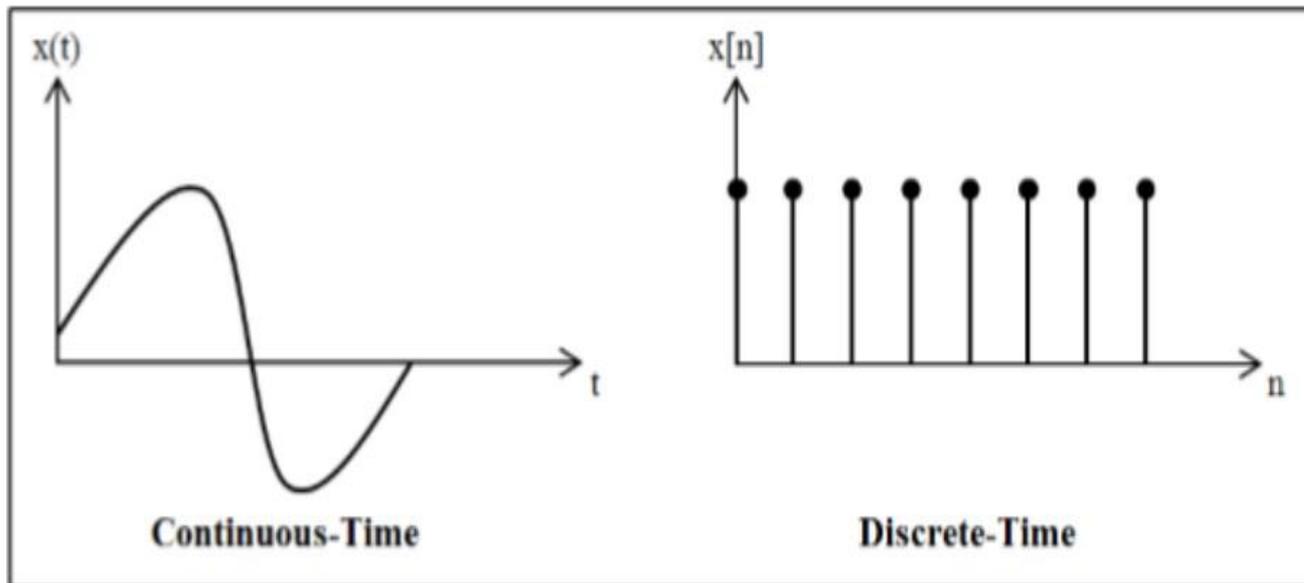


Continuous-Time and Discrete-Time Signals



A Continuous-Time (CT) signal is a signal that is defined and exists for every instant of time. These signals are represented by a continuous function and can take any value at any given point in time.

A Discrete-Time (DT) signal is defined only at specific intervals of time. These signals are represented as sequences of values at discrete time instances, typically obtained by sampling a continuous-time signal.

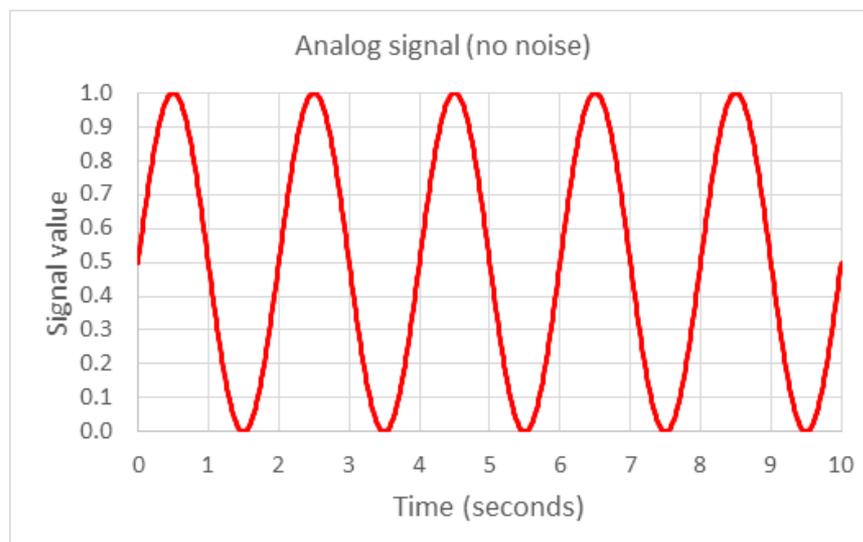


Analog and Digital Signals



An Analog Signal is a continuous signal that can take any value within a given range over time. It represents data in a physical form and can change smoothly and continuously.

- **Sound Waves:** A microphone converts sound waves into an analog electrical signal, where voltage varies continuously.
- **Temperature Readings:** A thermometer that shows temperature as a continuous reading is an analog device.
- **Radio Signals:** FM and AM radio transmissions are examples of analog signals.

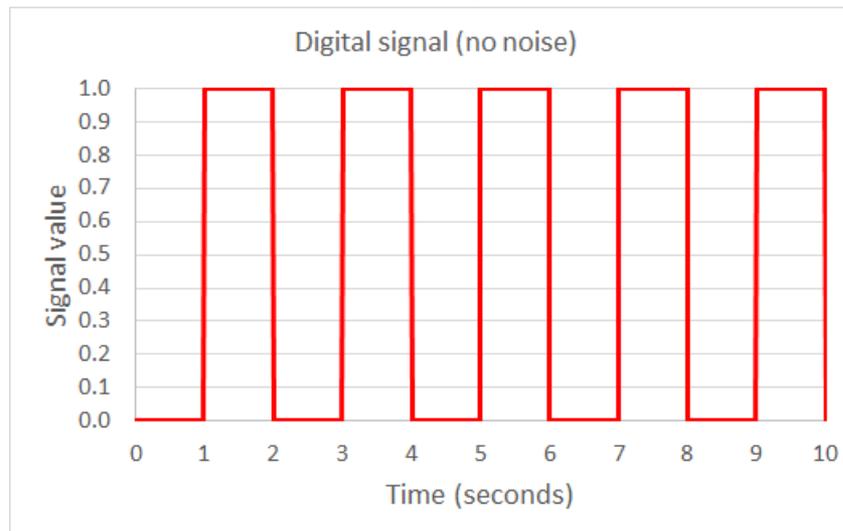


Analog and Digital Signals



A Digital Signal is a signal that can take only a finite number of distinct values, typically two values: 0 and 1 (binary). It represents data in discrete steps and is used in modern computing and digital communication systems.

- **Binary Data:** Data stored on a computer, where 0s and 1s represent information.
- **Digital Audio:** Music stored in MP3 format is a digital signal, where sound is represented in binary.
- **Digital Video:** Videos stored in digital formats such as MP4 are encoded as digital signals.



Differences Between Analog and Digital Signals



Feature	Analog Signals	Digital Signals
Nature	Continuous, smooth variations in value.	Discrete, step-like variations with fixed values (e.g., 0 and 1).
Range of Values	Infinite range of values within a given range.	Finite set of values (typically binary: 0 or 1).
Susceptibility to Noise	Highly susceptible to noise and distortion.	Less susceptible to noise due to discrete nature.
Processing	Requires analog systems for processing (e.g., amplifiers).	Processed by digital systems (e.g., computers, microprocessors).
Storage	Stored on analog media (e.g., magnetic tapes, vinyl records).	Stored on digital media (e.g., CDs, DVDs, hard drives).

Even and Odd Signals



A signal $x(t)$ or $x[n]$ is referred to as an *even* signal if

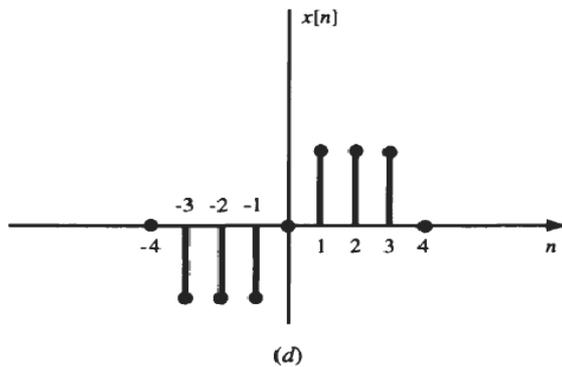
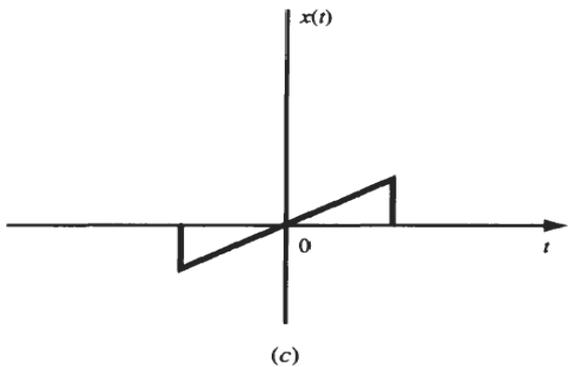
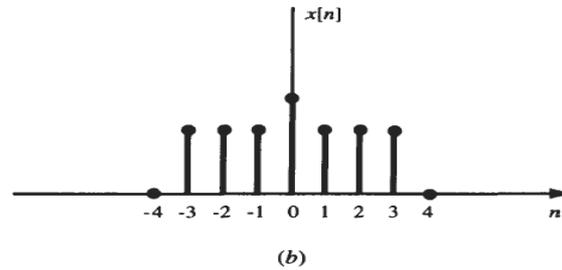
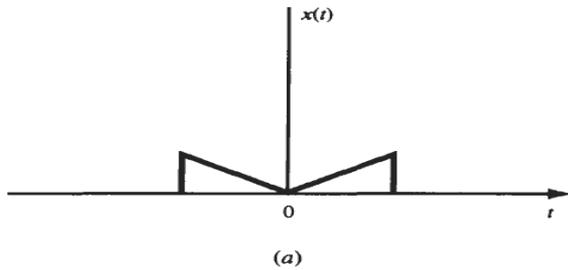
$$X(-t) = X(t)$$

$$X[-n] = x[n]$$

A signal $x(t)$ or $x[n]$ is referred to as an *odd* signal if

$$x(-t) = -x(t)$$

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



Even and Odd Signals Examples



1. $x(t) = t^2 + t^4$

Sol:

$$x(-t) = (-t)^2 + (-t)^4$$

$$x(-t) = t^2 + t^4$$

$$x(-t) = x(t)$$

Even

2. $x(t) = t^3$

Sol:

$$x(-t) = (-t)^3 = -t^3$$

$$x(t) = -x(-t)$$

Odd





Thank You

Q & A

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