EN1020 Circuits, Signals, and Systems: Introduction

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Section 1

Introduction to Signals and Systems

Outline

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- Signals and systems find many application in communications, automatic control, and form the basis for signal processing, machine vision, and pattern recognition.

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- They are functions of independent variables and carry information.

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- We will study sampling, Laplace transform, z-transform, and stability of systems EN2063.

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- Use Fourier techniques to understand frequency-domain characteristics of signals.

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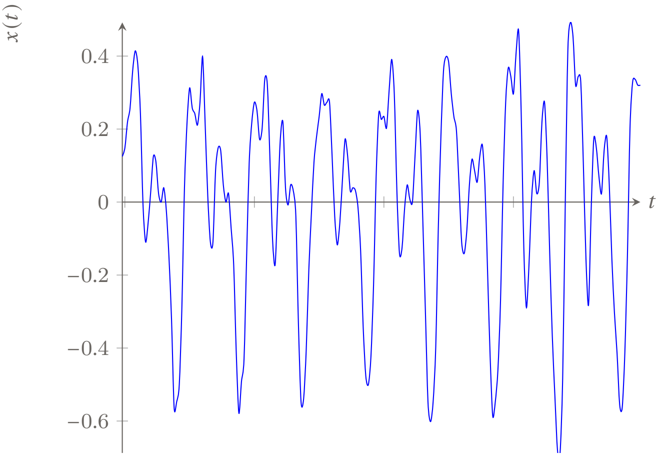
- There are some very strong similarities and also some very important differences between discrete-time signals and systems and continuous-time signals and systems.

Continuous-Time Signals $x(t)$

- The independent variable is continuous.
- E.g., sound pressure at a microphone as a function of time (one-dimensional signal).
- E.g., image brightness as a function of two spatial variables (two-dimensional signal).
- For convenience, we refer to the independent variable as time.



A function of a continuous variable
A speech signal: a continuous-time, one-dimensional signal

$f(x, y)$

An image on a film: a continuous-time, two-dimensional signal

Discrete-Time Signals $x[n]$

- Function of an integer variable.
- Takes on values at integer values of the argument of $x[n]$.

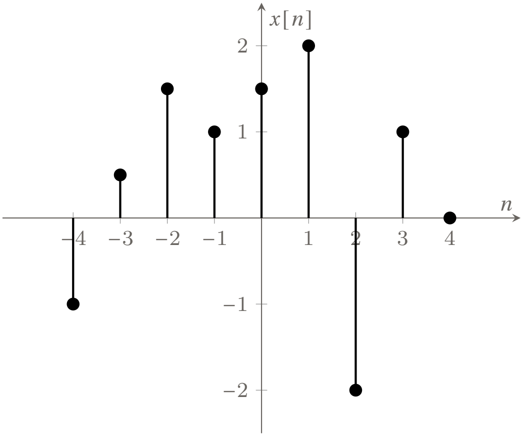


Figure: DT Signal

Digital Signals

- What is a digital signal?
  - A quantized discrete-time signal. I.e., $x[n, m]$. The signal can take only a value from a finite set of values.
- What is a digital image?
  - A two-dimensional, quantized, discrete-time signal.
  - A 600×800 image: $n \in [0, 599]$, $m \in [0, 799]$, $x[n, m] \in [0, 255]$. 8-bit image.

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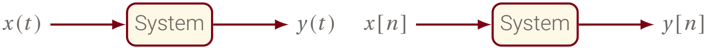


Figure: CT and DT Systems.

Types of Systems

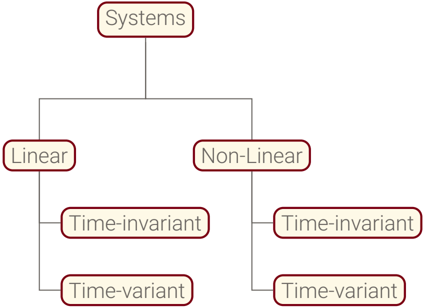


Figure: System types.

This course is focused on the class of linear, time-invariant (LTI) systems.

Systems Interconnections

- To build more complex systems by interconnecting simpler subsystems.
- To modify the response of a system.
- E.g.: amplifier design, stabilizing unstable systems.

Signal-Flow (Block) Diagrams

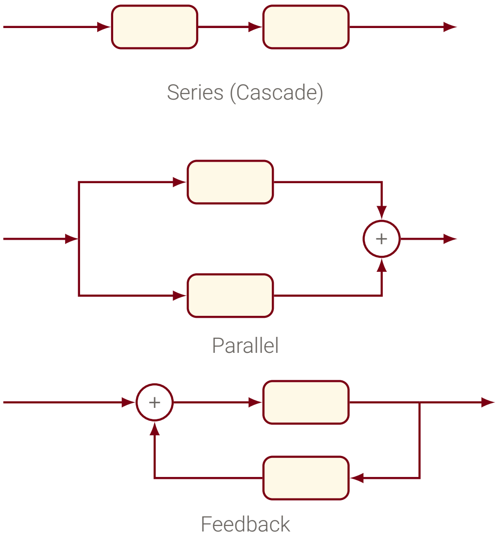
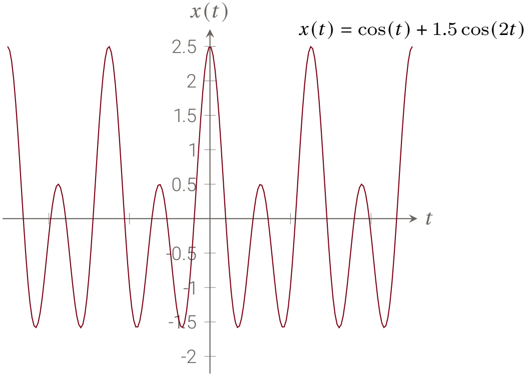
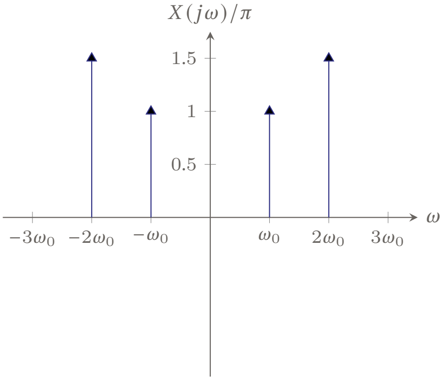


Figure: System interconnections.

Domains



Time domain representation.



Frequency domain representation.

Figure: Domains.

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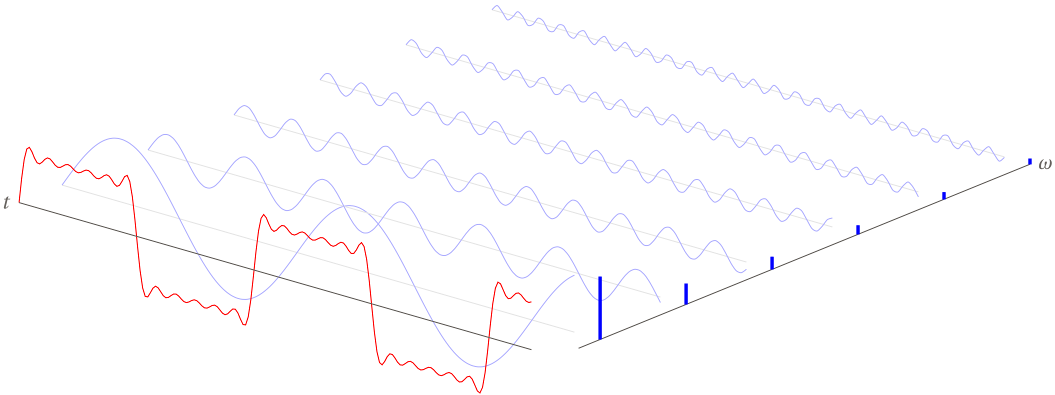

Figure: Square wave: time and frequency domains.