EBU4375: SIGNALS AND SYSTEMS

LECTURE 6: PART 1

Queen Mary
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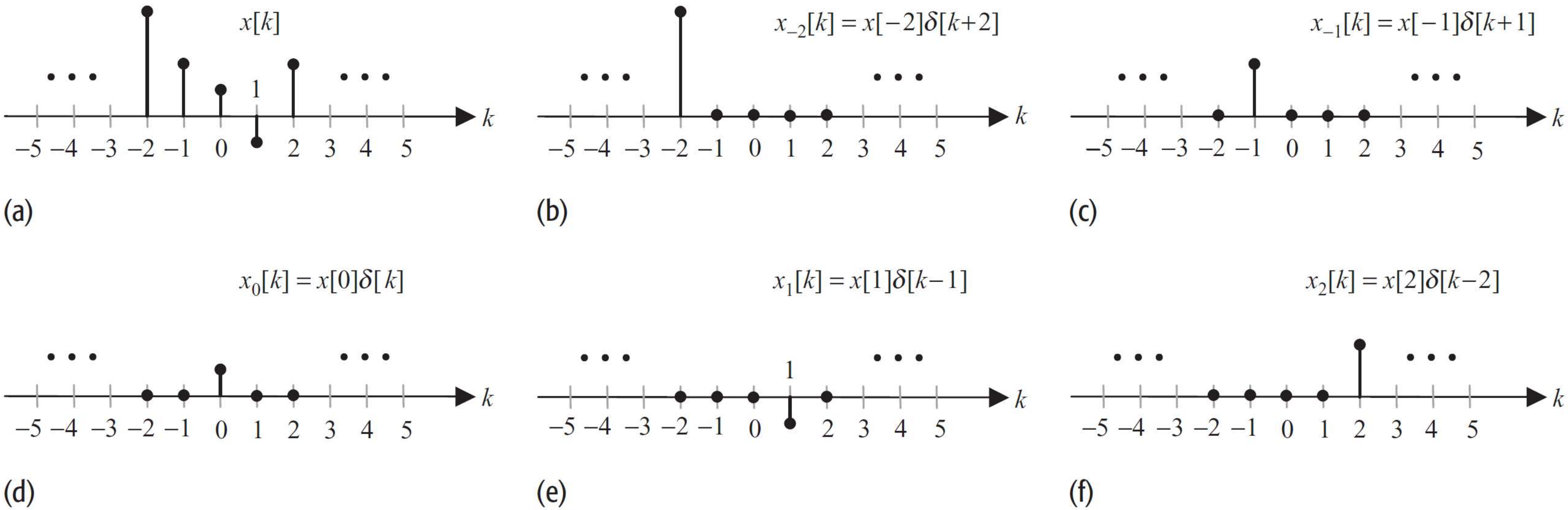
Basic Time Signals – Representation of Signals using Impulse Sequence (DT Signals)

In other words,

$$x_m[k] = x[m]\delta[k-m]$$

In terms of $x_m[k]$, the DT sequence $x[k]$ is, therefore, represented by

$$\begin{aligned} x[k] &= \cdots + x_{-2}[k] + x_{-1}[k] + x_0[k] + x_1[k] + x_2[k] + \cdots \\ &= \cdots + x[-2]\delta[k+2] + x[-1]\delta[k+1] + x[0]\delta[k] \\ &\quad + x[1]\delta[k-1] + x[2]\delta[k-2] + \cdots , \end{aligned}$$



Basic Time Signals – Representation of Signals using Impulse Sequence (DT Signals)

which reduces to

$$x[k] = \sum_{m=-\infty}^{\infty} x[m]\delta[k-m]$$

Basic Time Signals – Representation of Signals using Impulse Function (CT Signals)

Similarly, a continuous-time signal $x(t)$ may be expressed as

$$x(t) = \int_{-\infty}^{\infty} d\tau x(\tau)\delta(t-\tau)$$

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LECTURE 6: PART 2

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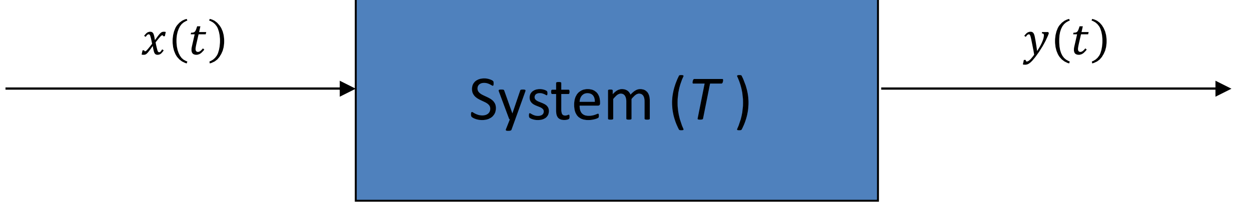
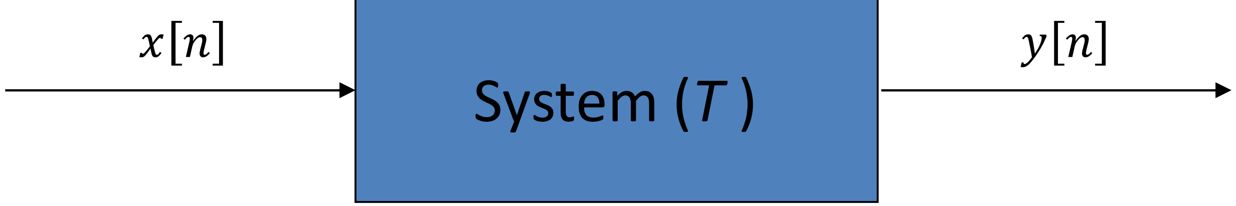
Continuous-time and Discrete-time Systems



Continuous-time System



Discrete-time System

Linear and Nonlinear Systems

- If the operator (T) satisfies the following two conditions then it is *linear* and represents a *linear* system:

1. <u>The Addition Rule:</u>

$$(T)x_1 = y_1 \quad and \quad (T)x_2 = y_2 \quad then \quad (T)\{x_1 + x_2\} = y_1 + y_2$$

   for any signals $x_1 \quad and \quad x_2$

2. <u>Scaling Rule:</u> $(T)\{\alpha x\} = \alpha y$ for any signal x and any scale-factor α

- Any system not satisfying these conditions is classified *nonlinear*

- Conditions 1. and 2. may be combined into the single condition

$$(T)\{\alpha_1 x_1 + \alpha_2 x_2\} = \alpha_1 y_1 + \alpha_2 y_2$$

where α_1, α_2 are arbitrary scalars.

Time-invariant and Time-variant Systems

A system is *time-invariant* if a time-shift (advance or retardation (or delay)) at the input causes an *identical* shift at the output. So for a continuous-time system, time-invariance exists if:

$$(T)\{x(t \pm \tau)\} = y(t \pm \tau) \quad ; \quad \tau \in \Re \qquad (2)$$

For a discrete-time system, the system is time- or shift-invariant if

$$(T)\{x[n \pm k]\} = y[n \pm k] \quad ; \quad k \in Z \qquad (3)$$

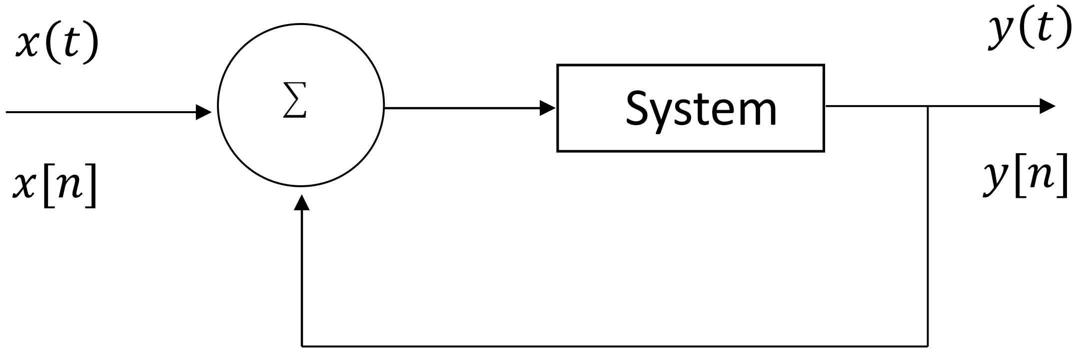
- A system not satisfying equations (2) and (3) is time-varying..

Linear Time-invariant Systems (LTI)

An LTI system posses together attributes of *linearity* and *shift-invariance*.

Feedback Systems

An important system-class in which output is fed back and added to the input



System Feedback