Digital Signal Processing

# Chap 1. Introduction

*Chang-Su Kim*

# Course Outline

- Pre-requisites
  - Engineering Mathematics
  - Signals and Systems

- Course Homepage
  - Homepage: http://portal.korea.ac.kr → http://mcl.korea.ac.kr

- Questions
  - Ask questions any time, but preferably during the lectures
  - Office: Engineering Bldg, Rm 215
  - Tel: 02-3290-3217
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# Course Outline

- Assessment Methods
  - Assignments: 15%
  - Attendance & Quizzes: 15%
  - Mid-term Exam: 30%
  - Final Exam: 40%

- Textbook
  - A. V. Oppenheim and R. W. Schafer, *Discrete-Time Signal Processing*, 3rd edition, Pearson, 2010.

- Reference
  - Sanjit K. Mitra, *Digital Signal Processing: A Computer-Based Approach*, McGraw Hill, 2006.

# Course Outline

| Week | Topics | Events |
|---|---|---|
| 1 | Chap 1. Introduction | |
| 2 | Chap 2. Discrete-Time Signals and Systems | |
| 3 | Chap 2. Discrete-Time Signals and Systems | |
| 4 | Chap 2. Discrete-Time Signals and Systems | |
| 5 | Chap 3. Z-Transform | |
| 6 | Chap 3. Z-Transform | |
| 7 | Chap 3. Z-Transform | |
| 8 | NA | Mid exam (30 OCT 2013) |
| 9 | Chap 4. Sampling of Continuous-Time Signals | |
| 10 | Chap 5. Transform Analysis of LTI Systems | |
| 11 | Chap 5. Transform Analysis of LTI Systems | |
| 12 | Chap 6. Structures for Discrete-Time Systems | |
| 13 | Chap 7. Filter Design Techniques | |
| 14 | Chap 8. DFT | |
| 15 | Chap 9. Computation of DFT | |
| 16 | NA | Final exam (16 DEC 2013) |

# DSP Systems (~2005)





# DSP Systems (2006)







# DSP Systems (2007)



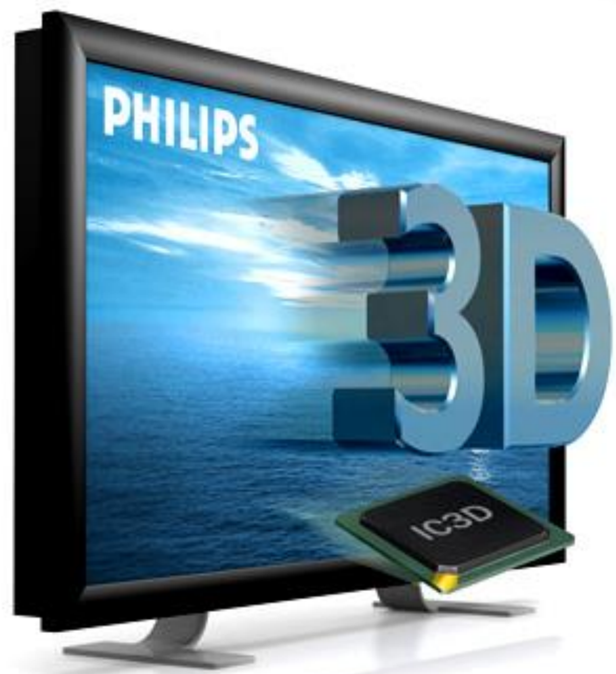



# DSP Systems (2008)



# DSP Systems (2009)





# DSP Systems (2013)



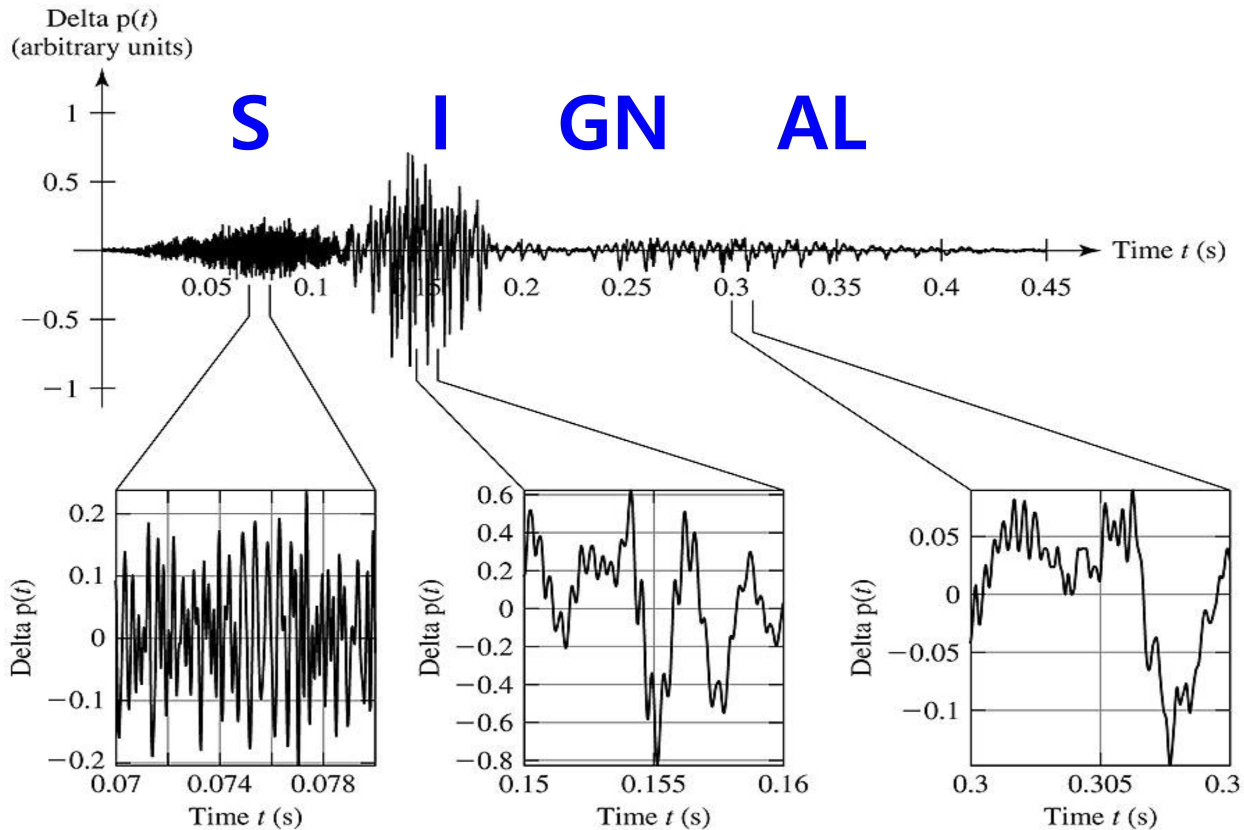

# DSP Systems (2014)






# Signals

- $s(t) = 1.05\ t^2$
- $s(x, y) = 3x+2xy+10y^2$



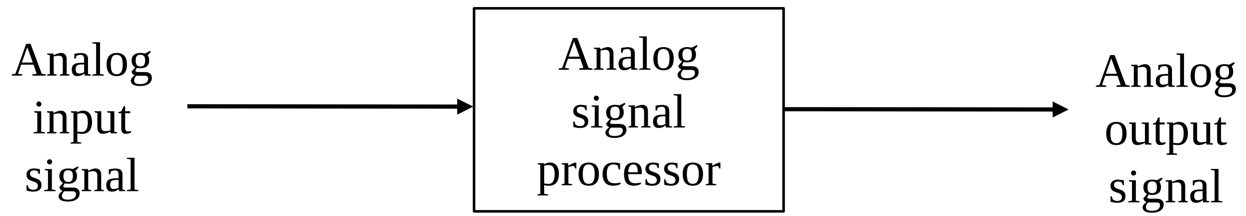
# Systems and Signal Processing

- A *system* performs an operation on a signal

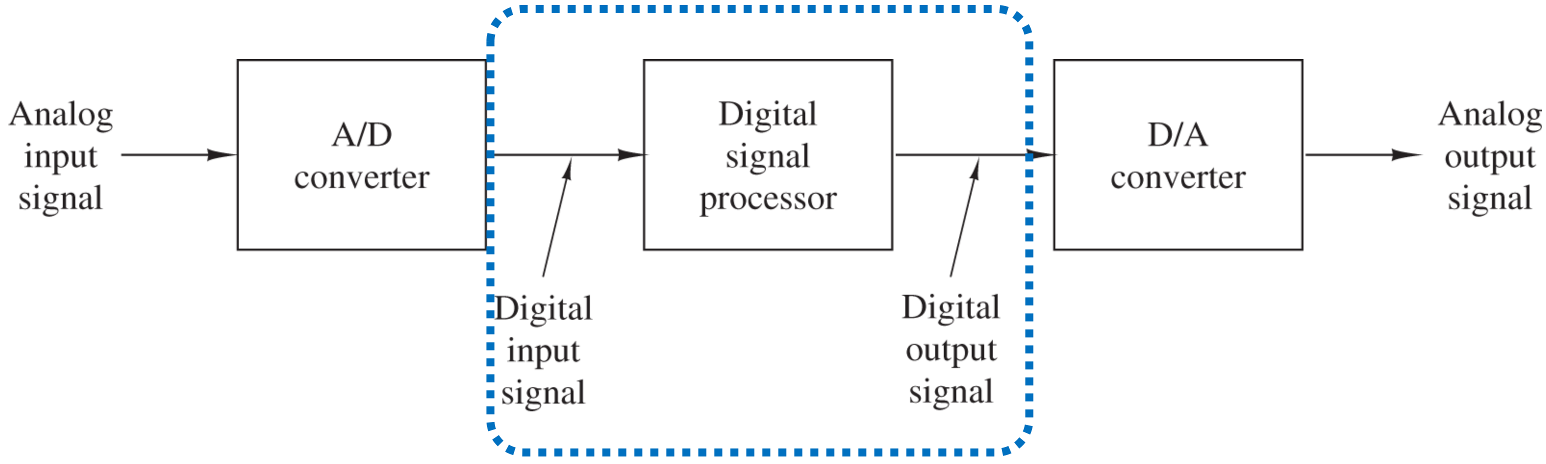

- Such operations are referred to as *Signal Processing*

# Analog Signal Processing vs. Digital Signal Processing

- Analog signal processing




- Digital signal processing

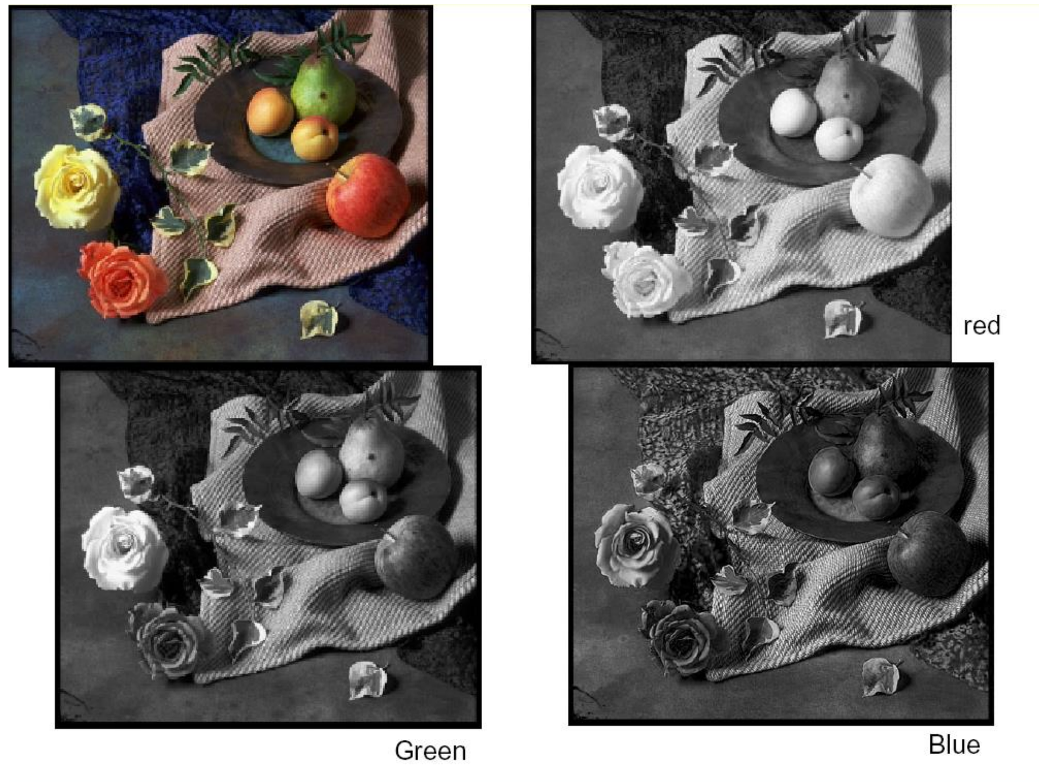


# Advantages of DSP over Analog Signal Processing

- Flexibility
- Accuracy
  - 16-bit, 32-bit, 64-bit digital computing
  - Extremely difficult to make accurate analog circuit components
- Easy storage and duplication
- Cost
  - Digital computing gets cheaper

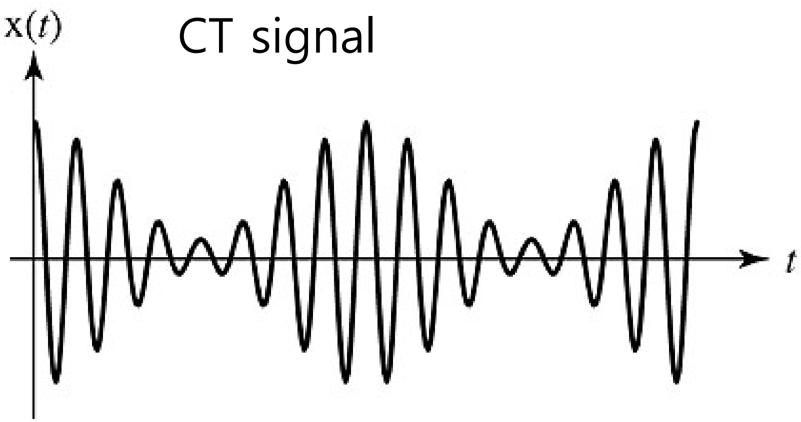
# A color picture is a **three-channel, two-dimensional** signal

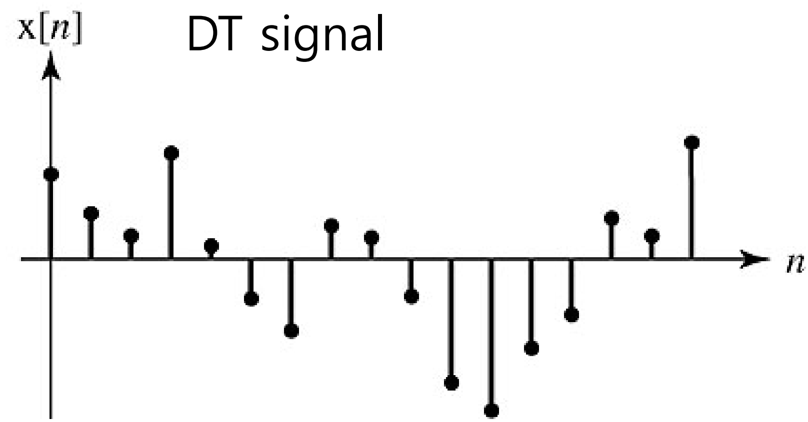
$$\mathbf{S}(x,y)=\begin{bmatrix} r(x,y) \\ g(x,y) \\ b(x,y) \end{bmatrix}$$




- In this work, we focus on single-channel, one-dimensional signals
- The single variable is called time

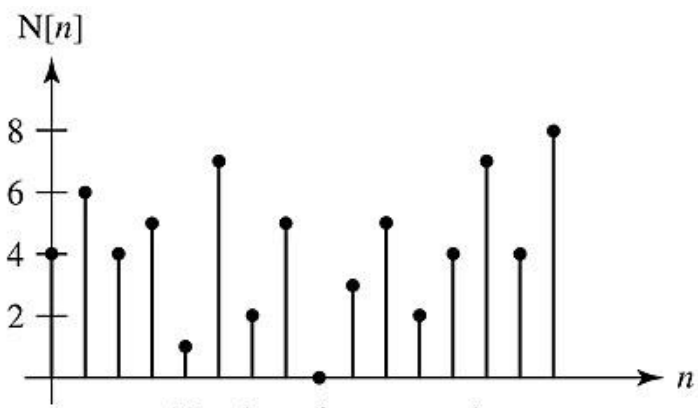
# Continuous-Time vs Discrete-Time Signals



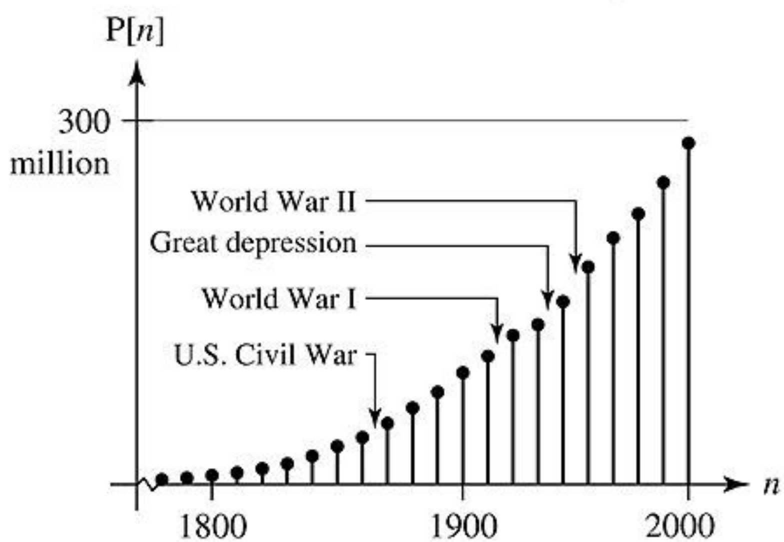




- DT signals often arise
  - by selecting values of an analog signal at discrete-time instants
  - by accumulating a variable over a period of time

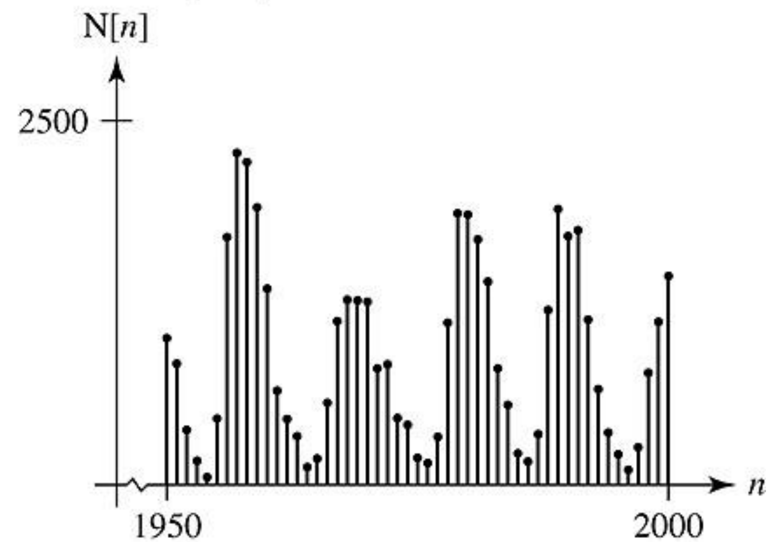
# Examples of Discrete-Time Signals




Number of cars crossing
an intersection between red lights




United States population




Number of annual sunspots

# Continuous-Valued vs Discrete-Valued Signals

- A discrete-time signal having a set of discrete values is called a **digital signal**
- Digitization =

  sampling (time) + quantization (value)

# Analog-to-Digital Conversion

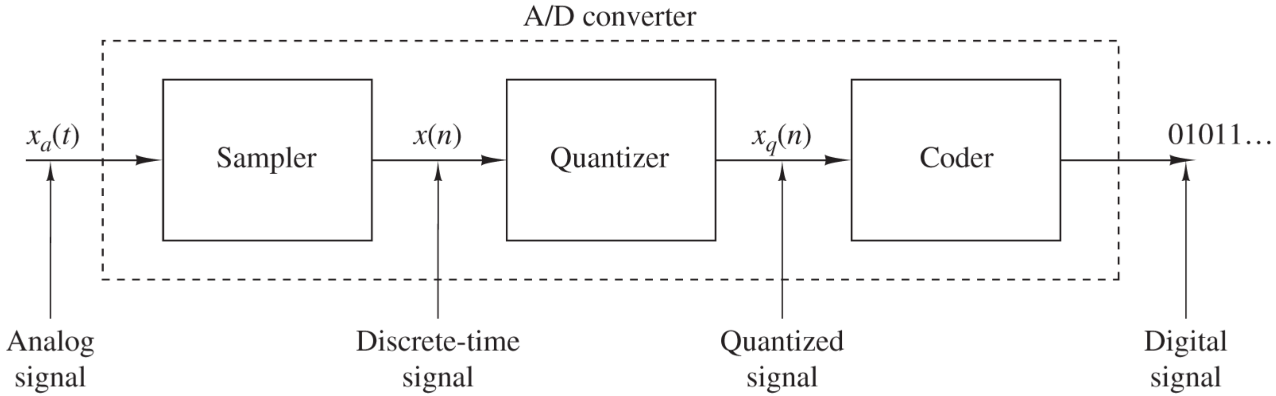



**Figure 1.4.1** Basic parts of an analog-to-digital (A/D) converter.

## Sampling

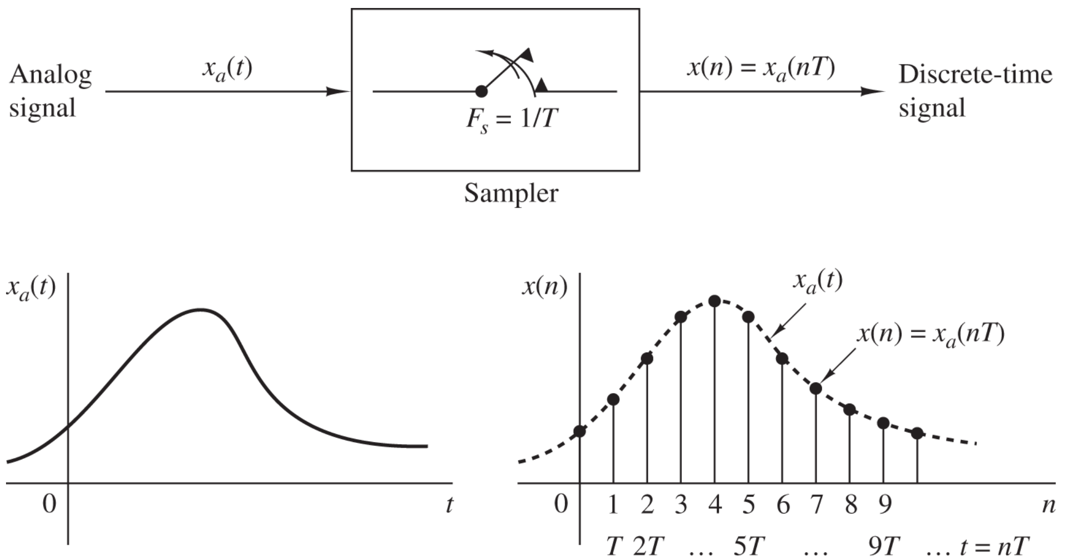
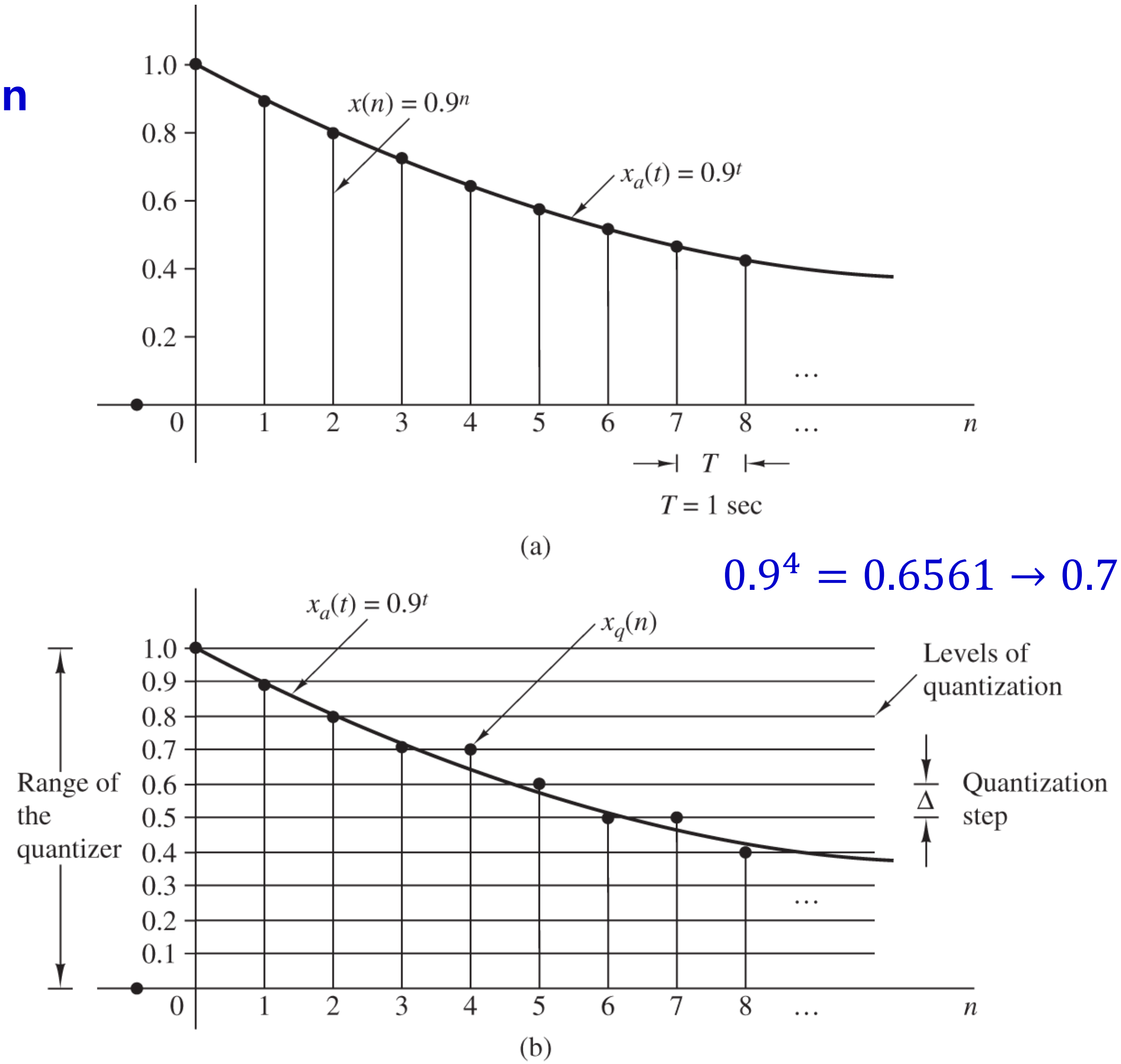



**Figure 1.4.3** Periodic sampling of an analog signal.

# Analog-to-Digital Conversion

**Quantization**




$0.9^4 = 0.6561 \rightarrow 0.7$

**Figure 1.4.7** Illustration of quantization.

# Digital-to-Analog Conversion

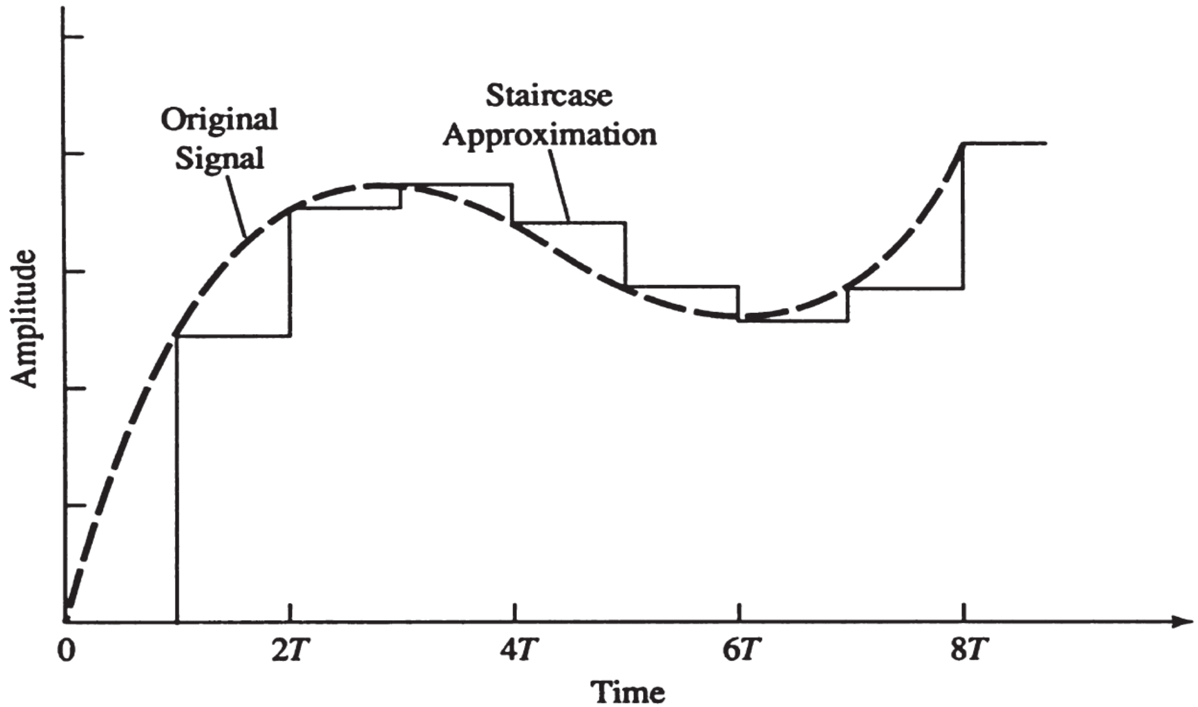



**Figure 1.4.2** Zero-order hold digital-to-analog (D/A) conversion.