DSP Overview

Chapter 0: Introduction of signal and signal processing

- Characterization and Classification of Signals
- Digital Signal Processing
- DSP Processes & Features

Chapter 1: Discrete Sequences and Systems

- Discrete Sequences
- Discrete Linear Time-Invariant Systems
- Causality and Stability Properties of LTI systems

Chapter 2: Periodic Sampling

- Sampling Low-Pass Signals
- Discrete Convolution

DSP Overview

Chapter 3: z-Transform

z-Transform & ROC

Inverse z-Transform

Chapter 4: The Discrete Fourier Transform

DTFT, DFS, DFT

DFT Leakage, Resolution, Properties

Circular Convolution, Frequency Response

Chapter 5: The Fast Fourier Transform

FFT (*Butterfly algorithm*) & Inverse FFT

Linear convolution with DFT

Piecewise Convolution for Long Sequence

Chapter 1

Chapter 1

1. **Basic Sequences**
   a. **Left-side, Right-side and Two-side**
   b. **Unit sample, Unit step, Rectangular sequence**
   c. **Real exponent, Sinusoidal sequence**

2. **Signal Processing Operational Symbols**
   a. **Basic operation of sequences**
   b. **Multiplication, Addition, Unit Delay**

3. **Discrete LTI System**
   a. ***Linear***
   b. ***Time-shift Invariant***
   c. ***Causality***
   d. ***Stability***

4. **For LTI systems, y(n)=x(n)* x(n)**

Chapter 2

2.1 Aliasing: Signal Ambiguity in the Frequency Domain

2.2 Sampling Low-Pass Signals

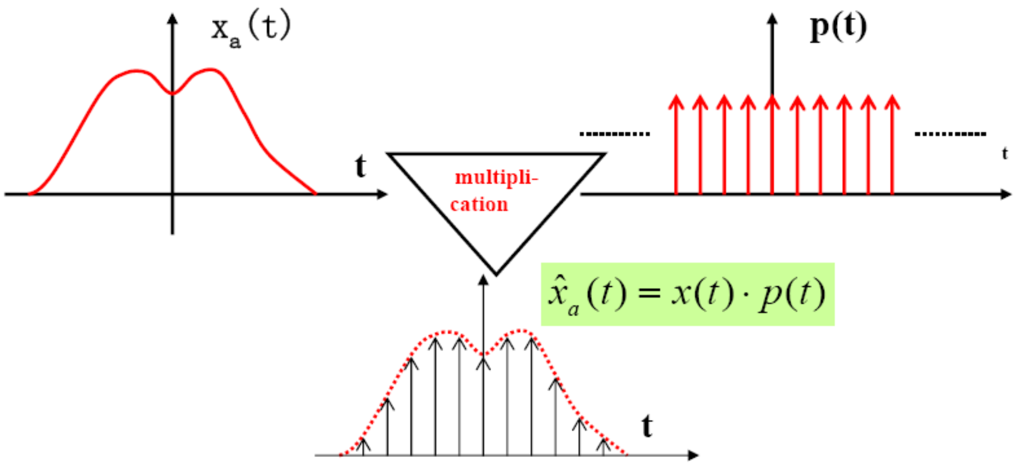
2.3 A Generic Description of Discrete Convolution

- **2.3.1 Discrete Convolution in the Time Domain**
- **2.3.2 The Convolution Theorem**
- **2.3.3 Applying the Convolution Theorem**

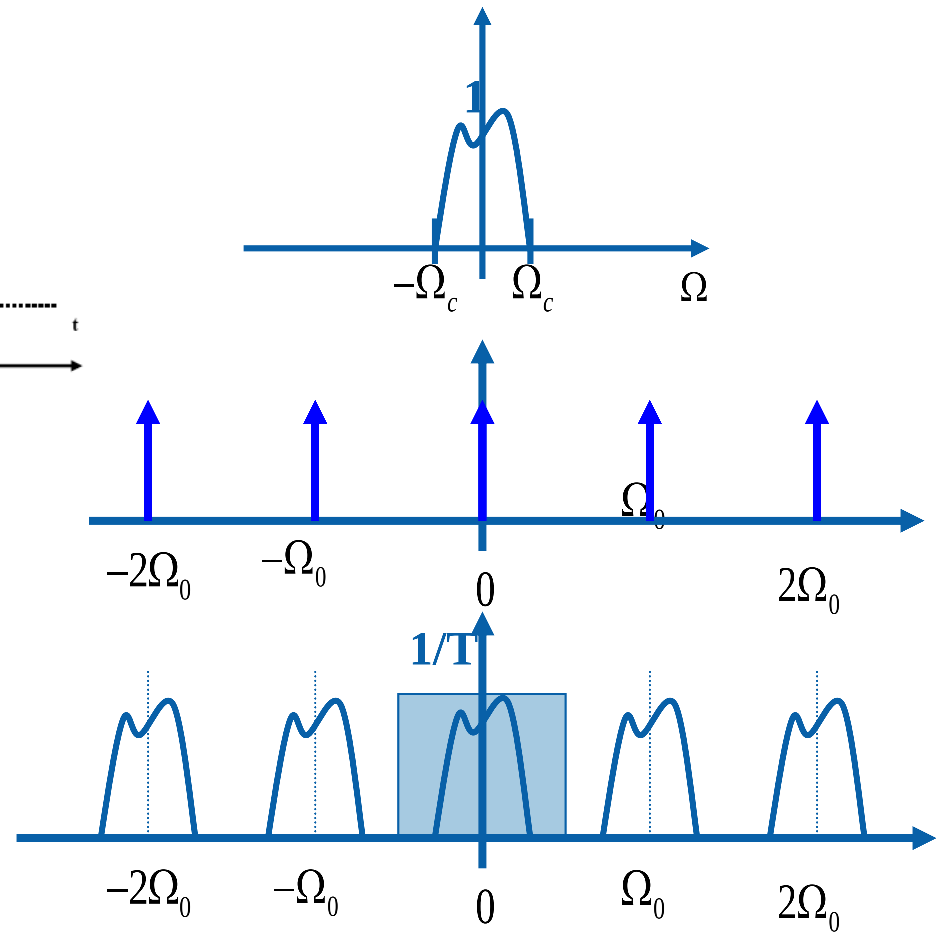
Sampling Theorem-Shannon Theorem

1. Band-limited signals

2. $f_s \geq 2 f_m$



$$\hat{x}_a(t) = x(t) \cdot p(t)$$



$$\hat{X}_a(\Omega) = \frac{1}{2\pi} X_a(\Omega) * P(\Omega)$$
$$= \frac{1}{T} \sum_{m=-\infty}^{\infty} X_a(\Omega - m\Omega_0)$$

Discrete Convolution in the Time Domain

Calculation steps:

(1) *Time-reversed*

h(-k) ← h(k)

(2) *Right shift n*

h(n-k) ← h(-k)

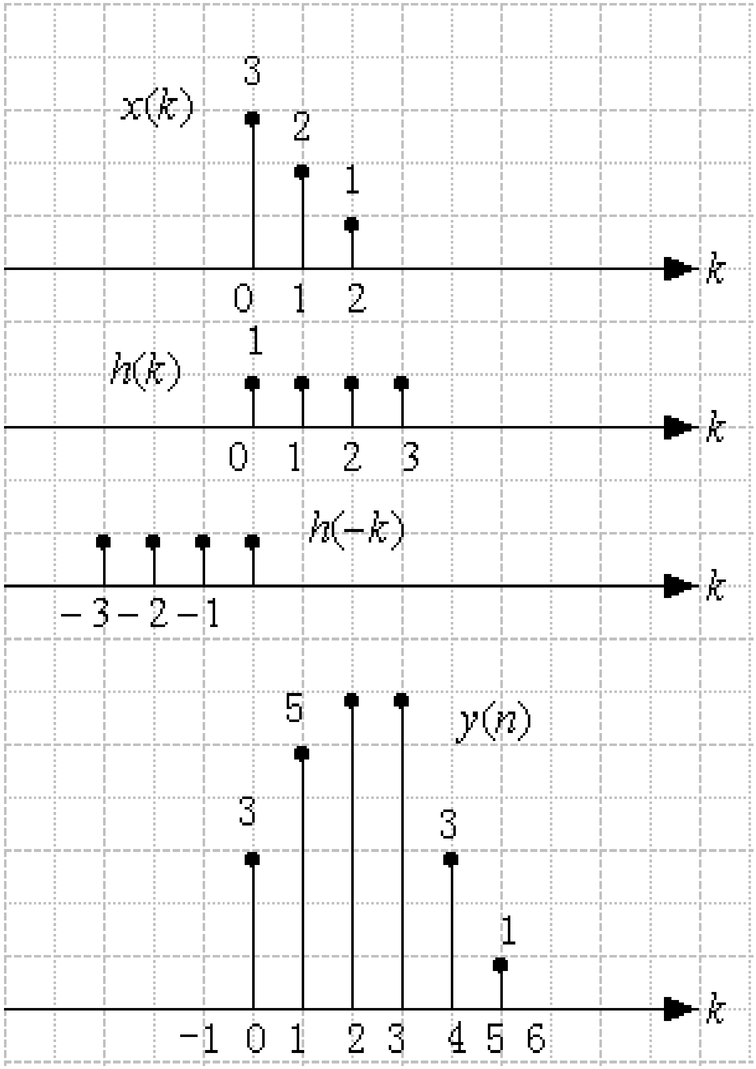
(3) *Multiplication*

x(n)·h(n-k)

(4) *Sum*

∑[x(n)·h(n-k)]

Note: the resulted length is *N+M-1.*



Chapter 3

3.1 The z-Transform

3.1.1 Poles and Zeros on the z-Plane and Stability

3.1.2 The ROC of z-Transform

3.1.3 The Properties of z-Transform

3.2 The Inverse z-Transform

3.2.1 General Expression of Inverse z-Transform

3.2.2 Inverse z-Transform by Partial-Fraction Expansion

Chapter 3

1. z-Transform

$$X(z) = Z[x(n)] = \sum_{n=-\infty}^{\infty} x(n) z^{-n}$$

- ***ROC & Pole-zero plot***

(a) Right-side Sequence: ROC |z|>r1;

(b) Left-side Sequence: ROC |z|<r2;

(c) Two-side Sequence: ROC r1<|z|<r2.

Chapter 3

2. The Properties of ZT

(a) Linear

(b) Time shifting $$Z[x(n+n_0)] = z^{n_0} X(z)$$

(c) Frequency shifting (scaling in the z-domain) $$Z[a^n x(n)] = X\left(\frac{z}{a}\right)$$

(d) Differential $$Z[nx(n)] = -z\frac{dX(z)}{dz} \qquad R_{x-} < |z| < R_{x+}$$

(e) Conjugation

(f) Initial Value Theorem $$\mathrm{x}(0) = \lim_{z\to\infty} X(z)$$

(g) Convolution in z-domain

$$Z[x(n)*h(n)] = X(z)\cdot H(z)$$

Chapter 3

3. Inverse z-Transform

$$x(n) = \frac{1}{2\pi j} \oint_c X(z) z^{n-1} dz$$

(a) Part Fractional method

(b) General Expression - Residue method

- **Draw the zero-pole plot, find the ROC, and draw the closed curve C, containing the origin.**
- **Calculate the residue numbers in & out of C, get the value of x(n).**