

# Sampling

TRAN Hoang Tung  
LE Nhu Chu Hiep

Information and Communication Technology (ICT) Department  
University of Science and Technology of Hanoi (USTH)

October 27, 2025

## What we have learnt?

- Signals and Systems
- LTI systems: convolution
- Fourier Series
- Fourier Transform

## What we have learnt?

- Signals and Systems
- LTI systems: convolution
- Fourier Series
- Fourier Transform

## Today

Sampling: Continuous to Discrete

## 1 Samples

## 2 Aliasing

## 3 Reconstruction

# 1 Samples

## 2 Aliasing

## 3 Reconstruction

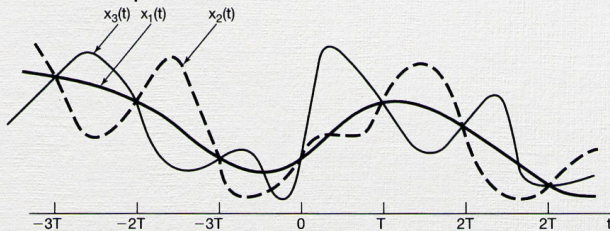
A continuous-time signal can be **completely represented** by its samples at points equally spaced in time. For examples:

- 1 moving pictures, which consist of a sequence of individual frames
- 2 printed pictures



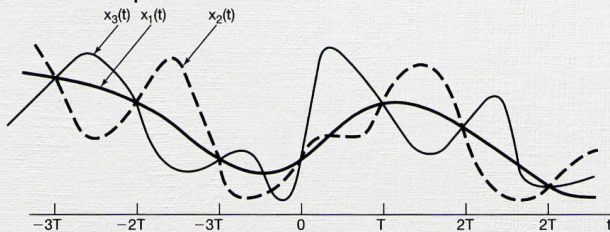
**Attention:** An infinite number of signals can generate a given set of samples.

**Attention:** An infinite number of signals can generate a given set of samples.





**Attention:** An infinite number of signals can generate a given set of samples.



If

- a signal is band limited
- the samples are taken sufficiently close

then the samples uniquely specify the signal, and we can reconstruct it perfectly.

# Impulse-Train Sampling

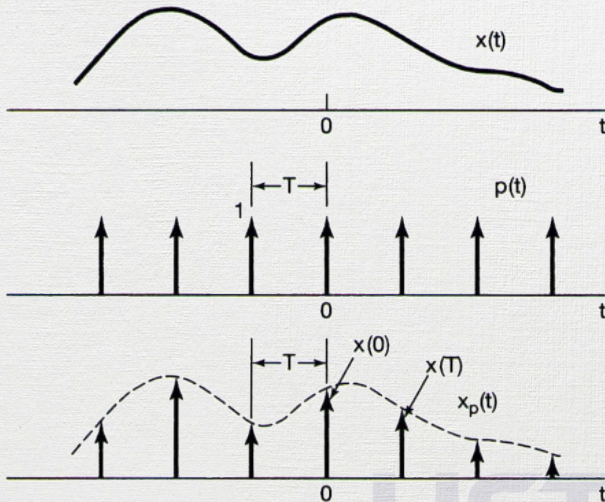
Signals &  
Systems

TRAN  
Hoang Tung

Samples

Aliasing

Reconstruction



**Question:** what happens in frequency domain?

Signals &  
Systems

TRAN  
Hoang Tung

Samples

Aliasing

Reconstruction



# Impulse-Train Sampling

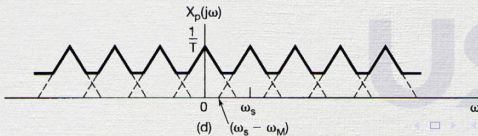
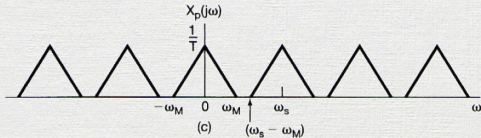
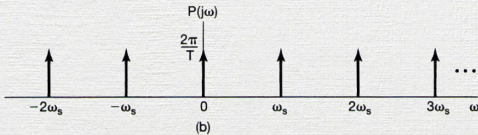
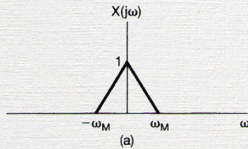
Signals &  
Systems

TRAN  
Hoang Tung

Samples

Aliasing

Reconstruction



$$\omega_{\text{sampling}} > 2\omega_{\text{maximum}}$$

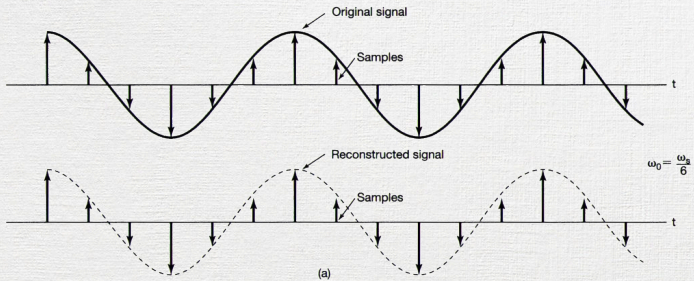


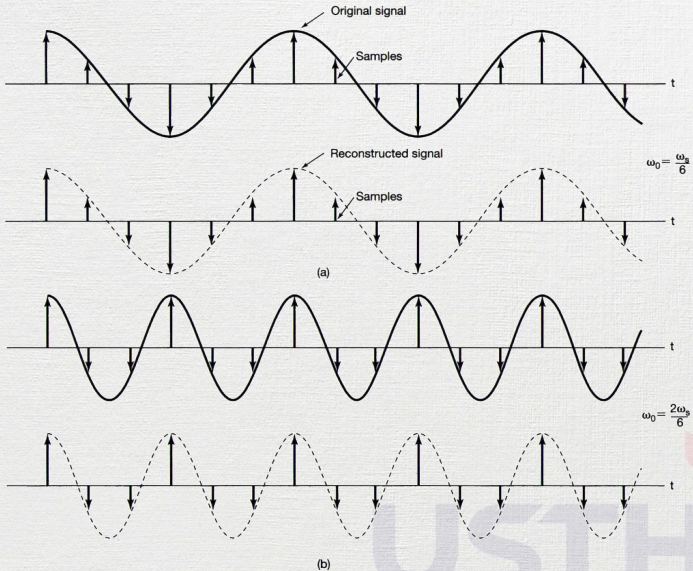
1 Samples

2 Aliasing

3 Reconstruction







# Aliasing

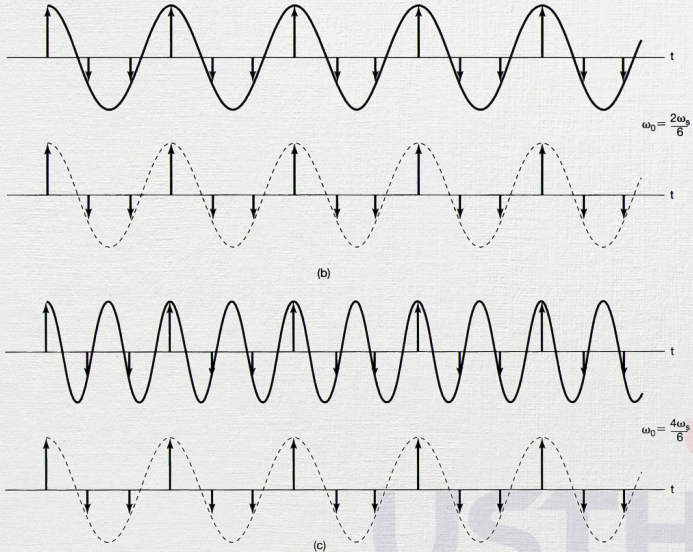
Signals &  
Systems

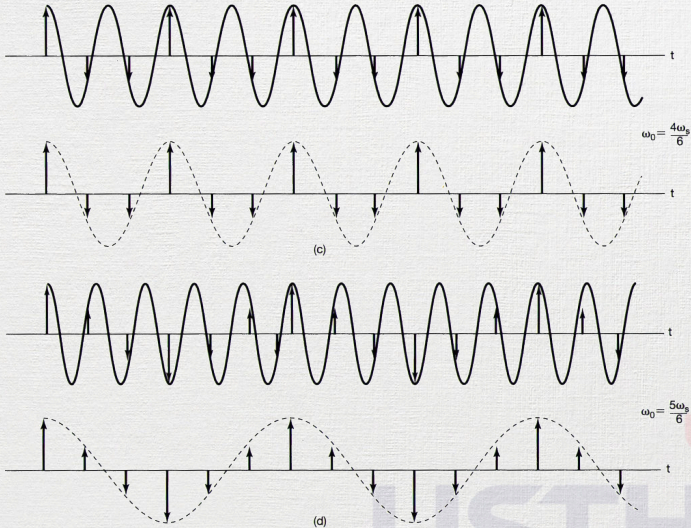
TRAN  
Hoang Tung

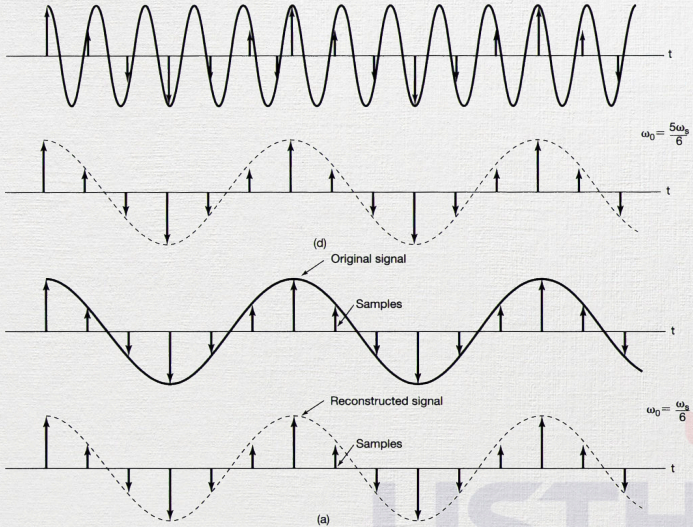
Samples

Aliasing

Reconstruction









1 Samples

2 Aliasing

3 Reconstruction



