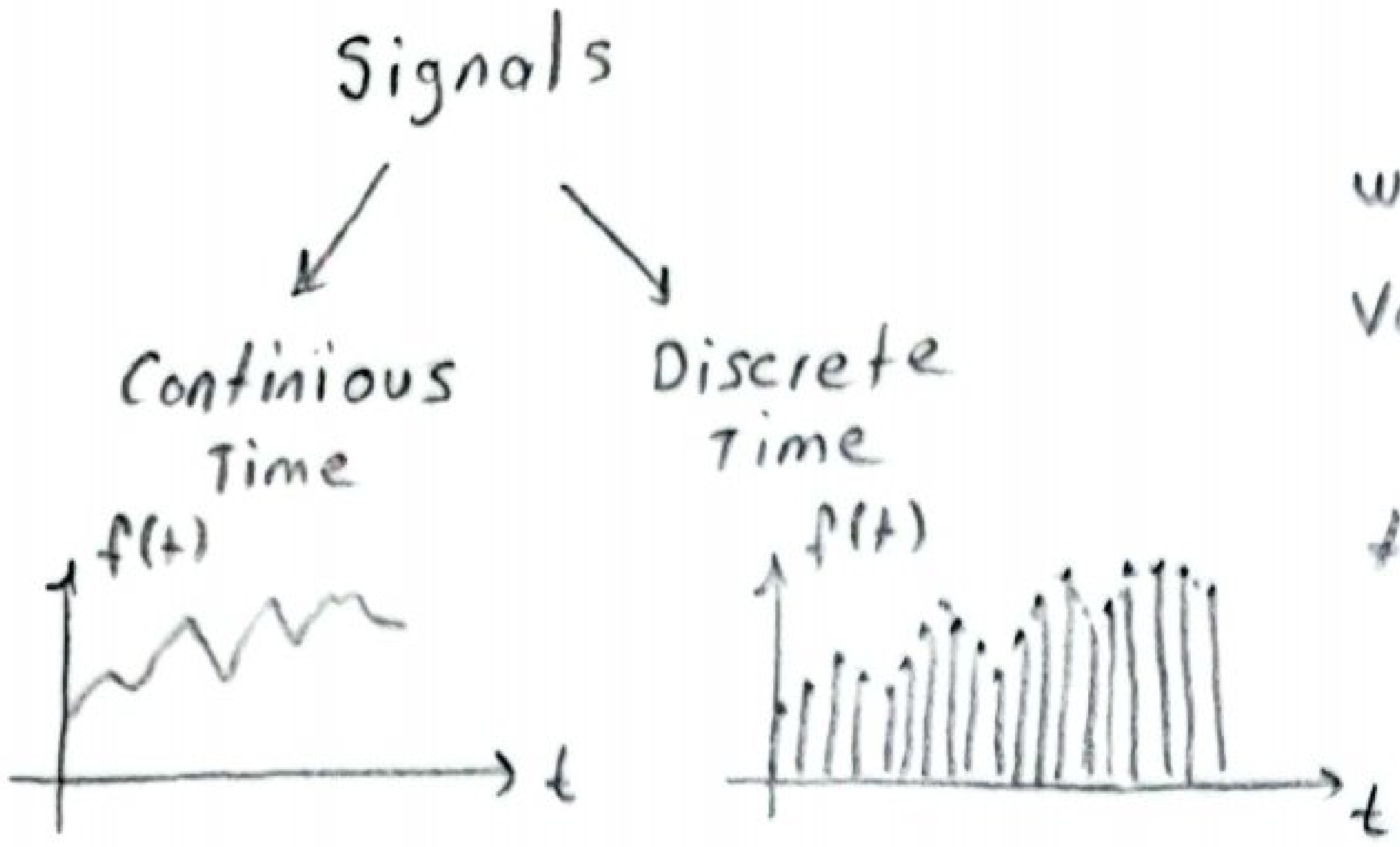
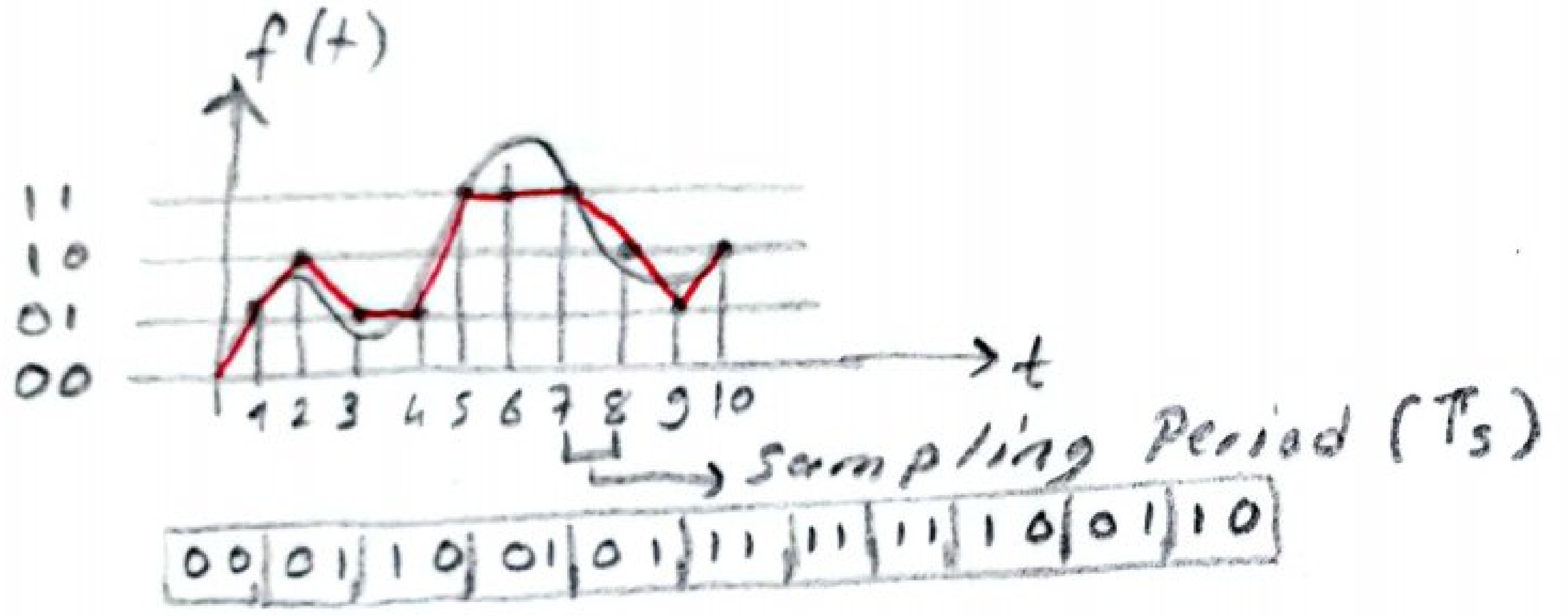
Signals and Systems



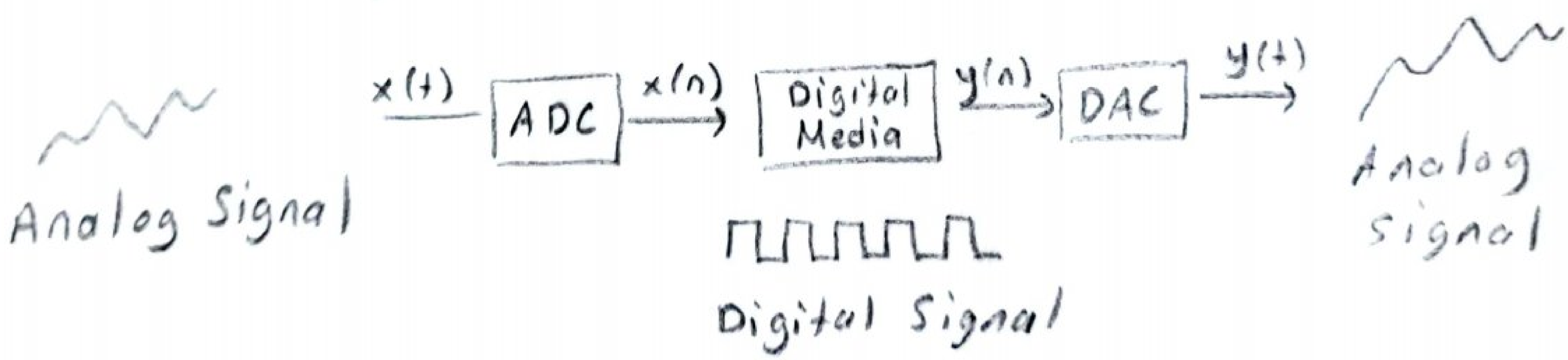
Signal is a function which represents the time variation of a physical variable

System is a function that manuplates the signal

we use sampling and quantisation to convert an analog signal into digital form.



$T_s = \frac{1}{f_s} \rightarrow$ Sampling Frequency



Convolution Theorem

In time domain, the response of a system to generate output can be calculated using the convolution function.

$$\underbrace{y(n)}_{\text{output}} = \underbrace{x(n)}_{\text{input}} \overbrace{*}^{\text{convolution}} \underbrace{h[n]}_{\text{system response}}$$

The convotion can be calculated either in continious or discrete time...

<u>continious time</u>

$$y(t) = \int_{-\infty}^{\infty} x(\tau).h(t-\tau)\, d\tau$$

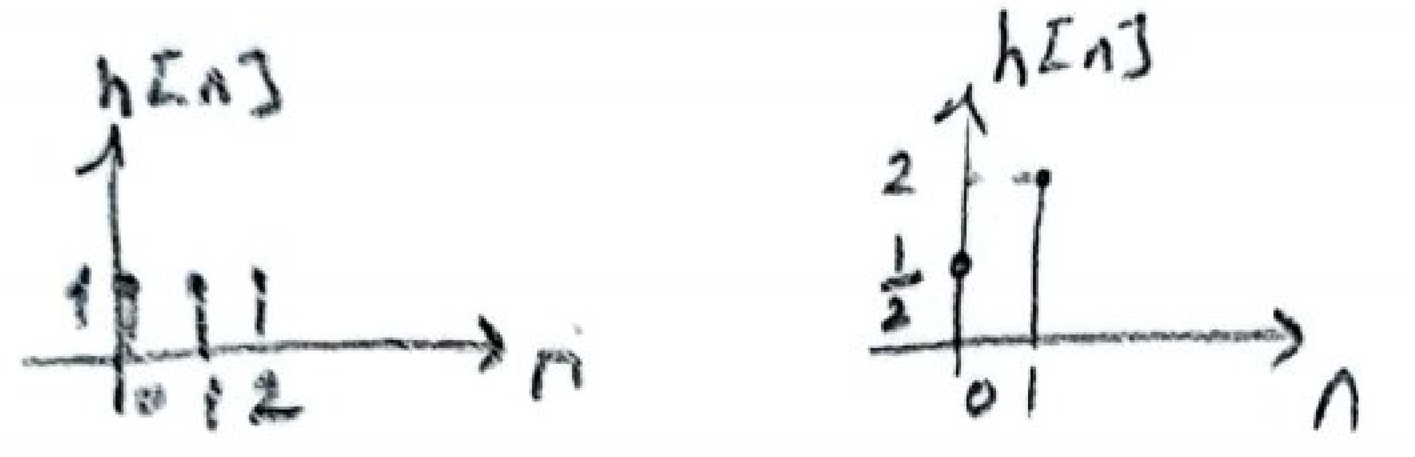
↳ convolution Integral

<u>Discrete time</u>

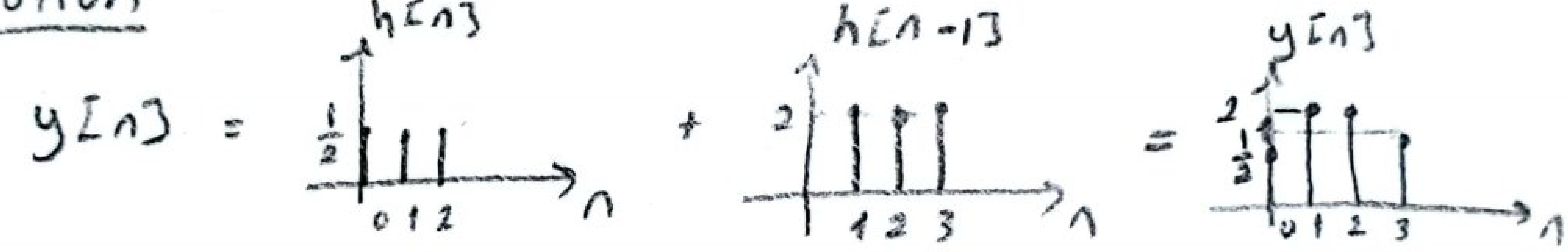
$$y[n] = \sum_{k=0}^{N} x[k].h[n-k]$$

↳ convolution Sum

<u>Example</u>: Consider an LTI system with impulse response h[n] and a given input x[n] please evoluate the output y[n].



<u>Solution</u>



<u>Time domain and Frequency domain</u>

<u>Representations of Signals</u>

x(t) → Time domain representation of signals

x(w) → Freq. " " "

A signal can be Transformed From time domain to Freq. domain using

Fourier Transfrom → for discrete and conti time

Z Transform → for discrete time

Laplace Transform → for continious time

we need to transform a signal from time domain to Freq. domain to be able to calculate the output of the convolution by multiplication instead of convolving them

$$x(t) * h(t) = X(w) \cdot H(w)$$

↓ convotion in time domain

↓ Multiplication in Freq. domain

and $X(w)$ can be calculated using one of the Transform techniques, i.e Fourier Transform

1. $X(w) = \int_{-\infty}^{\infty} x(t) \cdot e^{-jw_0 t} \, dt$ where $w_0 = \frac{2\pi k}{T}$

2. $x(t) = \int_{-\infty}^{\infty} X(w) \cdot e^{jw_0 t} \, dt$

1. is used to convert $x(t)$ to $X(w)$
2. is " " " $X(w)$ to $x(t)$

This property is used to apply a filter in Freq. domain by multiplication

a. $x(t) \xrightarrow{\mathcal{F}(x(t))} X(w)$ Fourier Transform

b. $X(w) \cdot H(w) = Y(w)$ Convolution (for filtering)

c. $Y(w) \xrightarrow{\mathcal{F}^{-1}(x(t))} y(t)$ Inverse Fourier Trans.