

Signals & Functions ~~subject~~ → Sample Theory. Introduction

↳ Analogue & Digital

Signal → Quantity that conveys some information (generally).

↳ A pattern involving a varying quantity

↳ Mathematically convenient to represent as a function of one or more independent variables.

- eg:
- Pressure at a point represents an audio signal (function of time).
 - Voltage output of a microphone also represents the same signal.
 - Electrical activity of auditory nerve fibres also represent the same
 - Image/photo is a two dimensional signal
 - ↳ function of two axes of space
 - Video is a 3 dimensional signal
 - ↳ function of two axes of space & 1 of time.

Why Signal Processing?

↳ Pretty much any system involves making use of information in the form of signals. ~~Info~~

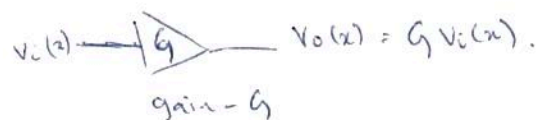
↳ Signals are manipulated to produce a new signal or make some inference from the manipulated signal.

↗
This is Signal Processing → Core to pretty much any system!

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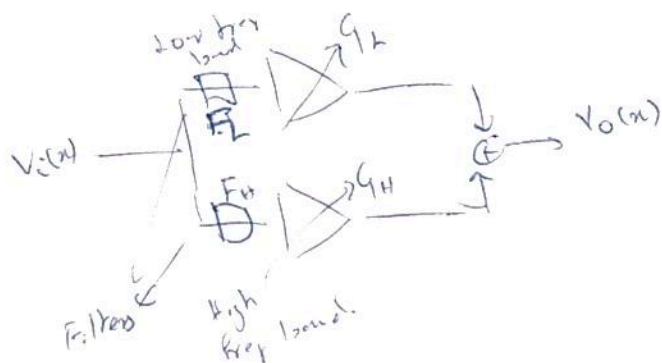
Examples of signal processing

= Amplifier \rightarrow Increase amplitude of signal (any signal)

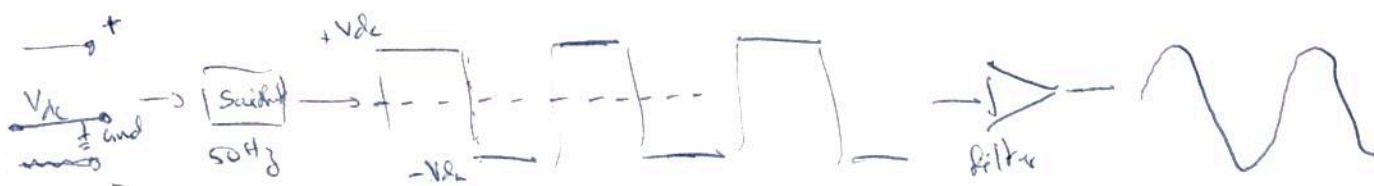


= Equalizer (channel)

\rightarrow Attenuate or amplify different frequency bands (channels)



= Alternator (DC to AC)



~~Example~~ - Signal processing view

- Also need power consideration!

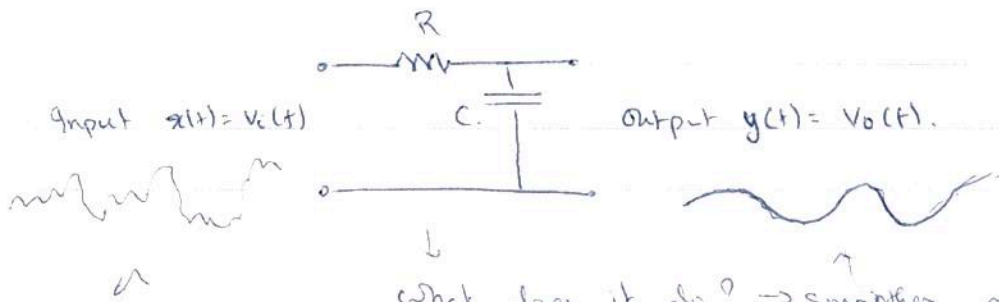
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Why Digital Signal Processing?

- Explosive growth & development in microprocessor & microelectronics.
- Cheap.
- Algorithms & systems not possible with analog signal processing as possible with DSP.

What is DSP?

Consider the system,



What does it do? → smooths out the signal

$$H(s) = \frac{1}{1 + sRC}$$

↓ Impulse Invariant

$$H(z) = \frac{RC}{1 - e^{-RCs} z^{-1}}$$

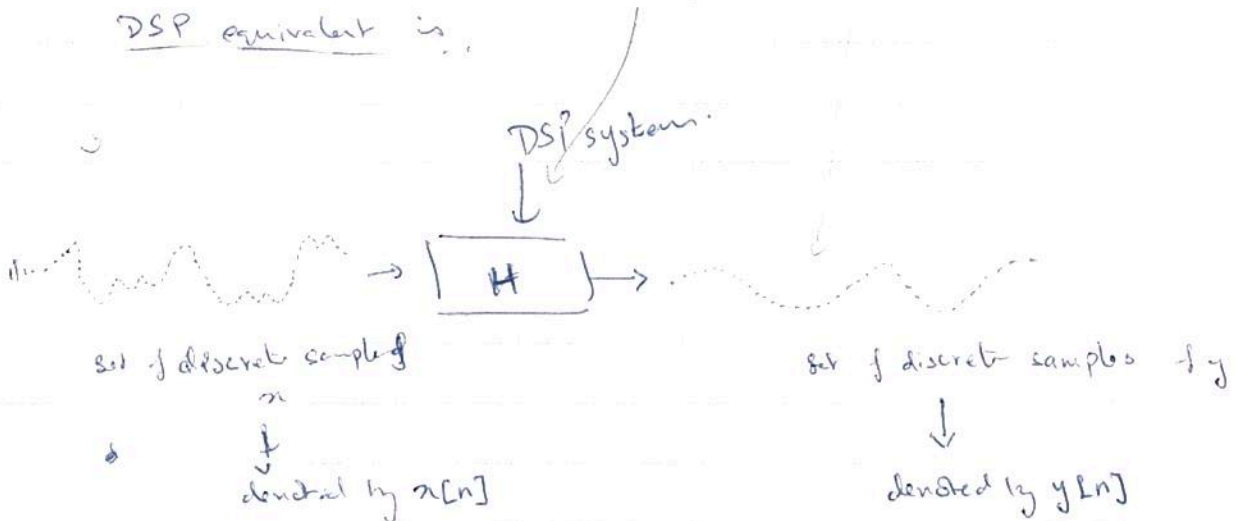
↳ reduces variation

↳ low pass filter

↳ attenuates high frequency components

Components

DSP equivalent is,

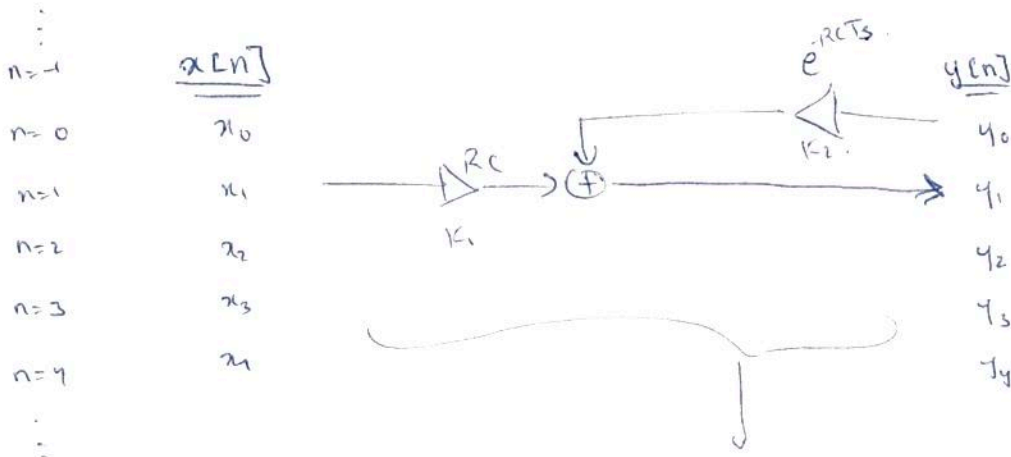


$n \rightarrow$ integers.

They are

→ $x[n]$ & $y[n]$ are sequences of

(11)



DSF equivalent to

$$x(t) \xrightarrow{R} \frac{1}{T} \int_0^T x(t) dt \rightarrow y(t).$$

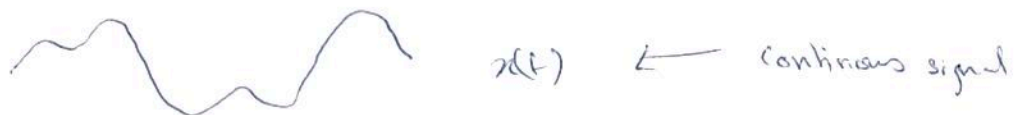
Some Questions you should have at this point

→ Ans $x[n]$ equivalent to $x(t)$? How would you know?
 $y[n]$ $y(t)$.

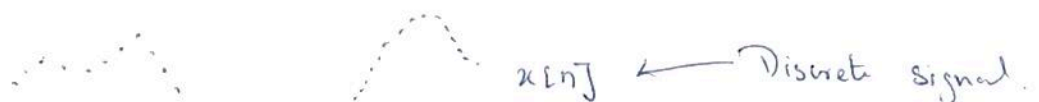
→ What does equivalent mean? ~~what does it mean for~~

→ How would you analyze the situation to answer these questions?
 i.e., How to think about these signals & systems?

Sampling



↓ Sampling.



T_s → sample period.

$$f_s = 1/T_s$$

↑
sampling rate.

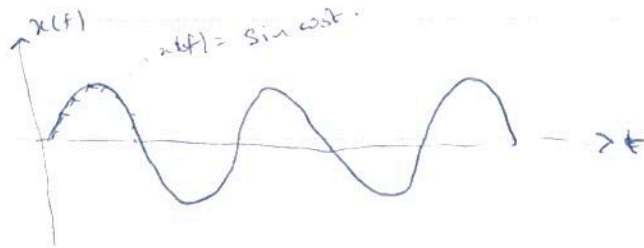
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Sampling Theorem / Nyquist Theorem

For ~~lossless~~ sampling without

what value of T_s/f_s should be chosen?

Consider a sinusoid



For sinusoid $f_s > 2f_0$.

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What about signals in general?

↳ not sinusoids

$x(t)$ → decompose into sinusoids (Fourier analysis)

↓

If ~~the~~ sinusoid of highest frequency is fine
then entire signal is fine.

Recap of

→

Continuous Fourier
Analysis
here

i.e.,

$$f_s > 2f_{\max}$$

↳ Nyquist Theorem.

(Proof after discussion of Fourier analysis)

~~Linear & Time Invariant Systems~~