EDISP
(English) Digital Signal Processing

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General information

Lectures 2h/week, Tue, 14:15-16 $\longrightarrow$ *Mind the excepions – see the schedule!*

Labs $\approx$4h/2weeks: Monday 8:15-12, room 022. See the schedule. *First meeting for all students – Monday 8 Oct, 9:15*

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Web page *http://staff.elka.pw.edu.pl/˜jmisiure/* $\longrightarrow$ Slides on Monday evening! (usually ;-))

Homeworks Announced as a preparation for the tests.

Exams Two short tests within lecture hours (see the lab schedule) and a final exam during the winter exam session (TBA).

Scoring:

2x10%	=	20%	tests
6x5%	=	30%	lab + entry test (lab 0 – not scored)
		50%	final exam
2x2%	=	4%	extra for homeworks

Short path `if [(score≥41)&&(tests≥15)&&(test2≥5)]; then score*=2; fi`

Books

base book The course is based on selected chapters of the book:

A. V. Oppenheim, R. W. Schafer, *Discrete-Time Signal Processing*, Prentice-Hall 1989 (or II ed, 1999; also previous editions: *Digital Signal Processing*).

free book A free textbook covering some of the subjects can be found here: `http://www.dspguide.com/pdfbook.htm` *The book is slightly superficial, but it can be valuable*

Additional books available in Poland:

R.G. Lyons, Wprowadzenie do cyfrowego przetwarzania sygnałów (WKiŁ 1999)

Craig Marven, Gilian Ewers, Zarys cyfrowego przetwarzania sygnałów, WKiŁ 1999 [en: A simple approach to digital signal processing, Wiley & Sons, 1996]

Tomasz P. Zieliński, Od teorii do cyfrowego przetwarzania sygnałów, WKiŁ 2002 (and next edition with slightly modified title)

You may also buy/borrow a laboratory scriptbook for a Polish language course (Cyfrowe Przetwarzanie Sygnałów, red. A Wojtkiewicz, Wydawnictwa PW) – but our lab is different!

A schedule was here - see the webpage for an updated version!

What Is EDISP All About ;-)

Theory Discrete-time signal processing

Practice Digital signal processing

Application examples:

Filters Guitar effects, radar, software radio, medical devices...

Adaptive filters Echo canceller, noise cancellation (e.g. hands-free microphone in a car),...

Discrete Fourier Transform/FFT Signal analyzer, OFDM modulation, Doppler USG, ...

Random signals Voice compression, voice recognition....

2D signals Image processing, USG/tomography image reconstruction, directional receivers, ...

Upsampling/Interpolation CD audio output, ...

Oversampling CD audio D/A conversion (example)

Please have a look at the black/green-board.

Notice & remember some things:

- Upsampling
- Filtering (and what happens to the signal spectrum)
- Frequency response (frequency characteristics) of a filter

Signal classification

Continuous or Discrete **amplitude** and **time**.

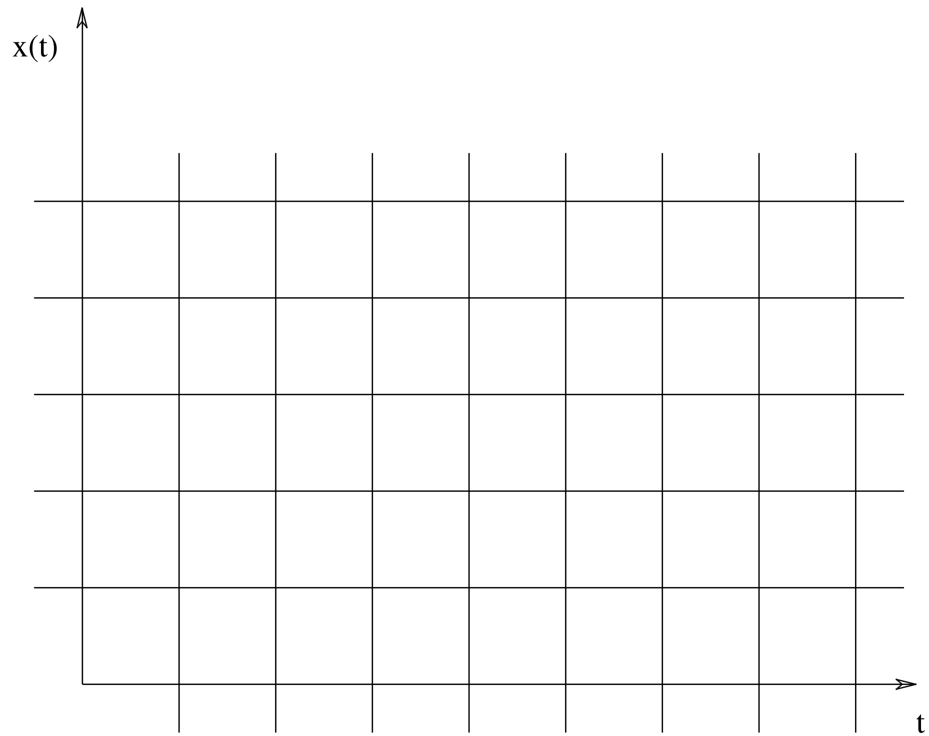
CA-CT $\longrightarrow$ “analog” signals

DA-CT $\longrightarrow$

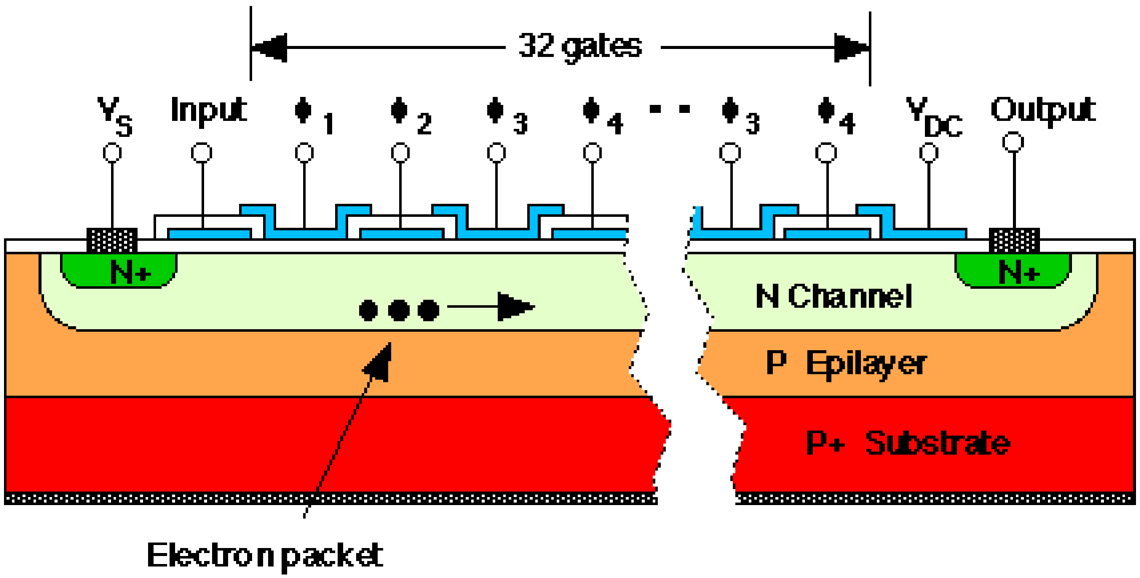
CA-DT $\longrightarrow$ CCD, SC, SAW devices

DA-DT $\longrightarrow$ digital devices

We’ll speak mainly about DT properties; only in some subject DA will be of importance.



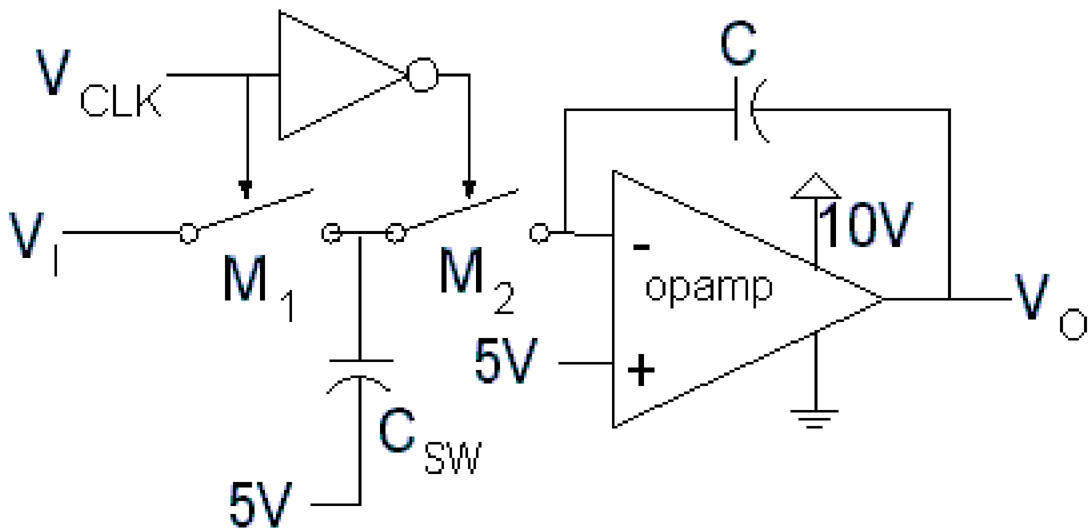
CCD device (side remarks)



Charge is transferred on the clock edge (discrete time!).

Clock is usually polyphase (2-4 phases).

SC device (side remarks)



DT signal representations

DT signal $\longleftarrow\longrightarrow$ a number sequence

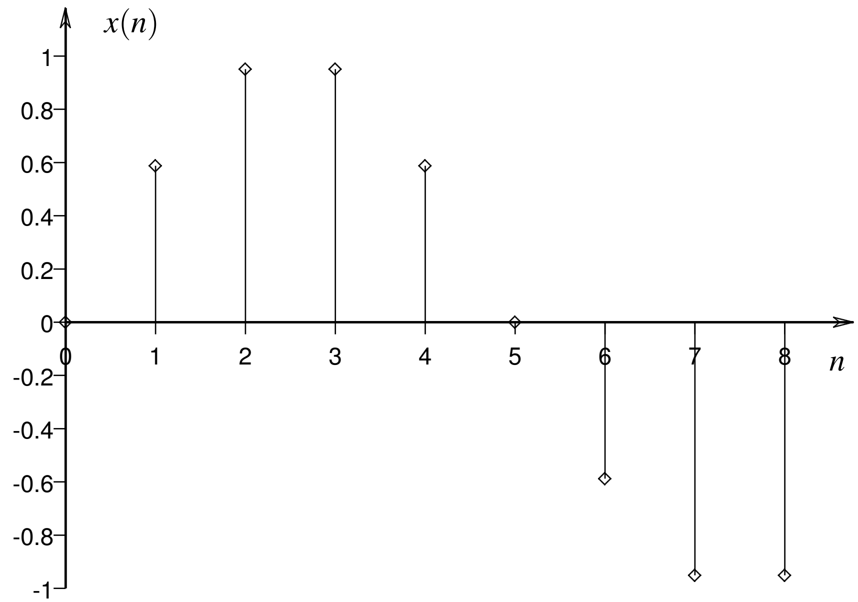
$$x[n] = \{x(n)\}$$

$x[n]$ is a number sequence (or ...)

$x(n)$ is a $n-$th sample

$\longrightarrow$ $x(n)$ is *undefined* for $n \notin \mathrm{I}$

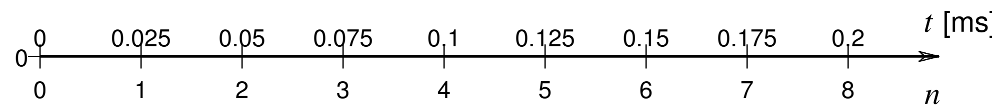
- it *may* come from sampling of analog signal
- but it may also be inherently discrete
- n may correspond to: time, space, ...



However, the most popular interpretation is: periodic sampling in time.

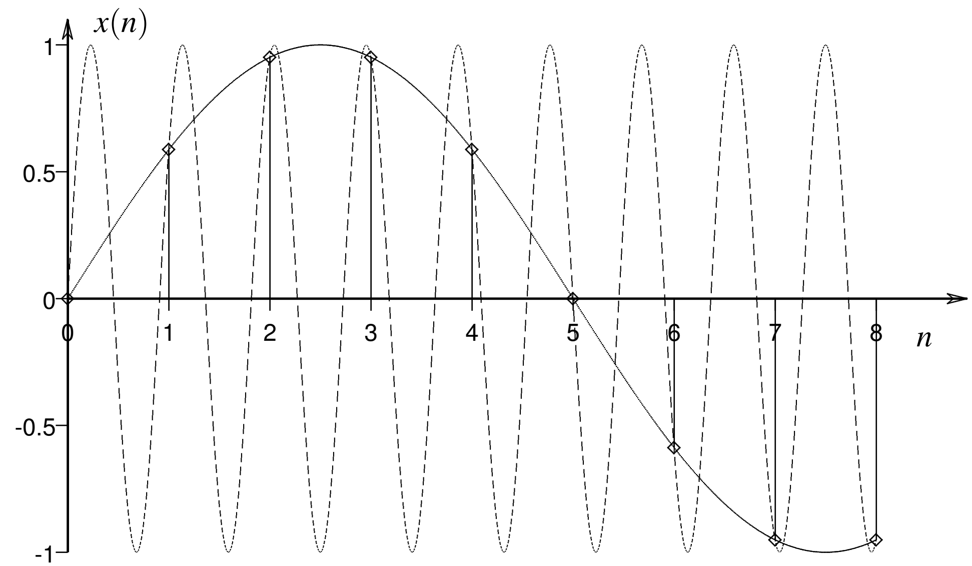
Periodic sampling

$$n \longleftarrow\!\!\longrightarrow n \cdot T_s$$



$$x(n) = x_a(nT_s)$$

$$n = t/T_s, \;\; T_s = 0.025 \text{ [ms]}$$



Misinterpretations

$\longrightarrow$ we do not know what is between points

a) $sin(n \cdot (1/5) \cdot \pi)$ or

b) $sin(n \cdot (2 + 1/5) \cdot \pi)$?

We have to **know** which one to choose $\longrightarrow$ sampling theorem