

COM-303

**Signal processing for communications**

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Cursus	Sem.	Type
Auditeurs en ligne	E	Opt.
Communication systems	BA6	Obl.
Computer science	BA6	Opt.

Contact language	English
Credits	6
Session	Summer
Semester	Spring
Exam	Written
Workload	180h
Weeks	14
<b>Hours</b>	<b>6 weekly</b>
Lecture	4 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

Students learn digital signal processing theory, including discrete time, Fourier analysis, filter design, adaptive filtering, sampling, interpolation and quantization; they are introduced to image processing and data communication system design.

**Content**

1. Basic discrete-time signals and systems: signal classes and operations on discrete-time signals, signals as vectors in Hilbert space
2. Fourier Analysis: properties of Fourier transforms, DFT, DTFT; FFT.
3. Discrete-Time Systems: LTI filters, convolution and modulation; difference equations; FIR vs IIR, stability issues.
4. Z-transform: properties and regions of convergence, applications to linear systems.
5. Filter Design: FIR design methods, IIR design methods, filter structures.
6. Stochastic and Adaptive Signal Processing: random processes, spectral representation, Optimal Least Squares adaptive filters.
7. Interpolation and Sampling: the continuous-time paradigm, interpolation the sampling theorem, aliasing.
8. Quantization: A/D and D/A converters.
9. Multi-rate signal processing: upsampling and downsampling, oversampling.
10. Multi-dimensional signals and processing: introduction to Image Processing.
11. Practical applications: digital communication system design, ADSL.

**Keywords**

Signal processing, discrete-time, continuous-time, filter, filter design, sampling, aliasing, DSP, Fourier transform, FFT, modem, ADSL

**Learning Prerequisites****Required courses**

- Calculus
- Linear Algebra

**Recommended courses**

- Signals and systems
- Basic probability theory

**Important concepts to start the course**

Vectors and vector spaces, functions and sequences, infinite series

### Learning Outcomes

By the end of the course, the student must be able to:

- Identify signals and signal types
- Recognize signal processing problems
- Apply the correct analysis tools to specific signals
- Check systems stability
- Manipulate rational transfer functions
- Implement signal processing algorithms
- Design digital filters
- Interpret complex signal processing systems

### Transversal skills

- Use a work methodology appropriate to the task.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.
- Use both general and domain specific IT resources and tools

### Teaching methods

Course with exercises sessions and coding examples and exercises in Python (Jupyter Notebooks)

### Expected student activities

Complete weekly homework, explore and modify Jupyter Notebook examples

### Assessment methods

Final exam fully determines final grade.

### Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

### Resources

#### Bibliography

**Signal processing for Communications**, EPFL Press, 2008, by P. Prandoni and M. Vetterli. The book is available for sale in printed form online and in bookstores; in iBook format on the Apple store and is also available as a free pdf file at <http://www.sp4comm.org/>

#### Ressources en bibliothèque

- [Signal processing for Communications / Prandoni & Vetterli](#)

#### Notes/Handbook

Lecture slides available for download at the beginning of the semester.  
A complete online DSP MOOC is available on Coursera.

#### Websites

- <https://www.coursera.org/learn/dsp1/>
- <https://www.coursera.org/learn/dsp1/>
- <https://www.coursera.org/learn/dsp2/>
- <https://www.coursera.org/learn/dsp3/>
- <https://www.coursera.org/learn/dsp4/>

**Moodle Link**

- <https://go.epfl.ch/COM-303>

**Prerequisite for**

Adaptive signal processing, image processing