Module Description, available in: EN

From Fourier to Wavelets

General Information

Number of ECTS Credits

3

Module code

FTP_Fourier

Valid for academic year

2019-20

Last modification

2018-11-06

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Berne	Lausanne			Lugano	Zurich		
Instruction						**X** E 100%		
Documentation						**X** E 100%		
Examination						**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basics of analysis:
  Integration methods (substitution, integration by parts), complex numbers, zeros of polynomials
- Basics of linear algebra:
  decomposition of a vector in a basis, scalar product, matrix calculus (addition, multiplication, inversion)
- Basics of Fourier series:
  real / complex Fourier series, calculation of their coefficients for basic examples

Brief course description of module objectives and content

Wavelet analysis offers an alternative to - and in many cases, such as signal and image processing, an improvement over - Fourier analysis. This is due to its adaptability to localised properties of data.
In this module, wavelet theory is developed in detail and its advantages over Fourier analysis are highlighted.
After the elaboration of wavelet theory, the second part of the course will focus on a number of important applications.

Aims, content, methods

Learning objectives and competencies to be acquired

- The students know the basics of Fourier and wavelet theory. They know the advantages of the latter.
- The students are able to apply this knowledge, i.e. to analyse, filter and reconstruct data in the framework of both theories.
- The students gain some familiarity with applicable software.
- The students are able to apply wavelet theory in practice, within the framework of selected applications. In particular they know the advantages of the most commonly used wavelet bases.

Module content with weighting of different components

- **Fourier theory:**
  Real and complex Fourier series, Fourier transform (FT) and its inverse, properties and examples,
  further topics: discrete/fast FT, sampling, filtering, windowing, selected applications
- **Wavelet theory:** advantages of wavelets over Fourier,
  basic example: Haar, multiresolution analysis, filters from wavelets, basic filter relations,
  discrete/fast wavelet transform, tensor wavelets, further topics,
  software
- **Wavelets in general:** vanishing moments, regularity, compact support, …
  Specific examples: Daubechies, Coifman, …
- **Applications**, selected among: denoising, compression, object detection/recognition

Teaching and learning methods

The module has a theory and an applications part.
The two parts can be taught by different lecturers.

- **Theory part:** lecturing, guided exercises
- **Applications part:** In the second part selected applications are presented by the lecturer. The students then work on problems relating to these selected applications. During the exercise class, they get advice from the lecturer.

Literature

- W. Bäni. Wavelets: eine Einführung für Ingenieure, second edition. Oldenbourg, 2005.
- B. Burke. Ondes et ondelettes. Pour la science, 1996.
- S. Mallat. A wavelet tour of signal processing, second edition. Academic Press, 1999.
- Y. Meyer. Ondelettes. Hermann, 1989.
- G. Strang and T. Nguyen. Wavelets and filter banks, revised edition. Wellesley-Cambridge Press, 1997.
- Further references and much more: www.wavelet.org (site hosted by EPFL)

Assessment

Certification requirements

Module does not use certification requirements

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

pocket calculator (no other)

Other permissible aids

any written/printed material
(open book)

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted