

**Course offered for the PhD program
in Civil, Chemical and Environmental Engineering
Curriculum in Wind Science and Engineering
A.Y. 2018/2019 (XXXIV cycle)**

(possibility of participation for students in other PhD cycles or other PhD courses)

1. Title

Time-frequency analysis of signals and examples of application

2. Course description

The main aim of the course is to describe the peculiar aspects of the time-frequency analysis of signals, providing the students with the minimum necessary background knowledge and then focusing on two tools of great use such as the wavelet and Hilbert transforms. Several examples taken from real experiments of fluid dynamics will be described in order to introduce participants to the use of the presented techniques.

3. Course Organization

- Recap on scalar product between functions, statistical moments, cross-correlation, Fourier series, Fourier transform. Examples and discussion on the limits of frequency analysis (2 hours)
- Introduction to time-frequency analysis. Short-time Fourier transform: characteristics and limits. Wavelet functions and continuous wavelet transform: definitions and examples. Inverse wavelet transform (2 hours)
- Wavelet scalograms, spectra and dynamical filters. Redundancy of the continuous wavelet transform. Outline of discrete wavelet transform. Cross-wavelet transform. Frequency and amplitude demodulation through wavelet transform: potential and limits (2 hours)
- Hilbert transform and analytic signals. Demodulation through Hilbert transform. Hilbert cross-correlation analysis. Wavelet-Hilbert procedure for the extraction and demodulation of multiple components present in a signal. Examples of application to fluid dynamical signals (2 hours)

4. Lecturer

Prof. Guido Buresti
Department of Civil and Industrial Engineering
University of Pisa, Italy
g.buresti@ing.unipi.it

5. Duration and credits

8 hours + final test (2 credits)

6. Activation mode and teaching period

The minimum number of participants to activate the course is 3. The proposed timetable is:

Tuesday July 9th: 14:30-16:30

Wednesday July 10th: 9:30-12; 14:30-16:30

Thursday July 11th: 9:00-10:30; 10:45-12:15 (final test)

7. Deadline for registration

The deadline for applications is July 8th, 2019. Please, send an e-mail confirmation to Giuseppe Piccardo, giuseppe.piccardo@unige.it.

8. Final exam

Test examination at the end of the course

9. Recommended references

- Class slides provided by Prof. Buresti