The objective of this course is to present an area that has recently emerged in signal processing and applied mathematics based on the representation of complex signals, images and transients using wavelets and time-frequency analysis. This course introduces the theoretical foundations of wavelets as well as some of their applications to fields including communication, audio, speech, image and video.
# Content

## 1. The Short time Fourier transform and the Continuous Wavelet Transform

**Degree competences to which the content contributes:**

**Description:**
(ENG) Review of the properties and limitations of the Fourier Transform. Time-frequency representation of signal with the Short Term Fourier Transform, Heisenberg uncertainty principle and time frequency resolution, Definition and properties of the Continuous Wavelet Transform (CWT), Invertibility of the CWT and relation with convolution.

## 2. Multiresolution analysis

**Degree competences to which the content contributes:**

**Description:**
(ENG) Reminder on vectorial spaces, Definition of Multiresolution analysis, Conjugate Mirror Filters, Haar and Sinc wavelets, Choosing a wavelet (Vanishing moments and support size), Daubechies wavelets, Other important wavelets families, Wavelet and Iterated Filter Banks.

## 3. Practical work in laboratory on Time-Frequency Analysis of Signals

**Degree competences to which the content contributes:**

**Description:**
(ENG) Introduction on MATLAB Notebook, Practical analysis of signals with Short Time Fourier Transform and with the Continuous Wavelet Transform (parameter estimation), Wavelet transform and filter bank (One stage filter bank, Iterated Filter Banks), Application to Denoising.

## 4. Discrete Wavelet and Filter banks

**Degree competences to which the content contributes:**

## 5. Extensions of multiscale analysis of Signals

**Degree competences to which the content contributes:**
6. Practical work in laboratory on Image Analysis and Coding

Degree competences to which the content contributes:

Description:
(ENG) Linear filtering of images,
Multiscale analysis with pyramid (decomposition and subsampling),
Study of wavelets families,
Image analysis with wavelets,
Image compression with wavelets,

Qualification system

Laboratory 50%
Study and presentation of a practical work 50%

Bibliography

Basic: