ACADEMIC YEAR 2021-22
DEPARTAMENTO DE MATEMÁTICAS
UNIVERSIDAD AUTÓNOMA DE MADRID

WAVELETS AND SIGNAL PROCESSING

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Course objectives: The objective of this course is to learn some techniques use in signal processing using cosine bases and wavelets. There will be some practice sessions with the computer.

1. Sampling of signals and images. Shannon sampling theorem. Finite signals. Discrete and Fast Fourier transform. Discrete images.

2. Orthonormal bases to process signals and images. Continuous bases of sine and cosine. Block bases. Discrete orthonormal bases. Cosine transform and fast algorithms. Trees of discrete bases.

3. Orthonormal wavelets in one dimension. Definition of orthornormal wavelet. Haar and Shannon wavelets. Multiresolution analysis. Filters to build wavelets. Lemarié-Meyer wavelets. Null moments of a wavelet and coefficient estimation

4. Coding and quantization. JPEG format for images. Coding and entropy. Shannon entropy. Huffman algorithm.

5. Frames. Reconstruction formula for frames. Gabor systems and Balian-Low theorem. Balian-Low theorem for frames.

REFERENCES

[Ch] C.K. Chui, *An Introduction to Wavelets,* Academic Press, San Diego, 1992.
[Co] A. Cohen, *Numerical Analysis and wavelet methods*, Elsevier, 2003
[D] I. Daubechies, *Ten Lectures on Wavelets*, SIAM, 1992.
[A] A. García García, Bases en espacios de Hilbert: teoría de muestreo y wavelets. 2ª Edicíón, Editorial Sanz y Torres, Madrid, 2014.
[HW] E. Hernández, G. Weiss. *A first course on Wavelets* CRC Press, 1997.
[M] S. Mallat. *A Wavelet Tour of Signal Procesing*. 2nd Edition. Academic Press, 1999.
[P] M.A. Pinsky, Introduction to Fourier Analysis and Wavelets, The Brooks/Cole Series in Advanced Mathematics, 2002.
[S] G. Strang, T. Nguyen. *Wavelets and Filter Banks*. Wellesley-Cambridge Press, 1997.

Times and room: Monday and Wednesday,16:00 to 17:30 and also Friday 22 of April and 6 of May in Room 14-500.

Final exam: Friday, May 20, 2022, in the morning.

FINAL MARK: 0,5h+0,5F (H= Homework; F= Final exam)