# Course guide
# 230089 - IPAV - Introduction to Audiovisual Processing

**Last modified:** 15/01/2024

**Unit in charge:** Barcelona School of Telecommunications Engineering
**Teaching unit:** 739 - TSC - Department of Signal Theory and Communications.

**Degree:** BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Compulsory subject).

**Academic year:** 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

## LECTURER

**Coordinating lecturer:** Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

**Others:** Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

## PRIOR SKILLS

See "requisites" section

## REQUIREMENTS

PROBABILITAT I ESTADÍSTICA - Precorequisit
SENYALS I SISTEMES - Precorequisit

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Generical:**
3. They will have acquired knowledge related to experiments and laboratory instruments and will be competent in a laboratory environment in the ICC field. They will know how to use the instruments and tools of telecommunications and electronic engineering and how to interpret manuals and specifications. They will be able to evaluate the errors and limitations associated with simulation measures and results.

## TEACHING METHODOLOGY

lectures
laboratory classes
Individual (learning)
Mid-term exam
Final Exam
Laboratory sessions

## LEARNING OBJECTIVES OF THE SUBJECT

Develop the intuition on the behaviour of audiovisual systems and the characteristics of signals with special emphasis on audiovisual signals. Introduce the fundamental elements of the perception of audiovisual signals. Provide useful additional tools for processing in the time and transformed domains generic and audiovisual discrete signals. Illustrate practical applications of audiovisual signal processing.

Learning outcome:
- She/he knows the human visual and auditory system. She/he knows how to characterize audiovisual signals in time and frequency. She/he knows how to represent them and she/he knows the principles of perception of audiovisual signals. She/he knows how to analyse and extract characteristics of audiovisual signals.
- She/he knows how to characterize analogue and discrete signals and systems in the time and frequency domains. She/he knows how to use the Fourier's transform of analog and discrete signals, and she/he knows the sampling theorem. Especially, she/he knows how to apply this knowledge to audiovisual signals and systems.

## STUDY LOAD

| Type | Hours | Percentage |
|---|---|---|
| Self study | 85,0 | 56.67 |
| Hours small group | 13,0 | 8.67 |
| Hours large group | 52,0 | 34.67 |

**Total learning time:** 150 h

## CONTENTS

### 1. Human Perceptive System

**Description:**
- User's importance
- Human Auditory System
- Human Visual System

**Related activities:**
Practice I. Signal analysis with DFT. Application to speech signals

**Full-or-part-time:** 16h
Theory classes: 6h
Self study : 10h

### 2. The signal in the time and spatial domains

**Description:**
- Sequences x[n] and x[m,n]
- Quantization
- 1D: Non uniform quantization. Dynamic margin control
- 2D: Grey transformations. Histogram. Histogram equalization

**Related activities:**
Practice II. Quantization of audio-visual signals
Practice III. Image histrogram and 2D-DFT

**Full-or-part-time:** 22h
Theory classes: 8h
Self study : 14h

### 3. The signal in the frequency domain

**Description:**
- Short-term 1D Fourier Transform
- Spectrogram. Time-frequency analysis
- 2D Fourier Transform
- 2D-DFT
- Importance of the phase

**Related activities:**
Practice III. Image histogram and 2D-DFT

**Full-or-part-time:** 26h
Theory classes: 10h
Self study : 16h

### 4. Sampling, decimation and interpolation

**Description:**
- 2D Sampling
- Decimation and interpolation
- Change of samplig rate

**Related activities:**
Practice IV: Decimation and interpolation of 1D signals
Practice V: Decimation, interpolation and filtering of 2D signals

**Full-or-part-time:** 26h
Theory classes: 10h
Self study : 16h

### 5. 2D convolution and correlation

**Description:**
- 2D convolution.
- Correlation (1D). Periodicity estimation.
- Correlation (2D). Pattern detection.

**Related activities:**
Practice IV. Filtering and equalization

**Full-or-part-time:** 11h
Theory classes: 4h
Self study : 7h

### 6. Linear time-invariant systems and filtering

**Description:**
- Z transform
- Systems defined by means of finite difference equations
- Filtering. Filter specification, linear phase, design of filter with Matlab, equalization.

**Full-or-part-time:** 26h
Theory classes: 10h
Self study : 16h

### 7. Audio-visual signal format

**Description:**
- Information compression
- Audio signal formats
- Image signal formats. Colour respresentation

**Related activities:**
Practice II. Quantization of audio-visual signals
Practice III. Image histogram and 2D-DFT

**Full-or-part-time:** 10h
Theory classes: 4h
Self study : 6h

## ACTIVITIES

### Mid-term exams

**Description:**
Continuous Assesment

**Full-or-part-time:** 4h
Theory classes: 2h
Laboratory classes: 2h

### Practice I. Signal analysis with DFT. Application to speech signals

**Full-or-part-time:** 2h
Laboratory classes: 2h

### Practice II. Quantization of audio-visual signals

**Full-or-part-time:** 2h
Laboratory classes: 2h

### Practice III. Image histogram and 2D-DFT

**Full-or-part-time:** 2h
Laboratory classes: 2h

### Practice IV. Decimation and interpolation of 1D signals

**Full-or-part-time:** 2h
Laboratory classes: 2h

**Practice V. Decimation, interpolation and filtering of 2D signals**

**Full-or-part-time:** 2h
Laboratory classes: 2h

**Final exam**

**Description:**
Final Exam

**Full-or-part-time:** 3h
Theory classes: 3h

## GRADING SYSTEM

Partial exam (CNT): 30%
Laboratory work and quiz (LAB): 20%
Final exam (FNL): 50%

Formula: max ( 0.30*CNT + 0.20*LAB + 0.50*FNL , 0.20*LAB + 0.80*FNL )

## BIBLIOGRAPHY

**Basic:**
- Mariño, J.B.; Vallverdú, F.; Rodríguez, J.A.; Moreno, A. Tratamiento digital de la señal: una introducción experimental [on line]. 3a ed. Barcelona: Edicions UPC, 1999 [Consultation: 19/02/2015]. Available on: http://hdl.handle.net/2099.3/36344. ISBN 8483012928.

**Complementary:**
- Oppenheim, A.V.; Schafer, R.W. Discrete-time signal processing. 3rd ed. Upper Saddle River: Prentice Hall, 2010. ISBN 9780131988422.
- Gonzalez, R.C.; Woods, R.E. Digital image processing [on line]. 4th ed.; global ed. New York: Pearson, 2018 [Consultation: 03/07/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=5573669. ISBN 1292223049.