

Course guide

230092 - PSAVC - Audiovisual and Communication Signal Processing

Last modified: 11/04/2025

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: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: MARGARITA ASUNCION CABRERA BEAN - MONTSERRAT NAJAR MARTON
Others: Primer quadrimestre:
MARGARITA ASUNCION CABRERA BEAN - 40
MONTSERRAT NAJAR MARTON - 10

REQUIREMENTS

INTRODUCTION TO AUDIOVISUAL PROCESSING - Precorequisite
INTRODUCTION TO COMMUNICATIONS - Precorequisite

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Generical:
12 CPE N2. They will be able to identify, formulate and solve engineering problems in the ICC field and will know how to develop a method for analysing and solving problems that is systematic, critical and creative.

TEACHING METHODOLOGY

Application lectures
Lectures
Group work
Personal work
Short answer test
Exams with exercises (Control and Final Exam)

LEARNING OBJECTIVES OF THE SUBJECT

- To plan and use the needed information in order to develop a project or academic work, based on a critical appraisal of the used information resources.
- To apply the acquired skills to carry out a task. To identify the need for continuous learning and for the design of an strategy to carry out that task.
- To identify, model and raise problems from open situations. To explore and apply alternatives for its resolution, and to use approximate solutions when necessary.
- To identify and model complex systems. To perform analysis and qualitative approaches, establishing the uncertainty of the results. To pose hypotheses and validate them experimentally. To identify the major components and to establish commitments and priorities.

Learning outcomes.

At the end of the course, the students will have acquired advanced knowledge in:

- characterizing signals as realizations of stochastic processes.
- estimation theory.
- time-frequency signal analysis.
- optimal filtering.
- adaptive Filtering.
- applying all above concepts to the development of signal processing subsystems for voice, audio, image, video and communication signals.

STUDY LOAD

Type	Hours	Percentage
Self study	85,0	56.67
Hours large group	65,0	43.33

Total learning time: 150 h

CONTENTS

Lecture 1. Introduction

Description:

- Notation of vector and random variables.
- Characterization of stochastic processes (stationary and ergodic), correlation matrix and its properties, power spectral density, and linear discrete processes and systems.

Related activities:

- Modeling AR processes.
- Identification of nonlinearities using the spectral coherence function.

Full-or-part-time: 17h

Theory classes: 7h

Guided activities: 1h

Self study : 9h

Lesson 2. Detection

Description:

- The decision problem: hypothesis testing, terminology and examples.
- Decision criteria: MAP and Neyman-Pearson.
- Detection of deterministic signals and the Receiver Operating Characteristic (ROC) curve.

Related activities:

Application to the detection of radar signals.

Full-or-part-time: 27h

Theory classes: 9h

Guided activities: 2h

Self study : 16h

Lesson 3. Estimation Theory

Description:

- Parameter estimation and MVUE estimator.
- Cramer-Rao limit and efficient estimator.
- Maximum Likelihood estimation, MAP estimation and MMSE estimation.

Related activities:

- CRLB in signal delay, frequency and angle of arrival estimation.
- ML estimation of channel, signal delay, frequency, power and SNR.

Full-or-part-time: 38h

Theory classes: 13h

Guided activities: 3h

Self study : 22h

Lesson 4. Optimum Filtering

Description:

- Linear least mean square estimation.
- Filtering problems: system identification, equalisation, cancelation, prediction and interpolation.
- Wiener filter in the frequency domain.
- Linear Regression and Least Squares design.

Related activities:

- Interference cancellation, deconvolution and channel equalization, predicting processes over time.
- Estimation of the channel impulse response.

Full-or-part-time: 23h

Theory classes: 7h

Guided activities: 3h

Self study : 13h

Lesson 5. Adaptive filtering

Description:

- Gradient method for linear regression.
- Stochastic gradient methods. LMS algorithm.
- LMS convergence and mismatch. Normalized LMS algorithm.

Related activities:

- Active noise cancellation.
- Hands-free telephone.
- Adaptive differential coding (ADPCM).

Full-or-part-time: 22h

Theory classes: 7h

Guided activities: 2h

Self study : 13h

ACTIVITIES

Midterm exam

Description:

Midterm exam

Related competencies :

12 CPE N2. They will be able to identify, formulate and solve engineering problems in the ICC field and will know how to develop a method for analysing and solving problems that is systematic, critical and creative.

Full-or-part-time: 2h

Theory classes: 2h

(ENG) Proves de resposta llarga (Examen Final)

Full-or-part-time: 3h

Theory classes: 3h

Applied Work

Full-or-part-time: 18h

Self study: 12h

Theory classes: 3h

Practical classes: 3h

GRADING SYSTEM

Midterm and Final Exam.

The final mark will be computed as:

$\max(0.85 \cdot \text{Final_exam}, 0.55 \cdot \text{Nota_examen_final} + 0.3 \cdot \text{Midterm_exam}) + 0.15 \cdot (\text{Lab_work})$

The re-assessed final mark of the course is computed from a final exam (85%) and from the non-re-assessed laboratory part (15%)

This course will assess the following generic skills:

- Self Learning (Middle Level)
- Ability to identify, formulate and solve engineering problems (Middle level)

EXAMINATION RULES.

Neither notes nor any kind of electronic devices are allowed.

BIBLIOGRAPHY

Basic:

- Manolakis, D.G.; Ingle, V.K.; Kogon, S.M. Statistical and adaptive signal processing: spectral estimation, signal modeling, adaptive filtering, and array processing. Boston: Artech House, 2005. ISBN 9781580536103.
- Kay, S.M. Fundamentals of statistical signal processing. Englewood Cliffs: Prentice Hall, 1993-2013. ISBN 0130422681.

Complementary:

- Theodoridis, S. Machine learning : a bayesian and optimization perspective [on line]. 2nd ed. London: Elsevier Academic Press, 2020 [Consultation: 17/03/2021]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=6118601>. ISBN 9780128188033.

RESOURCES

Other resources:

1. Problems publication
2. Course slides