Course guides
230092 - PSAVC - Signal Processing for Communications and Audiovisual Systems

Last modified: 29/04/2020

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: 2020 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer:
Najar Marton, Montserrat
Vidal Manzano, Jose

Others:
Vidal Manzano, Jose
Najar Marton, Montserrat
Pages Zamora, Alba Maria
Riba Sagarra, Jaume
Fernández Rubio, Juan Antonio
Cabrera Bean, Margarita
Marqués Acosta, Ferran
Vazquez Grau, Gregorio

REQUIREMENTS

Prerequisite: IPSAV and ICOM
Corequisite: AMT

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

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: 11h 30m
Theory classes: 4h
Guided activities: 1h
Self study : 6h 30m

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:
Aplication to the detection of radar signals.

Full-or-part-time: 14h 30m
Theory classes: 4h 30m
Guided activities: 1h 30m
Self study : 8h 30m

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: 33h
Theory classes: 11h
Guided activities: 2h
Self study : 20h

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: 29h
Theory classes: 5h
Guided activities: 4h
Self study : 20h

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: 25h 46m
Theory classes: 6h
Guided activities: 5h
Self study : 14h 46m

Lesson 6. Spectral estimation

Description:
- Periodogram and tradeoff between bias and variance.
- Filter banks and Capon estimator.
- Detectors spectral lines.

Related activities:
- Characterisation of biologic signals. Spectrum sensing.
- Non-parametric spectral estimation. Detection of spectral lines.

Full-or-part-time: 24h 50m
Theory classes: 7h
Guided activities: 4h
Self study : 13h 50m

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: 6h
Practical classes: 6h

(ENG) Proves de resposta llarga (Examen Final)

GRADING SYSTEM

Midterm and Final Exam.

The final mark will be computed as:

max(Final_exam, 0.55·Nota_examen_final+0.3·Midterm_exam))+0.15 (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:
- Kay, S.M. Fundamentals of statistical signal processing. Englewood Cliffs: Prentice Hall, 1993-2013. ISBN 0130422681.
- 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.

Complementary:
- Theodoridis, S. Machine learning: a bayesian and optimization perspective. 2nd ed. London: Elsevier Academic Press, 2020. ISBN 9780128188033.

RESOURCES

Other resources:
1. Problems publication
2. Course slides