Last update: 05-07-2019

230092 - PSAVC - Signal Processing for Communications and Audiovisual Systems

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

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

ECTS credits: 6 Teaching languages: Catalan

Teaching staff

Coordinator: 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

230092 - PSAVC - Signal Processing for Communications and Audiovisual Systems

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

Total learning time: 150h	Hours large group:	65h	43.33%
	Self study:	85h	56.67%

Last update: 05-07-2019

230092 - PSAVC - Signal Processing for Communications and Audiovisual Systems

Content

Lecture 1. Introduction

Learning time: 11h 30m

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

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.

Lesson 2. Detection

Learning time: 14h 30m

Theory classes: 4h 30m
Guided activities: 1h 30m
Self study : 8h 30m

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.

Lesson 3. Estimation Theory

Learning time: 33h

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

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.

Last update: 05-07-2019

230092 - PSAVC - Signal Processing for Communications and Audiovisual Systems

Lesson 4. Optimum Filtering

Learning time: 29h

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

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.

Lesson 5. Adaptive filtering

Learning time: 25h 46m

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

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).

Lesson 6. Spectral estimation

Learning time: 24h 50m

Theory classes: 7h
Guided activities: 4h
Self study : 13h 50m

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.

Last update: 05-07-2019

230092 - PSAVC - Signal Processing for Communications and Audiovisual Systems

Planning of activities

Midterm exam	Hours: 6h Practical classes: 6h
Description: Midterm exam	

(ENG) Proves de resposta llarga (Examen Final)

Qualification 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)

Regulations for carrying out activities

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. London: Elsevier Avcademic Press, 2015. ISBN 9780128015223.

Others resources:

1. Problems publication
2. Course slides