230918 - TRS - Signal Processing

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 ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Montserrat Nájar Martón
Others: Vicente Jiménez Serres

Requirements
Probability and Stochastics Processes - Prerequisite
Signals and Systems - Prerequisite

Degree competences to which the subject contributes

Basic:
CB5. (ENG) GREELEC: Que els estudiants pugin desenvolupar habilitats d’aprenentatge per emprendre estudis superiors amb un alt grau d’autonomia.

Specific:
CE21. (ENG) GREELEC: Capacitat de construir, explotar i gestionar sistemes de captació, transport, representació, processat, emmagatzament, gestió i presentació d’informació multimèdia, des del punt de vista dels sistemes electrònics. (Mòdul de tecnologia específica - Sistemes Electrònics).
CE22. (ENG) GREELEC: Capacitat per a seleccionar circuits i dispositiu electrònics per a la transmissió, l'encaminament o enrutament i els terminals, tant en entorn fixes com mòbils. (Mòdul de tecnologia específica - Sistemes Electrònics).

Teaching methodology
Application lectures.
Lectures.
Lab lectures.
Group work.
Personal work.
Exams with exercises (Controls and Final Exam).
Lab sessions.

Learning objectives of the subject
- Characterization of signals as stochastic processes.
- Detection theory.
- Estimation theory.
- Time-frequency analysis of signals.
- Optimal filtering.
- Adaptive filtering.
## Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>39h</th>
<th>26.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>26h</td>
<td>17.33%</td>
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<td>Self study:</td>
<td>85h</td>
<td>56.67%</td>
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## Content

### Lesson 1. Process characterization in discrete time.

**Description:**
- Vector notation and random variable.
- Characterization of stochastic processes (stationary and ergodic), correlation matrix and properties, power spectral density, discrete processes and linear systems.

**Related activities:**
- Modeling of an AR process.

**Learning time:** 10h  
Theory classes: 8h  
Laboratory classes: 2h

### Lesson 2. Detection theory

**Description:**
- The problem of decision making: verification of hypothesis, terminology and examples
- MAP and Neyman-Pearson criteria
- Detection of deterministic signals and ROC

**Learning time:** 12h  
Theory classes: 10h  
Laboratory classes: 2h

### Lesson 3. Estimation Theory.

**Description:**
- The problem of estimation.
- Estimation of parameters and MVUE estimator.
- Cramer-Rao limit and efficient estimator.
- Estimation of maximum likelihood, MAP and MMSE estimate.

**Learning time:** 17h  
Theory classes: 15h  
Laboratory classes: 2h

### Lesson 4. Optimal filtering.

**Description:**
- Mean square linear estimation.
- Types of filtering: system identification, equalization, cancellation, prediction and interpolation.
- Wiener filter in frequency.
- Linear regression and least squares.

**Learning time:** 11h  
Theory classes: 9h  
Laboratory classes: 2h
Lesson 5. Adaptive filtering

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<th>Learning time: 14h</th>
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<tr>
<td>Theory classes: 10h</td>
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<td>Laboratory classes: 4h</td>
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**Description:**
- Gradient method for linear regression.
- Stochastic gradient methods (LMS).
- Convergence and mismatch. Normalized LMS

**Qualification system**

The completion of all lab sessions and presentation of the corresponding reports during the semester in which the course is taken are mandatory and, therefore, a necessary condition for passing the course. Failure to do so, the student will get a "No Presentat" (NP) for the course without considering the percentages set forth below.

Un control tests consisting of exercises. (25%)
Follow-up of the work in the lab (20%)
Final exam (55%)

**Bibliography**

**Basic:**

**Complementary:**