Course guide
230918 - TRS - Signal Processing

<table>
<thead>
<tr>
<th>Unit in charge:</th>
<th>Barcelona School of Telecommunications Engineering</th>
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<tbody>
<tr>
<td>Teaching unit:</td>
<td>739 - TSC - Department of Signal Theory and Communications.</td>
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<tr>
<td>Degree:</td>
<td>BACHELOR'S DEGREE IN ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018). (Compulsory subject).</td>
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<tr>
<td>Academic year:</td>
<td>2023</td>
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<tr>
<td>ECTS Credits:</td>
<td>6.0</td>
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<tr>
<td>Languages:</td>
<td>Catalan, Spanish</td>
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**LECTURER**

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

Others: 

**PRIOR SKILLS**

- Content associated with Probability and Stochastics Processes
- Content associated with Signals and Systems

**DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES**

**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 dispositius electrònics per a la transmissió, l'encaminament o enrutament i els terminals, tant en entorn fixs com mòbils. (Mòdul de tecnologia específica - Sistemes Electrònics).

**Basic:**

CBS. (ENG) GREELEC: Que els estudiants puguin desenvolupar habilitats d'aprenentatge per emprendre estudis superiors amb un alt grau d'autonomia.

**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>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Self study</td>
<td>85,0</td>
<td>56.67</td>
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<tr>
<td>Hours large group</td>
<td>52,0</td>
<td>34.67</td>
</tr>
<tr>
<td>Hours small group</td>
<td>13,0</td>
<td>8.67</td>
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Total learning time: 150 h

CONTENTS

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.

Full-or-part-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

Full-or-part-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.

**Full-or-part-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.

**Full-or-part-time:** 11h
- Theory classes: 9h
- Laboratory classes: 2h

**Lesson 5. Adaptive filtering**

**Description:**
- Gradient method for linear regression.
- Stochastic gradient methods (LMS).
- Convergence and mismatch. Normalized LMS

**Full-or-part-time:** 14h
- Theory classes: 10h
- Laboratory classes: 4h

**GRADING 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. The lab is not reevaluable.

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

**BIBLIOGRAPHY**

**Basic:**

**Complementary:**