Course guide
230630 - STP - Stochastic Processes

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: Academic year: 2016  ECTS Credits: 2.5
Languages: English

LECTURER

Coordinating lecturer: JAUME RIBA

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.

Transversal:
2. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

3. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

4. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

- Lectures
- Application classes
- Group work (distance)
- Individual work (distance)
- Exercises
- Short answer test (Control) (Mid Term Exam)
- Extended answer test (Final Exam)
LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is to revisit the fundamental concepts and introduction of advanced concepts of the theory of stochastic processes, that is, models for systems that evolve unpredictably in time, from a unified and formal perspective, with a general application framework, and with emphasis on those aspects most related with the field of signal processing and communications. Stochastic Processes constitute a very broad topic that can be approached with different angles, some are more mathematical oriented and some are more application oriented. This means that only some aspects (a small sample) will be covered in the course. Anyway, it is intended to be of great help either for students interested in getting a solid introductory background as a basis for other courses in the masters, and/or for students interested in a more in-depth theory to improve their understanding of the mathematical language used by the scientific community to describe those phenomena which are probabilistic in nature.

In general, the emphasis is put in those concepts more related with the areas of signal processing and communications, moving a little from the direct application and going in further depth. Less emphasis is put on those pure mathematic concepts or in those that are too much specialized. However, in-depth pure mathematics are required sometimes even for applications, and this is always a trade-off that the course tries to respect, balancing theory and intuition as much as possible.

Learning results of the subject:

- Ability to model signals and phenomena in a probabilistic manner.
- Ability to optimize system performance in statistical terms.
- Ability to use analytical tools that are useful in the study of stochastic models that appear in various engineering fields.
- Ability to predict system performance using statistical reasoning, and test it using numerical methods.
- Ability to apply the theory to specific engineering applications.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>36.5</td>
<td>58.40</td>
</tr>
<tr>
<td>Hours large group</td>
<td>26.0</td>
<td>41.60</td>
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</tbody>
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Total learning time: 62.5 h

CONTENTS

1. Random Variables

Description:
- Probability review Flow control
- Two random variables. Independence, orthogonality, uncorrelation.
- Upper bounds on tail probabilities. Markov's, Chebychev and Chernoff bounds
- Sequences of random variables. Convergence types. The sample mean. Law of large numbers. Central limit theorem
- Non linear transformations of zero-mean Gaussian random variables (Price's theorem)
- On Wirtinger Calculus and Lagrange Multippliers)

Full-or-part-time: 56h
Theory classes: 16h
Guided activities: 2h
Self study: 38h
2. Random Processes

Description:
- Definition of random processes and review of deterministic signals.
- Statistical description of random processes: mean, autocorrelation and properties.
- Vector processes and spectral matrix.
- Pure and almost Cyclostationary random processes.
- Time averages, cyclic autocorrelation and cyclic spectrum.
- Response to linear systems to cyclostationary processes.
- Optimum linear and quadratic systems.
- A geometric perspective for random processes.
- Introduction to Poisson, Wiener and Markov processes.

Full-or-part-time: 69h
Theory classes: 23h
Guided activities: 2h
Self study : 44h

0. Required background (at introductory level)

Description:
- Linear algebra and real analysis.
- Probability and random variables (probability density function, expectation, moments).
- Deterministic Signals and Linear Time-Invariant systems (convolution, energy, mean power).
- Fourier analysis (frequency response, Fourier series and Fourier transform).

ACTIVITIES

EXERCISES

Description:
Weekly exercises assignments (individual work).

PROJECTS

Description:
- Description: midterm project assignment (working groups of two persons).
- Description: final project assignment (working group of two persons).

SHORT ANSWER TEST (CONTROL):

Description:
Individual Midterm written exam.
EXTENDED ANSWER TEST (FINAL EXAMINATION)

Description:
Individual Final written exam.

GRADING SYSTEM

Final examination: from 50% to 100%
Partial examinations and controls: from 0% to 50%
Exercises: from 0% to 50%
Individual assessments: from 0% to 25%
Group assessments: from 0% to 50%
The final grade is the maximum between the Final Exam mark and the weighted former mark.

BIBLIOGRAPHY

Basic:

Complementary: