

Course guide

230914 - PPE - Probability and Stochastic Processes

Last modified: 11/04/2025

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN ELECTRONIC ENGINEERING AND TELECOMMUNICATION (Syllabus 2018).
(Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: ORIOL SERRA ALBO

Others: Primer quadrimestre:
ORIOL SERRA ALBO - 10

PRIOR SKILLS

Calculus of one and several variables. Linear algebra.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CE2. (ENG) GREELEC: coneixements bàsics sobre l'ús i programació dels ordinadors, sistemes operatius, bases de dades i programes informàtics amb aplicació a l'enginyeria. (Mòdul de formació bàsica).

Transversal:

CT4. (ENG) GREELEC: TREBALL EN EQUIP: ser capaç de treballar com a membre d'un equip interdisciplinari, ja sigui com un membre més o realitzant tasques de direcció, amb la finalitat de contribuir a desenvolupar projectes amb pragmatisme i sentit de la responsabilitat, assumint compromisos tenint en compte els recursos disponibles.

Basic:

CB2. (ENG) GREELEC: Que els estudiants sàpiguen aplicar els coneixements adquirits al seu treball o vocació d'una forma professional i tinguin les competències que solen demostrar-se per mitjà de l'elaboració i defensa d'arguments i la resolució de problemes dins de la seva àrea d'estudi.

CB3. (ENG) GREELEC: Que els estudiants tinguin la capacitat de reunir i interpretar dades rellevants (normalment dins de la seva àrea d'estudi) per emetre judicis que incloguin una reflexió sobre temes rellevants de caire social, científic o ètic.

TEACHING METHODOLOGY

- Lectures.
- Application classes.
- Exercises.

LEARNING OBJECTIVES OF THE SUBJECT

Probability theory. Random variables. Concepts of Statistics and Stochastic Processes.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

1. Basic probability theory

Description:

Combinatorics: Permutations and combinations. Random experiment, sample space, random events. Probability space. Discrete spaces, Laplace formula. Continuous spaces, Borel sigma-algebra. Independence and conditional probability. Bayes Theorem and the formula of total probability. The meaning of probability.

Related activities:

Questionnaire Basic Probability

Full-or-part-time: 15h

Theory classes: 15h

2. Random variable

Description:

Random variable. Cumulative distribution function. Discrete random variables, probability function. Examples of discrete variables (Bernoulli, geometrical, binomial, Poisson). Continuous random variables, density function. Examples of continuous variables (uniform, exponential, gaussian). Theorem of DeMoivre-Laplace. Conditional density. Functions of one random variable (discrete case, continuous case, special cases). Statistical parameters: Mean, variance, standard deviation. Moments and centered moments. Chebyshev's inequality. Law of large numbers.

Related activities:

Questionnaire Random Variables

Full-or-part-time: 13h

Theory classes: 13h

3. Several random variables

Description:

Several random variables. Joint cumulative distribution function. Discrete case, joint probability function. Continuous case, joint density function. Examples of multidimensional variables (multinomial, uniform, gaussian). Marginal distributions. Independence of random variables. Conditional distributions. Functions of several variables. Sum of random variables: convolution theorem. Change of variables. Theorem of the mean. Covariance and correlation coefficient. Orthogonality, incorrelation and independence. Estimation of random variables. Linear estimation. Orthogonality principle.

Related activities:

Questionnaire Multivariate Random Variables
Partial Exam (3h)

Full-or-part-time: 14h

Theory classes: 14h



4. Statistics

Description:

Random variables relevant in statistics: n-dimensional Gaussian, Chi square, Student's t, Fisher's F. Central Limit Theorem. Populations and samples. Descriptive statistics (histograms, boxplots, scatterplots). Statistical samples: distribution and parameters. Estimation of parameters: method of the moments and method of maximum likelihood. Confidence intervals (for the mean, for the variance, for proportions, for comparing populations).

Related activities:

Questionnaire Statistics

Full-or-part-time: 13h

Theory classes: 13h

5. Stochastic Processes

Description:

Introduction to stochastic processes. Distribution and density functions. Stochastic Mean value, autocorrelation and autocovariance. Stochastic processes Stationary in the strict sense and in a wide sense. Gaussian stochastic processes. The Poisson process. Random oscillations.

Related activities:

Questionnaire Random Processes

Full-or-part-time: 10h

Theory classes: 10h

GRADING SYSTEM

Biweekly questionnaires 10%

Partial exams: 40%

Final exam: 50%

BIBLIOGRAPHY

Basic:

- Leon-Garcia, A. Probability, statistics and random processes for electrical engineering. 3rd ed. Upper Saddle River, NJ: Pearson Education, 2009. ISBN 9780137155606.
- Ross, S.M. Introduction to probability and statistics for engineers and scientists. 5th ed. Oxford: Academic Press, 2014. ISBN 9780123948113.

Complementary:

- Fàbrega, Josep; Fiol, Miquel Àngel; Sanvicente, Emilio; Serra, Oriol. Variables aleatòries i processos estocàstics : problemes. 3a ed. Barcelona: Edicions UPC, 1999. ISBN 9788483013069.
- Aroca, Josep Maria. Probabilitat i variables aleatòries: notas de classe [on line]. 2019 Available on: <https://web.mat.upc.edu/josep.m.aroca/pie/probabilitat-apunts-jmaroca.pdf>.

RESOURCES

Hyperlink:

- <https://chance.dartmouth.edu/>. Resource