

Course guide

230460 - PE - Probability and Statistics

Last modified: 13/06/2023

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

Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Consultar aquí / See here:
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura>

Others: Consultar aquí / See here:
<https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma>

PRIOR SKILLS

Derivatives and integrals of functions of one and several variables.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

3. Ability to select numerical and optimization methods suitable for solving physical and engineering problems. Ability to apply the knowledge of numerical algorithms and optimization.
4. Ability to solve math problems that may arise in engineering. Ability to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, ordinary and partial differential equations, probability and statistics.

General:

1. ABILITY TO IDENTIFY, FORMULATE, AND SOLVE PHYSICAL ENGINEERING PROBLEMS. Planning and solving physical engineering problems with initiative, making decisions and with creativity. Developing methods of analysis and problem solving in a systematic and creative way.

Transversal:

2. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.

TEACHING METHODOLOGY

There will be three theoretical and two practical weekly sessions. The theoretical lectures will be devoted to a careful presentation of the basic concepts and the main results which will be illustrated with some examples. The practical sessions will be devoted to the solution of a variety of exercises and problems.

LEARNING OBJECTIVES OF THE SUBJECT

To study random variables and stochastic processes as main tools for modelling random phenomena. To present the applications of probability theory to statistical inference.

Learning outcomes:

- To use correctly the formal mathematical language of probability theory.
- To master probability calculus and the use of random variables and random vectors.
- To know the main ideas and methods of Statistics.
- To know the main concepts on stochastic processes.
- To understand the Poisson process and others of interest in physics and engineering.

STUDY LOAD

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

Total learning time: 150 h

CONTENTS

1. Basic Probability

Description:

- 1.1 Deterministic and stochastic mathematical models. Random experiments. Classical and frequency definitions of probability.
- 1.2 Axiomatic definition of probability. Discrete and continuous probability spaces.
- 1.3 Independence and conditional probability. The law of total probability and Bayes' formula.

Full-or-part-time: 21h

Theory classes: 5h

Practical classes: 4h

Self study : 12h

2. Random Variables

Description:

- 2.1 The notion of random variable. Probability distribution function.
- 2.2 Discrete random variables. Examples: Bernoulli, binomial, geometric, Poisson.
- 2.3 Continuous random variables. Probability density function. Examples: uniform, exponential, Gaussian. De Moivre-Laplace's Theorem. Mixed random variables.
- 2.4 Conditional distribution and density functions.
- 2.5 Functions of a random variable.

Full-or-part-time: 22h

Theory classes: 6h

Practical classes: 4h

Self study : 12h

3. Statistical Parameters

Description:

- 3.1 Mean and variance.
- 3.2 Expectation theorem. Moments and central moments.
- 3.3 Markov and Chebyshev's inequalities. Frequency interpretation of probability.

Full-or-part-time: 10h

Theory classes: 2h
Practical classes: 2h
Self study : 6h

4. Random Vectors

Description:

- 4.1 Multidimensional random variables. Joint distribution and density functions.
- 4.2 Independent random variables. Conditional density functions. Conditional expectation.
- 4.3 Functions of several random variables. Sum of independent random variables: convolution theorem.
- 4.4 Expectation of sums and products. Covariance and correlation coefficient.
- 4.5 Multidimensional Gaussian random variables.

Full-or-part-time: 27h

Theory classes: 7h
Practical classes: 4h
Self study : 16h

5. Statistical Inference

Description:

- 5.1 The weak law of the large numbers. The central limit theorem.
- 5.2 Distributions arising from the normal law (chi-square, t, F).
- 5.3 Sampling. Parameter estimation.
- 5.4 Confidence intervals. Statistical hypothesis testing. Distribution fitting.
- 5.5 Least squares estimation.

Full-or-part-time: 42h

Theory classes: 12h
Practical classes: 7h
Self study : 23h

6. Introduction to Stochastic Processes

Description:

- 6.1 The notion of a stochastic process. Distribution and density functions of order n.
- 6.2 Mean, autocorrelation and autocovariance of a process.
- 6.2 Strict and wide sense stationary stochastic processes.
- 6.3 Gaussian processes.

Full-or-part-time: 14h

Theory classes: 4h
Practical classes: 2h
Self study : 8h

7. The Poisson Process

Description:

- 7.1 The Poisson process. Transitions statistics.
- 7.2 Processes arising from the Poisson process.
- 7.3 Introduction to time-continuous Markov processes.

Full-or-part-time: 14h

Theory classes: 4h
Practical classes: 2h
Self study : 8h

GRADING SYSTEM

There will be a final exam (EF) and a partial exam (EP). The students' participation in practical sessions will be also taken into account (P). The final score will follow from
 $\max(EF, 0.65*EF+0.30*EP+0.05*P)$

Students who do not pass the subject in the ordinary call may do an extraordinary exam at the end of the academic year that reevaluates the whole subject.

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. A first course in probability. 10th ed. Harlow, England: Pearson Education, 2020. ISBN 9781292269207.
- De Groot, M.H. Probabilidad y estadística. 2a ed. Wilmington, DE: Addison-Wesley Iberoamericana, 1988. ISBN 0201644053.
- Fàbrega, J. [et al.]. Variables aleatòries i processos estocàstics: problemes. 3a ed. Barcelona: Edicions UPC, 1999. ISBN 9788483013069.

Complementary:

- Sanz, M. Probabilitats. Barcelona: Edicions Universitat de Barcelona, 1999. ISBN 8483380919.
- Grimmett, G.R.; Stirzaker, D.R. Probability and random processes. 3rd ed. Oxford: Oxford University Press, 2001. ISBN 0198572220.
- Ross, S.M. Introduction to probability models [on line]. 12th ed. Amsterdam: Academic Press, 2019 [Consultation: 22/10/2020]. Available on: <https://www.sciencedirect.com/science/book/9780123756862>. ISBN 9780128143469.

RESOURCES

Other resources:

Aroca, J.M. Probabilitat i Processos Estocàstics, classnotes ETSETB.
Aroca, J.M. Estadística, classnotes ETSETB.
Problems set.