230460 - PE - Probability and Statistics

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN ENGINEERING PHYSICS (Syllabus 2011). (Teaching unit Compulsory)
ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: JOSEP FÀBREGA CANUDAS

Others: JOSEP FÀBREGA CANUDAS
JORGE LUIS VILLAR SANTOS

Prior skills

Derivatives and integrals of functions of one and several variables.

Degree competences to which the subject contributes

Specific:
2. Ability to select numerical and optimization methods suitable for solving physical and engineering problems. Ability to apply the knowledge of numerical algorithms and optimization.
1. 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.
Generical:
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 an random vectors.
- To known 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.

Last update: 06-05-2019

230460 - PE - Probability and Statistics

Study load

Total learning time: 150h	Hours large group:	65h	43.33%
	Self study:	85h	56.67%

Last update: 06-05-2019

230460 - PE - Probability and Statistics

Content

1. Basic Probability

Learning time: 21h

Theory classes: 5h
Practical classes: 4h
Self study : 12h

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.

2. Random Variables

Learning time: 22h

Theory classes: 6h
Practical classes: 4h
Self study : 12h

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.

3. Statistical Parameters

Learning time: 10h

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

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.

Last update: 06-05-2019

230460 - PE - Probability and Statistics

4. Random Vectors

Learning time: 27h

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

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.

5. Statistical Inference

Learning time: 42h

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

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.

6. Introduction to Stochastic Processes

Learning time: 14h

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

Description:
6.1 The notion of 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.

Last update: 06-05-2019

230460 - PE - Probability and Statistics

7. The Poisson Process	Learning time: 14h Theory classes: 4h Practical classes: 2h Self study : 8h

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

Qualification 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.

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. 8th ed. Upper Saddle River: Pearson Education International, 2010. ISBN 9780136079095.

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. 10th ed. Amsterdam ; Boston: Academic Press, 2010. ISBN 9780123756862.

Others resources:

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