UNIVERSIDAD DE MURCIA

FACULTY OF MATHEMATICS

Deepening in Probability and Stochastic Processes

Syllabus

Course code:	1595
Number of ECTS credits:	6
Semester:	2nd (February-June)
Prerequisites:	None
Recommended components:	Elements of probability and statistics (1576) and Probability Theory (1590). Have general knowledge of Combinatorics, Matricial Algebra, Mathematical Analysis and Measure Theory.
Language of instruction:	Spanish. (Students are allowed to write homework and exams in English)

Course description

The main generating functions used in Probability Theory are studied in this subject, particularly the characteristic function. We will study also the different modes of convergence of sequences of random variables and an introduction to stochastic processes.

Learning outcomes and competences

After completion of this course you will:

1. know the generating functions and their main properties, mainly the characteristic function.
2. know deeply the main unidimensional and multidimensional probability distributions.
3. know different versions of the central limit theorem.
4. know different versions of the laws of large numbers.
5. know the general concept of stochastic process and some of the most usual processes.

Course contents

I. Regression.

Regression line. Regression curve.

II. Generating functions.

Unidimensional probability generating function. Unidimensional moment generating function. Unidimensional characteristic generating function. Multidimensional generating functions.

III. Characteristic function. Inversion Theorem.

Inversion theorem. Derivability of the characteristic function. Continuity theorems.

IV. Notable probability distributions.

Some unidimensional discrete distributions. Some unidimensional continuous distributions. Multinomial distribution. Bivariate and multivariate normal distribution.

V. Convergence of sequences of random variables.

Almost sure convergence. Convergence in probability. Convergence in distribution. Convergence in p-th mean. Relationships between the different types of convergence.

VI. The central limit theorem.

Introduction. Convergence to the normal law under different hypothesis.

VII. Laws of large numbers.

The weak law of large numbers. The strong law of large numbers.

VIII. Stochastic processes.

Stochastic processes. Finite-dimensional distributions of an stochastic process. Kolmogorov's Theorem.

IX. Markov chain. Poisson process.

Definition of Markov Chain. Examples. Chapman-Kolmogorov equation. Finite Markov chains. Expression of the matrix P^n. Introduction to the Poisson process. Applications.

References

1. Billingsley, P. *Probability and Measure*; John Wiley and Sons, 1979.
2. Feller, W. *Introducción a la teoría de las probabilidades y sus aplicaciones*; Limusa, 1985.
3. Koralov, L.B. and Sinai, Y.G. *Theory of probability and random processes*; Springer, 2007.
4. Ross, S.M. *Introduction to probability models*; Academic Press, 1989.
5. Ross, S.M. *Stochastic models*; John Wiley and Sons, 1996.
6. Zoroa, P. and Zoroa, N. *Elementos de probabilidades*; DM, 2008