SYLLABUS

Stochastic Processes for Engineers:

Theory and Applications

I.- DATA AND IDENTIFICATION

Course name:	**Stochastic Processes for Engineers: Theory and Applications**
Character:	**Mandatory**
Studies:	**Master Advanced Sciences of Modern Telecommunications**
Cicle:	**Postgraduate**
Departament:	**Estadística i Investigació Operativa**
Instructor:	**Francisco Montes**

II.- GENERAL

The course of Stochastic Processes for Engineers: Theory and Applications is a *mandatory* course of the Master in Systems and Services in the Society of the Information, with a total of 5 ECTS.

The course has a theoretical character, but special emphasis will be put in showing the applications of probability and stochastic processes in engineering, particularly in the field of telecommunications and signal processing. Some classes will take place in the computing lab to acquaint the students in the use of *ad hoc* statistical packages, R and/or Matlab.

III.- WORK SCHEME

Lectures	3 h/week x 10 weeks	30 hours
Computing labs	1 h/week x 10 weeks	10 hours
Lectures preparation	2 h/lecture x 20 lectures	40 hours
Homewok and exams preparation		40 hours
Exams		3 hours
Tutorials		7 hours
	Total	**130 hours**

IV.- AIMS

- The aims of this course are:
  - To remember the essentials of the Theory of Probability.
  - To acquaint the student with the theory of the Stochastic Processes and its application to the field of the telecommunication and related problems.

V.- SKILLS TO BE ACQUIRED

- Acquisition of a general knowledge on the matter.
- Acquisition of practical knowledge on the use and application of the Stochastic Processes in the field of the telecommunications.

VI.- CONTENT AND SCHEDULE

- Part I: *Probability space. Random variables and random vectors. Convergence of random sequences*.

  The aim of this part is to provide students with a basic background indispensable for following the rest of contents.

- Part II: *Stochastic processes*

  This part constitutes the core of the matter and seeks to acquaint the student with the concept of stochastic process and his properties. This part is completed with the study of some of the most well-known processes: White noise, Random walk, Poisson and Wiener processes.

- Part III: *Statistical signal processing*

  The third part is devoted to the applications of the theory previously exposed in the field of the telecommunications, with special emphasis on statistical signal processing.

Chapter	Topic	Semanas
1	**Probability space. Random variables. Random vectors. Conditional distributions.**	1
2	**Expectation. Inequalities. Characteristic function.**	1
3	**Convergence of sequences of random variables. Types of convergences. Law of large numbers. Central limit theorem.**	1

4	**Stochastic processes. Classification of stochastic processes. Wide sense stationarity. Point processes. Poisson processes. Markov chains.**	3
5	**Linear transformations of stationary processes. Doob decomposition. Stochastic Karhunen-Loeve expansions. Campbell Theorem.**	2
6	**Statistical signal processing. Kalman filter. Wiener filter for random sequences. Stochastic simulation.**	2

VII.- REFERENCES

Chapters 1, 2 and 3:

- Billingsley, P. *Probability and Measure*. 3rd edition. ISBN: 0471007102, Wiley (1995)
- Kay, S. *Intuitive Probability and Random Processes using MATLAB*. ISBN: 0387241574, Springer (2005)
- Montes, F. *Introducción a la Probabilidad*. Notas de clase. Dpt. d'Estadística i I. O. (2004)

Chapters 4, 5 and 6:

- Balakrishnan, A. V. *Introduction to Random Processes in Engineering*. ISBN: 978-0-471-74502-0, Wiley (2005)
- Billingsley, P. *Probability and Measure*. 3rd ·dition. ISBN: 0471007102, Wiley (1995)
- Dougherty, E. R. *Random Processes for Image Signal Processing*. ISBN: 0780334957, Wiley-IEEE Press (1998)
- Kay, S. *Intuitive Probability and Random Processes using MATLAB*. ISBN: 0387241574, Springer (2005)
- León-García, A. *Probability and Random Processes for Electrical Engineering*. 2nd Edition. ISBN: 020150037X, Addison-Wesley (1994)
- Miller, S. L. and Childers, D. G. *Probability and random processes: with applications to signal processing and communications*. ISBN: 0121726517, Elsevier Academic Press, (2004)
- Stark, H. and Woods, J. W. *Probability and Random Processes with Applications to Signal Processings*. 3rd Edition. ISBN: 0130200719, Prentice Hall (2002)

VIII.- PREREQUISITES

- Basic background in Algebra, Calculus and Probability.

IX.- METHODOLOGY

The methodology of the course will consist principally of lectures, reinforced with some sessions in the computing lab, homework and a final project.

- **Lectures.** During these classes the key concepts will be introduced and examples will be furnished in order to help students understanding the theory and to show its applicability to real problems. The participation of students during the classes will be encouraged.

- **Homework** will complement the work in class. Mostly it will involve the working out of problems. You are encouraged to work together on the homework, but do not copy any part of a homework. Each student must produce his/her own homework to be handed in. Homework solutions will be made available shortly after the due date. I will endeavor to make the homework solutions detailed enough to allow you to understand how the question could be approached.

- **The final project** which will be an application of the methods taught in class, or a review article on a special topic of interest. Each person in the class will be required to hand in a report of roughly 8-10 pages.

X.- COURSE GRADING

The course grade will be based on the final score derived from the weighted average of percentage scores on the following items:

- Final exam 60%
- Final project presentation and report 30%
- Participation in class discussions on reading assignments 10%.

XI.- DISCLAIMER

This syllabus should be taken as a fairly reliable guide for the course content. However, you cannot claim any rights from it and in particular I reserve the right to change due dates or the methods of assessment. Official announcements will ALWAYS be those made in class.