

ELEMENTS OF STATISTICS AND SIGNAL PROCESSING

1.1. Identification

University:	Alma Mater Studiorum – Università di Bologna												
School:	School of Engineering												
Course:	Elements of Statistics and Signal Processing												
ECTS:	6												
Semester:	<i>Winter</i>				X	<i>Summer</i>							
Category	<i>Fundamental course</i>					X	<i>Specialisation course</i>						
Module	<i>MFI</i>		<i>MFI</i>		<i>MFI</i>	X	<i>MSI</i>		<i>MSI</i>		<i>MSI</i>		
Teachers:	Riccardo Rovatti												
Language:	<i>English</i>	X	<i>Italian</i>	X	<i>Swedish</i>		<i>Spanish</i>						

1.2. Learning-outcomes

- knowledge about the fundamentals of statistical modelling of signals treated in electronic equipment.
- knowledge about the mathematical tools allowing the atatistical design of information processing devices

1.3. Competencies

▪ General

- To have critical understanding of technical and scientific tools.
- To be able to select and apply appropriate mathematical models.
- Communication skills.
- To be able to work in an international context

▪ Specific

- To understand the methods for modelling signals as stochastic quantities.
- To understand the methods for modelling some information processing tasks in statistical terms.
- To perform simple classical statistical analysis of signals by analytic and numerical means.

1.4. Contents

1. Review of basic mathematical tools. Introduction to some ad-hoc more advanced math,
2. Review of basic concepts related to random variables and stochastic processes.
3. Stationarity, ergodicity, exactness.
4. The action of linear blocks on stochastic vector processes.

5. The action of quantization on stochastic processes.
6. Gaussian random vectors and processes.
7. Limit behaviours.
8. Power spectrum.
9. Linear prediction and Wold decomposition.
10. Self-similar processes and $1/f$ noise.
11. Finite memory processes.
12. Finite Markov chains.

1.5. Teaching Methodology

- Lecture sessions.

1.6. Evaluation

- Oral exams

1.7. Bibliography

- P. Billingsley. *Probability and Measure*. John Wiley & Sons, New York, 3rd edition, 1995.
- B. Sz-Nagy F. Riesz. *Functional Analysis*. Ungar, New-York, 1955.
- R.G. Gallager. *Information Theory and Reliable Communication*. John Wiley & Sons, New York, 1968.
- S. M. Kay. *Fundamentals of Statistical Signal Processing - Estimation Theory*. Prentice-Hall, London, 1993.
- M. Loève. *Probability Theory I*. Springer-Verlag, New York, 1977.
- E. Seneta. *Non-negative Matrices and Markov Chains*. Springer Verlag, New York, 1980.
- A.N. Shiryayev. *Probability*. Springer Verlag, New York, 2nd edition, 1989.