Universida_{de}Vigo

IDENTIFYING DATA
Statistical Signal Processing

Subject	Statistical Signal Processing				
Code	V05M145V01303				
Study programme	Máster Universitario en Ingeniería de Telecomunicación				
Descriptors	ECTS Credits		Choose	Year	Quadmester
	5		Optional	2nd	1st
Teaching language	English				
Department					
Coordinator	López Valcarce, Roberto				
Lecturers	López Valcarce, Roberto				
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General description	Statistical Signal Processing, encompassing both estimation and detection theory, can be found at the core of many decision-making and information-extracting systems, including communications, audio and image processing, biomedicine, radar, and big data systems, just to name a few. In this course an introduction to the basics of estimation and detection theory is provided. Since the course is targeted to electrical engineering students, the focus is on the development of practical estimation and detection algorithms amenable to implementation in digital processing systems.				

Training and Learning Results

Code	
B4	CG4 Capacity for mathematical modeling, calculation and simulation in technological centers and engineering companies, particularly in research, development and innovation tasks in all areas related to Telecommunication Engineering and associated multidisciplinary fields.
B8	CG8 Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
C23	CE23/PS3 Ability to apply methods of statistical processing of signal communications systems and audiovisual.

Expected results from this subject

Expected results from this subject	Training and Learning Results
Ability to apply statistical estimation techniques in communications and multimedia systems	C23
Ability to apply statistical detection techniques in communications and multimedia systems	C23
Ability to determine and interpret fundamental limits in estimation and detection problems	B4 C23
Ability to evaluate the performance of estimation and detection techniques, by analytical as well as by Monte Carlo simulation methods	B8 C23

Contents

Topic	
Part 1: Parameter Estimation	- The statistical estimation problem. Performance metrics: bias, variance, MSE. Minimum Variance Unbiased Estimator (MVUE). - Fisher Information and Cramer-Rao bound. Slepian-Bangs formula. - Best Linear Unbiased Estimator (BLUE) and Maximum Likelihood Estimator (MLE): definition, properties, and examples.

Part 2: Detection Theory		- Hypothesis tests: types. Performance metrics: false positives and false negatives. ROC curves.	
		- Neyman-Pearson theorem: likelihood ratio.	
		- Detection under the Bayesian philosophy: probability of error, risk, optimum detector.	
		- Examples: deterministic and random signals	

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	21	23	44
Practices through ICT	7	7	14
Autonomous problem solving	0	14	14
Autonomous problem solving	0	14	14
Simulation	0	25	25
Objective questions exam	2	12	14

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Lecturing	Presentation of main topics, possibly with audiovisual aids. Skills involved: CG4, CG8
Practices through ICT	Computer-based simulation in the lab, under the MATLAB programming environment, of statistical signal processing applications to communications and multimedia, via Monte Carlo methods. Performance analysis. Skills involved: CG8, CE23
Autonomous problem solving	Students will be given a series of short homework assignments throughout the course that they should turn in by the set deadline. Skills involved: CG4, CG8, CE23
Autonomous problem solving	
Simulation	Computer-based simulation of statistical signal processing applications to communications and multimedia, via Monte Carlo methods. Performance analysis. Skills involved: CG8, CE23

Personalized assistance

Methodologies	Description
Lecturing	Student aid will be provided during office hours by appointment, as well as on-line (email). See https://moovi.uvigo.gal/user/profile.php?id=11637
Practices through ICT	Student aid will be provided during lab hours and office hours by appointment, as well as on-line (email). See https://moovi.uvigo.gal/user/profile.php?id=11637

Assessment

	Description	Qualification	Training and Learning Results	
Autonomous problem solving	Students will be given a series of short homework assignments throughout the course that they should turn in by the set deadline.	30	B4 B8	C23
Autonomous problem solving	(*)Asignaranse unha serie de exercicios ao longo do curso que os estudantes deberán resolver e entregar no prazo fixado	30	B4 B8	C23
Objective questions exam	Comprehensive test in which students must solve a number of exercises or problems.	40	B4 B8	C23

Other comments on the Evaluation

Students may choose one of the following two assessment options:

1) Continuous assessment: Final grade will consist of:

- comprehensie test (up to 4 points)

- homework assignments (up to 6 points)

A minimum grade of 35% in the comprehensive test is required in order to pass the course. Otherwise, the overall grade will be:

a) 4 points, if the overall grade without considering the 35% requirement in the test is no less than 5.

b) Directly that of the comprehensive test, otherwise.

Homework grades from the ordinary call will be kept for the extraordinary call, in which the student will be allowed to retake the comprehensive test. Students assume continuous assessment with the submission of any homework assignment.

2) Global assessment: The final grade is the one achieved in the comprehensive test, for both the ordinary and extraordinary calls.

Plagiarism is regarded as serious dishonest behavior. If any form of plagiarism is detected in any of the reports or exams, the final grade will be FAIL (0), and the incident will be reported to the corresponding academic authorities for prosecution.

Sources of information
Basic Bibliography
S. M. Kay, **Fundamentals of Statistical Signal Processing, vol. I: Estimation Theory**, 1, Prentice Hall, 1993
S. M. Kay, **Fundamentals of Statistical Signal Processing, vol. II: Detection Theory**, 1, Prentice Hall, 1998
Complementary Bibliography
L. L. Scharf, **Statistical signal processing: detection, estimation and time series analysis**, 1, Pearson, 1991
T. K. Moon, W. C. Stirling, **Mathematical Methods and Algorithms for Signal Processing**, 1, Pearson, 1999
IEEE, **http://ieeexplore.ieee.org/**,

Recommendations

Subjects that are recommended to be taken simultaneously
Communication Advanced Systems/V05M145V01302

Subjects that it is recommended to have taken before
Data Communication/V05M145V01204
Signal Processing in Communications/V05M145V01102