# Universida<sub>de</sub>Vigo

Subject Guide 2023 / 2024

IDENTIFYIN	IDENTIFYING DATA							
Statistical	Signal Processing							
Subject	Statistical Signal							
	Processing							
Code	V05M145V01303							
Study	Máster							
programme	Universitario en							
	Ingeniería de							
	Telecomunicación							
Descriptors	ECTS Credits	Choose	<u>Year</u>	Quadmester				
	5	Optional	2nd	1st				
Teaching	English							
language								
Department								
Coordinator	López Valcarce, Roberto							
Lecturers	López Valcarce, Roberto							
E-mail	valcarce@gts.uvigo.es							
Web	http://moovi.uvigo.gal							
General	Statistical Signal Processing, encompassing both estimation and detection theory, can be found at the core of							
description	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	B8
Monte Carlo simulation methods	C23

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

- 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

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

	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 statistica 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 IC	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	Tra	ining and
	·		Learn	ing Results
Autonomous problem	Students will be given a series of short homework assignments	30	В4	C23
solving	throughout the course that they should turn in by the set deadline.		В8	
Autonomous problem	(*)Asignaranse unha serie de exercicios ao longo do curso que os	30	В4	C23
solving	estudantes deberán resolver e entregar no prazo fixado		В8	
Objective questions	Comprehensive test in which students must solve a number of	40	B4	C23
exam	exercises or problems.		В8	

# 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