# Universida<sub>de</sub>Vigo

### Subject Guide 2023 / 2024

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(*)Estatístic	a avanzada nara a enveña	ría hiomédica			
Subject	(*)Estatística				
Subject	avanzada para a				
	enxeñaría				
	biomédica				
Code	V04M192V01101				
Study	Máster				
programme	Universitario en				
	Ingeniería				
	Biomédica				
Descriptors	ECTS Credits		Choose	Year	Quadmester
	6		Mandatory	1st	1st
Teaching	Spanish	·			
language	Galician				
Department					
Coordinator	de Uña Álvarez, Jacobo				
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Lecturers	de Uña Álvarez, Jacobo				
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General	This course aims to be a usef	ul tool in the training o	of a biomedical engi	neer. Its main c	bjective is to train
description	students in the knowledge and handling, both at a theoretical and practical level, of statistical techniques and				
	the design of experiments applicable in the field of biomedical engineering.				
Training an	d Learning Results				

I I a	
Cod	e
A2	That the students can apply their knowledge and their ability to solve problems in new or unfamiliar environments
	within broader (or multidisciplinary) contexts related to their field of study.
A4	Students can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and
	non-specialist audiences clearly and unambiguously.
B1	Ability to design, develop, implement, manage and improve products and processes in the different areas of the
	biomedical engineering, by means of appropriate analytical, computational or experimental techniques.
B2	Ability to direct activities related to the CG1 competence
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Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and B5 other similar works.

B8

Ability to apply the principles and methods of quality. Ability to design, implement and manage suitable experiments, analyze their results and draw conclusions in the field C1 of biomedical engineering.

Expected results from this subject			
Expected results from this subject	Training and		
	Learning Results		
Know data analysis techniques and design of experiments applicable to biomedical engineering.	A2		
	B1		
	B5		
	C1		
Apply data analysis and experiment design techniques in the field of biomedical engineering.	A2		
	A4		
	B1		
	B2		
	B5		
	B8		
	C1		

Contents	
Торіс	
Topic 1. Extension of experimental design and analysis	Basic principles and concepts of experimental design. Replicated designs. Blocking factor. Interaction. Factorial design with two factors: model, relevant hypothesis tests, ANOVA II table, main effects model. Factorial design with three factors. Fractional designs. One-half fraction of a 2 <sup>k</sup> design: main fraction and complementary fraction. Fractions of three- factor designs: Latin squares.
Topic 2. Introduction to quality control	Dimensions of quality and engineering. Basic principles of statistical quality control. Control by variables and control by attributes. Control charts: warning limits, action limits and decision rules. Characteristic operating function. Control by variables: x-bar chart, R chart, S chart, charts for individual measurements. Capability analysis. Control by attributes: p-chart, np-chart, c-chart and u-chart.
Topic 3. Industrial reliability and survival analysis	Concept of reliability and reliability measures. Reliability function and failure rate function. Mean residual life time. Notable probabilistic models: Exponential, Gamma, Weibull, Lognormal, Loglogistic. System reliability. Reliability studies: censored data and truncated data. Parametric methods of estimation and inference on reliability. Non-parametric methods: Kaplan-Meier and Nelson-Aalen curves. Goodness-of-fit plots. Accelerated life tests. Cox regression. Multiple types of failure.
Topic 4. Linear methods in regression and classification	Linear model and generalised linear model (logistic and Poisson). Estimation and inference. Model evaluation and selection (prediction error; information criteria; cross-validation and bootstrap). Variable selection and regularisation (variable subset selection; stepwise regression; LASSO and Ridge regression). Dimension reduction.
Topic 5. Non-linear methods in regression and classification	Modelling of non-linear effects: expansion in bases and penalised spline regression. Generalised additive model. Estimation and inference. Regression and classification methods based on trees: decision trees and random forests. Brief introduction to support vector machines and neural networks.

Planning					
	Class hours	Hours outside the classroom	Total hours		
Lecturing	30	48	78		
Practices through ICT	18	36	54		
Autonomous problem solving	0	15	15		
Essay questions exam	3	0	3		

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

# Methodologies

	Description
Lecturing	The contents of the subject will be presented in a lecture session.
Practices through ICT	Data processing through the use of free R software.
Autonomous problem solving	Autonomous resolution of practical exercises proposed during the theory classes.

Personalized assistance			
Methodologies	Description		
Lecturing	In all the methodologies foreseen in this subject, personalized attention is contemplated, both in the classroom and through voluntary tutorials.		
Practices through ICT	In all the methodologies foreseen in this subject, personalized attention is contemplated, both in the classroom and through voluntary tutorials.		
Autonomous problem solving	In all the methodologies foreseen in this subject, personalized attention is contemplated, both in the classroom and through voluntary tutorials.		

Assessment				
Description	Qualification	Т	rainin	g and
		Lea	rning	Results
Practices through Attendance at practicals and resolution of six practical case studies	60	A2	B1	C1
ICT throughout the course. Students will carry out practical cases of data		A4	B2	
analysis using R software. Each case study will account for 10% of the final			B5	
grade			B8	

A2 A4	B1 B2	C1
	B5	
	B8	

#### Other comments on the Evaluation

Continuous evaluation: The student's work throughout the course will be evaluated. In the final qualification, the tests carried out throughout the course (practical cases) will represent 60% and the final exam (to be made on the official date) 40%. To pass the subject, it will be compulsory to attend the final exam and to obtain qualification higher than 4 points (out of 10). In case of not obtaining in the final exam the minimum qualification to pass the subject, the grade to appear in the official record will be the minimum between 4.9 and the final qualification (weighted).

Second opportunity: In the second opportunity the same scale will be applied as in the continuous evaluation, with the practicals carried out throughout the course accounting for 60% and the final exam for 40%. In this case the qualifications of the practicals carried out throughout the course will be maintained and only the final exam will be repeated, in which a qualification higher than 4 points (out of 10) must be obtained in order to pass the subject. In case of not obtaining in the final test the minimum qualification to pass the subject, the grade to appear in the official record will be the minimum between 4.9 and the final qualification (weighted).

Global evaluation: As an alternative to the continuous evaluation system, students may choose, according to the mechanism established by the School, to be evaluated with a final exam that will represent 100% of the qualification. In this case, it will be necessary to obtain a qualification higher than 5 points (out of 10) in order to pass the subject.

Students are strongly requested to fulfill a honest and responsible behavior. It is considered completely unacceptable any alteration or fraud (i.e., copy or plagiarism) contributing to modify the level of knowledge and abilities acquired in exams, evaluations, reports or any kind of teacher proposed work. Fraudulent behavior may cause failing the course for a whole academic year. An internal dossier of these activities will be built and, when re-offending, the university rectorate will be asked to open a disciplinary record.

## Sources of information

#### Basic Bibliography

James, G., Witten, D., Hastie, T., Tibshirani, R., An Introduction to Statistical Learning: With Applications in R (https://www.statlearning.com), 2, Springer, 2021

Hastie, T., Tibshirani, R., Friedman, J., The Elements of Statistical Learning: Data Mining, Inference, and Prediction (https://hastie.su.domains/ElemStatLearn/), 2, Springer, 2009

Montgomery, D.C., Runger, G.C., Hubele, N.F., Engineering Statistics, 5, Wiley, 2011

Complementary Bibliography

Wood, S., Generalized Additive Models: An introduction with R., 2, Chapman and Hall/CRC Texts in Statistical Science, 2017

Faraway, J.J., Linear models with R, 2, Chapman and Hall, 2015

Dean, A., Voss, D., Design and Analysis of Experiments., Springer, 1999

Kuehl, R.O., **Diseño de experimentos. Principios Estadísticos para el Diseño y Análisis de Investigaciones**, 2, Thomson, 2001

Ryan, T.P., Modern Experimental Design, Wiley, 2007

Vilar Fernández, J.M., Modelos Estadísticos Aplicados, Universidade da Coruña, 2003

Montgomery, D.C., Control Estadístico de la Calidad, 3, Limusa Wiley, 2004

Montgomery, D.C., Introduction to Statistical Quality Control, Wiley, 2009

Kalbfleisch, J. D. y Prentice, R. L., **The Statistical Analysis of Failure Time Data**, 2, Wiley, 2011 Lawless, J. F., **Statistical Models and Methods for Lifetime Data**, 2, Wiley, 2003

Recommendations