Teaching Guide				
Identifying Data				2014/15
Subject (*)	Deseño e Análise de Experimentos		Code	614493010
Study programme	Mestrado Universitario en Técnicas Estadísticas (Plan 2011)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First-Second	Optativa	5
Language				
Prerequisites				
Department	Matemáticas			
Coordinador	Vilar Fernandez, Jose Antonio	E-mail	jose.vilarf@udc.es	
Lecturers	Vilar Fernandez, Jose Antonio	E-mail	jose.vilarf@udc.es	
Web				
General description	Introducir ao estudante nos principios básicos da planificación experimental, proporcionar un amplo rango de modelos etatísticos para a análise de datos procedentes de experimentos planificados e adquirir destreza no manexo sas técnicas de inferencia, enfatizando o axeitado do seu uso en función dos obxectivos buscados e das súas condicións de aplicabilidade. Complementar a aprendizaxe de aspectos teóricos e metodolóxicos co apoio do software.			

Study programme competences	
Code	Study programme competences
A1	A adquisición dos coñecementos de estatística e investigación operativa necesarios para a incorporación en equipos multidisciplinares pertencentes a diferentes sectores profesionais.
A2	Capacidade para comprender, formular, formular e resolver aqueles problemas susceptibles de ser abordados a través de modelos da estatística e da investigación operativa.
A3	Coñecer as aplicacións dos modelos da estatística e a investigación operativa.
A4	Coñecer algoritmos de resolución dos problemas e manexar o software axeitado.
A5	Modelar a dependencia entre unha variable resposta (dependente) e varias variables explicativas (independentes).
A6	Realizar inferencias respecto aos parámetros que aparecen no modelo.
A7	Tratamento de datos e análise estatística dos resultados obtidos.
A8	Capacidade de identificar e resolver problemas que requiran o uso de técnicas da análise de series de tempo.
A9	Obter os coñecementos precisos para unha análise crítica e rigorosa dos resultados.
A10	Complementar a aprendizaxe dos aspectos metodolóxicos con apoio de software.
A11	Adquirir destrezas na formulación e resolución de problemas cuantitativos.
A12	O estudante será capaz de comprender a importancia da Inferencia Estatística como ferramenta de obtención de información sobre a poboación en estudo, a partir do conxunto de datos observados dunha mostra representativa desta. Para iso deberá recoñecer a diferenza entre estatística paramétrica e non paramétrica.
A13	Ser capaz de manexar diverso software (en particular R) e interpretar os resultados que proporcionan estes nos correspondentes estudos prácticos.
A15	Fomentar a sensibilidade cara aos principios do pensamento científico, favorecendo as actitudes asociadas ao desenvolvemento dos métodos matemáticos, como: o cuestionamento das ideas intuitivas, a análise crítica das afirmacións, a capacidade de análise e síntese ou a toma de decisións racionais.
B1	Ser capaz de identificar un problema da vida real.
B2	Dominar a terminoloxía científica-metodolóxica para comprender e interactuar con outros profesionais.
B4	Habilidade para realizar a análise estatística con ordenador.
B5	Escoller o deseño máis axeitado para responder á pregunta de investigación.
B6	Utilizar as técnicas estatísticas máis axeitadas para analizar os datos dunha investigación.
B7	Planificar, analizar e interpretar os resultados dunha investigación considerando tanto os aspectos teóricos coma os metodolóxicos.
B8	Habilidade de xestión administrativa do proceso dunha investigación.
B9	Comunicación e difusión dos resultados das investigacións.
B10	Lectura con xuízo crítico de artigos científicos dende unha perspectiva metodolóxica.

C3	Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.
C6	Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.
C8	Valorar a importancia que ten a investigación, a innovación e o desenvolvemento tecnolóxico no avance socioeconómico e cultural da sociedade.

Learning outcomes			
Subject competencies (Learning outcomes)	Study programme competences		
To be able of planning experiments following a set of suitable stages, identifying all sources of variation, specifying the experimental procedure and the anticipated difficulties, and formulating proper mathematical models.	AC2 AC3 AC5 AC8 AC11 AC12	BC1 BC2 BC5 BC8 BC10	CC6 CC8
To use statistical software fluently.	AC4 AC10 AC13	BC2 BC8 BC9 BC10	CC3
To acquire capability to take part from a multidisciplinary team by working on experimental analysis.	AC1 AC15	BC2 BC8 BC9	
To be able of performing a critical review of the attained results.	AC9 AC11	BC10	
To obtain knowledge on the basic principles of the design of experiments.	AC3 AC5 AC9	BC5 BC7	
To manage a broad range of suitable design structures to be able of describing properly the performance of data coming from experimental planning processes.	AC5 AC11	BC6	
To know a range of statistical techniques to analyze data coming from the experimental planning processes. Specifically, knowlegede on how performing inference on model parameters.	AC4 AC6 AC7 AC10 AC13	BC4	
To know specific procedures to perform a critical and rigorous analysis of the results.	AC9	BC10	
To complete the learning process with the support of statistical software.	AC4 AC10 AC13	BC4	

Contents	
Topic	Sub-topic
1. Basic principles of experimental design.	1.1. Introduction: Advantages of planning an experiment. Variability sources. 1.2. Basic principles in experimental design. 1.3. Step by step guide to the experimental planing process. A real example. 1.4. Some standard experimental designs.

2. Designs with one source of variation.	2.1. Introduction. 2.2. Randomization. Model for a completely randomized design: Estimation of parameters, one-way analysis of variance, inference on contrasts and means. 2.3. Methods of multiple comparisons. 2.4. Checking the adequacy of the model. 2.5. Alternative approaches.
3. Designs with several sources of variation.	3.1. Introduction. 3.2. Randomization. The meaning of interaction. Complete model. Main effects model. 3.3. Estimation, analysis of variance, inference on contrasts. 3.4. Sample sizes. 3.5. Checking the adequacy of the model.
4. Analysis of covariance.	4.1. Introduction. 4.2. Mathematical models. 4.3. Estimation, analysis of variance, inference on contrasts. 4.3. Checking the adequacy of the model.
5. Random effects models and mixed models.	5.1. Random effects: variance components. Examples. 5.2. Mathematical models for random effects models: Estimation and analysis of variance. 5.3. Sample sizes. 5.4. Checking the adequacy of the model. 5.5. Mixed models: los mixtos: Estimation and analysis of variance.
6. Block designs.	6.1. Basic concepts. 6.2. Complete block designs: Models, estimatin, analysis of variance, inference on contrasts. 6.3. Incomplete block designs: Balanced incomplete block designs; group divisible designs; cyclic designs. Models, estimation, analysis of variance, inference on contrasts. 6.4. Row-column design: Latin square designs, Youden designs, cyclic and other row-column designs. Models, estimation, analysis of variance, inference on contrasts. 6.5. Alternative approaches.
7. Nested designs.	7.1. Introduction. 7.2. Nested designs in two stages.. 7.3. Nested designs in m stages. 7.4. Models including both nested and crossing sources of variation.
8. Split-plot dsigns.	8.1 Introduction: Motivation and examples. 8.2. Mathematical modrls. 8.3. Estimation and analysis of variance with complete blocks.
9. Designs with repeated measures.	9.1. Introduction: Experimental setup. 9.2. Dependence structures for repeated measures. 9.3. Mauchly's test of sphericity. 9.4. Univariate and multivariate analysis.
10. Factorial designs at two levels.	10.1. Two levels designs with two factors. 10.2. Two levels designs with three factors. 10.3. Two levels designs for k factors. 10.4. Adding centerpoints in a general design at two levels. 10.5. Algorithm of Yates.

Planning

Methodologies / tests	Ordinary class hours	Student?s personal work hours	Total hours
Guest lecture / keynote speech	20	30	50
Problem solving	16	24	40
Case study	0	25	25
Objective test	3	0	3
Personalized attention	7	0	7
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Lectures addressed to present the main theoretical and methodological concepts. Additional learning resources will be employed, such as slides showing real study cases and the use of statistical software (mainly R packages).
Problem solving	Lectures addressed to solve exercises and practical cases, where students will have an active role and will be gradually introduced in the manage of statistical software. Besides references, lists of exercises and questionnaires will be also provided.
Case study	Students should develop one or two practical works related to the subject contents.
Objective test	Final exam on the theoretical and practical contents of the subject. This exam consists in answering a list of short questions and/or solving some longer exercises in a reasoned way.

Personalized attention	
Methodologies	Description
Problem solving Case study	a) Tutorial sessions where students can receive personalized support to clarify doubts and solve exercises. b) Tutorial sessions during the development of the practical works. In these sessions, students can receive personalized support to solve doubts, correct mistakes and overcome possible difficulties in the application of theoretical concepts to the study case.

Assessment		
Methodologies	Description	Qualification
Case study	Assessment of practical cases.	30
Objective test	Exam for assessment of knowledge consisting of two parts: (i) Test of knowledge about key concepts for planning and analyzing an experiment (nearly one hour), and (ii) Solving one or two practical exercises with help of the statistical software (nearly two hours).	70
Others		

Assessment comments
To attain a satisfactory final assessment is required to pass the two aforementioned evaluations (study case and objective test).

Sources of information	
Basic	- Dean, A. y Voss, D. (1999). Design and Analysis of Experiments. Springer Texts in Statistics, Springer-Verlag, New York - Montgomery, D.C. (2009). Design and Analysis of Experiments. 7a Ed.. J. Wiley and Sons. - Kuehl, R.O. (2001). Diseño de Experimentos. Principios estadísticos para el diseño y análisis de investigaciones. 2a Ed.. Thomson Learning.

Complementary	- Berger, P.D. y Maurier, R.E. (2002). Experimental Design With Applications in Management, Engineering, and the Sciences. Belmont, CA: Duxbury Press - Coob, G.W. (1998). Introduction to Design and Analysis of Experiments. Springer-Verlag - Prat, A., Tort-Martorell, X., Groma, P. y Pozueta, L. (1997). Métodos estadísticos. Control y mejora de la calidad. Edicions UPC (Universitat Politécnica de Catalunya) - Gibbons, J.D. y Chakraborti, S. (1992). Nonparametric Statistical Inference, 3a. Ed.. Marcel Dekker, New York - Box, G.E.P., Hunter, W.G. y Hunter, J.S. (2005). Statistics for Experimenters: Design, Innovation, and Discovery. 2a. Ed. Wiley, New York. - Cox, D. y Reid, N. (2000). The Theory of the Design of Experiments. Monographs on Statistics and Applied Probability. Chapman & Hall CRC Press

Recommendations
Subjects that it is recommended to have taken before
Estatística Aplicada/614427104
Subjects that are recommended to be taken simultaneously
Modelos de Regresión/614427105 Análise Multivariante/614427114 Control Estatístico da Calidade/614427121
Subjects that continue the syllabus
Other comments
To obtain a satisfactory assessment of this subject is highly recommended regular attendance and active participation at lectures. It is also important to complete exercises and practical applications proposed in the development of the classes, in particular when lectures cannot be regularly attended. Previous knowledge of the basic principles of statistical inference and of the R package eases the learning of the subject. Also, solving questionnaires and list of exercises and taking advantage of the personalized tutorial sessions will be particularly helpful.