

**Linear Models 1**

Code: 104860  
ECTS Credits: 6

Degree	Type	Year	Semester
2503852 Applied Statistics	OB	2	2

**Contact**

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**Use of Languages**

Principal working language: catalan (cat)  
Some groups entirely in English: No  
Some groups entirely in Catalan: Yes  
Some groups entirely in Spanish: No

**Prerequisites**

- Knowledge in:
- Calculus
  - Descriptive Statistics
  - Statistical Programming
  - Statistical Inference
  - Statistical sampling

**Objectives and Contextualisation**

The objectives of the subject are to learn to design and analyze experiments using the following techniques:

- Analysis of the variance of one and several factors.
- Analysis of the variance with blocks, nested factors, fractional designs with interaction
- Analysis of Covariance and other special designs.

The subject is also intended to familiarize students with the use of SAS software.

**Competences**

- Analyse data using statistical methods and techniques, working with data of different types.
- Correctly use a wide range of statistical software and programming languages, choosing the best one for each analysis, and adapting it to new necessities.
- Critically and rigorously assess one's own work as well as that of others.
- Design a statistical or operational research study to solve a real problem.
- Formulate statistical hypotheses and develop strategies to confirm or refute them.
- Interpret results, draw conclusions and write up technical reports in the field of statistics.
- Make efficient use of the literature and digital resources to obtain information.
- Select and apply the most suitable procedures for statistical modelling and analysis of complex data.
- Select statistical models or techniques for application in studies and real-world problems, and know the tools for validating them.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.

- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Summarise and discover behaviour patterns in data exploration.
- Use quality criteria to critically assess the work done.

## Learning Outcomes

1. Analyse data through inference techniques using statistical software.
2. Analyse data using the model of block analysis of variance.
3. Analyse data using the model of covariance analysis.
4. Analyse data using the model of variance analysis for one or more factors.
5. Analyse data using the model of variance analysis with nested factors.
6. Choose the relevant explanatory variables.
7. Critically assess the work done on the basis of quality criteria.
8. Detect and contemplate interactions between explanatory variables.
9. Detect and respond to colinearity between explanatory variables.
10. Establish the experimental hypotheses of modelling.
11. Identify sources of bias in information gathering.
12. Identify the stages in problems of modelling.
13. Identify the statistical assumptions associated with each advanced procedure.
14. Make effective use of references and electronic resources to obtain information.
15. Make slight modifications to existing software if required by the statistical model proposed.
16. Plan studies based on time series.
17. Predict responses, compare groups (causal value) and identify significant factors.
18. Reappraise one's own ideas and those of others through rigorous, critical reflection.
19. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
20. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
21. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
22. Use a range of statistical software to adjust and validate linear models and their generalisations.
23. Use specific packages for experimental design.
24. Use statistical software to calculate sample size.
25. Validate the models used through suitable inference techniques.

## Content

Principles of Experimental Design.

- Objective
- Hypothesis
- Variables
- Bias control.
- Common designs
- Calculate sample size

Review Inference 1 and 2 populations:

- 1 Sample, known sigma
- 1 Sample unknown sigma
- 2 independent samples known sigma
- 2 independent samples unknown sigma
- 2 paired samples

1: ANOVA 1 Fully Randomized Factor

- Variance decomposition
- Model and ANOVA Table
- Contrasts

- Separation of Means - LSD / Bonferroni / Scheffe / Tukey
- Verification of the model (Levene Test, Waste Chart, Normality)

#### 2: ANOVA 1 Block

- Fixed / Random Factor
- Variance decomposition
- Model and ANOVA Table

#### 3: ANOVA 1 Factor with Complete Blocks

- Model and ANOVA Table
- Verification of the model
- Cross-Over Studies

#### 4: ANOVA 1 Factor Blocks InComplete

- Latin squares
- Model and ANOVA Table

#### 5: ANOVA 2 Factors

- Model and ANOVA Table
- Separation of Means - SNK / Dunnet / Other methods

#### 6: ANOVA 2 Factors with Interaction

- Model and ANOVA Table
- Interactions
- Separation of Means - SNK / Dunnet / Other methods

#### 7: ANOVA with Sub-Replicates

- Model and ANOVA Table

#### 8: ANCOVA

- Model and ANOVA Table

#### 9: ANCOVA with Interactions

- Model and ANOVA Table
- Interactions

#### 10: Other models

- Basic concepts of Screening Design
- Basic Concepts of Factorial Design 2k
- Basic concepts of the Surface Response method

#### Software

- R
- SAS System
- SAS Enterprise Guide

## Methodology

There will be theoretical sessions where the concepts related to the design of studies and experiments will be exposed.

These sessions will be complemented by practical sessions in a computer room where dedistance will be done with Statistical software.

All the above concepts will be applied through a work that can be done in a group.

## Activities

Title	Hours	ECTS	Learning Outcomes
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Type: Directed				
Theory	60	2.4	3, 2, 5, 4, 1, 18, 7, 8, 9, 10, 24, 11, 12, 13, 15, 16, 17, 21, 19, 20, 6, 14, 23, 22, 25	
Type: Supervised				
Pràctiques	45	1.8	3, 2, 5, 4, 1, 18, 7, 8, 9, 10, 24, 11, 12, 13, 15, 16, 17, 21, 19, 20, 6, 14, 23, 22, 25	

## Assessment

Continuous evaluation:

Report 30%

Practices 15%

Partial Exam 55% (Minimum grade 4)

Reassessed:

Maximum between:

100% final exam

Report 30% + Exam 70% (Minimum grade 4)

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exam	55	15	0.6	3, 2, 5, 4, 1, 18, 7, 8, 9, 10, 24, 11, 12, 13, 15, 16, 17, 21, 19, 20, 6, 14, 23, 22, 25
Practical Sessions	15	15	0.6	3, 2, 5, 4, 1, 18, 7, 8, 9, 10, 24, 11, 12, 13, 15, 16, 17, 21, 19, 20, 6, 14, 23, 22, 25
Report	30	15	0.6	3, 2, 5, 4, 1, 18, 7, 8, 9, 10, 24, 11, 12, 13, 15, 16, 17, 21, 19, 20, 6, 14, 23, 22, 25

## Bibliography

References

- Estadística para investigadores - Box, Hunter, Hunter - Ed. Reverté
- Estadística. Modelos y Series Temporales. Daniel Peña - Ed. Alianza
- Principles and procedures of statistics, a biometrical approach 2nd Ed - Steel, Torrie - McGraw Hill
- Biostatistics: A foundation for analysis in the health sciences. 4th Ed - Steel, Torrie - John Willey & Sons
- Design and Analysis of Experiments - Dean, Voss - Springer-Verlag New York, 1999
- Peña, D. (1998) Estadística. Modelos y Métodos. Tomo I: Fundamentos. Alianza Universidad Textos.
- Montgomery, DC. (2001). Design and Analysis of Experiments. John Willey and sons.