Course guide
205125 - 205125 - Computational Modelling for Engineering Processes

Last modified: 09/05/2025

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2025). (Optional subject).

Academic year: 2025 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Piulachs Lozada Benavente, Xavier

Others:

TEACHING METHODOLOGY

The course is largely practical, providing the student with a hands-on understanding of common statistical models employed in engineering beyond linear regression model. The theoretical basis of each topic is explained in a condensed manner, and the main concepts are then illustrated in computer laboratory sessions through the analysis of specific cases based on real data. These practical sessions are carried out using the R statistical software. Students must then work independently with the teaching resources provided in the classes, thereby assimilating the different concepts taught at both a theoretical and practical level.

LEARNING OBJECTIVES OF THE SUBJECT

Using the R statistical software, students should be able to model different types of response variable derived from engineering processes, choosing an adequate functional form to approximate the underlying relationship between the response variable and the predictors.

STUDY LOAD

Type	Hours	Percentage
Self study	48,0	64.00
Hours large group	16,5	22.00
Hours small group	10,5	14.00

Total learning time: 75 h

CONTENTS

Module 1. Introduction to R Statistical Software

Description:
- The R working environment and statistics.
- Basic built-in functions and data structures.
- Numerical and graphical tools in the exploratory data analysis.
- Simulate common probability distributions for discrete and continuous random variables.

Full-or-part-time: 11h 30m
Theory classes: 2h
Laboratory classes: 2h 30m
Self study : 7h

Module 2. Linear regression models in R

Description:
- General assumptions of simple and multiple linear regression model.
- Variable selection and definition of the adopted model.
- Validation of the model: Checking initial assumptions using residual plots.
- Confidence intervals for the mean response and prediction intervals for a new response.
- Extending the linear regression model: Generalized linear regression models.

Full-or-part-time: 18h
Theory classes: 5h
Laboratory classes: 3h
Self study : 10h

Module 3. Regression models for binary and categorical data in R

Description:
- Examples of dichotomous and categorical responses in engineering.
- Dealing with dichotomous responses: Binomial logistic regression model.
- Dealing with categorical responses: Multinomial logistic regression model.

Full-or-part-time: 14h
Theory classes: 3h 30m
Laboratory classes: 2h 30m
Self study : 8h

Module 4. Regression models for count data in R

Description:
- Examples of count data in engineering.
- Dealing with equidispersed count data: Poisson regression model.
- Dealing with overdispersed count data: Negative binomial regression model.
- Dealing with count data with an excess of zeros: Zero-inflated regression model and Hurdle regression model.

Full-or-part-time: 14h
Theory classes: 3h 30m
Laboratory classes: 2h 30m
Self study : 8h

Module 5. Group Project Task and Final Exam

Description:
- Classroom oral presentation of the group project task (2 – 3 students) on the penultimate day of course.
- Written exam in the classroom on the last day of the course.

Full-or-part-time: 17h 30m
Theory classes: 2h 30m
Self study : 15h

GRADING SYSTEM

- The overall final grade of each student will be expressed on a 0-10 scale, being 5 the minimum grade required to pass the subject. This grade is based on two scores: group task (50%) and written exam (50%).
- The group work presentation and the written exam are scheduled for the last week of classes in the bimester.
- Both active participation in the completion of the group work and its presentation in class are mandatory to pass the subject.
- There is an extraordinary written exam (50% of the final grade) on the date set by the School during the final exam period. Any student may take this second exam, with two scenarios: (a) students who have already passed the subject and wish to improve their grade may obtain a new exam score between 0 and 10; (b) students who have not yet passed the subject may obtain a maximum score of 5 on the exam. For all students, the final grade is calculated based on the group work score and the higher of the two written exam scores.

BIBLIOGRAPHY

Basic:
- Wiley, Joshua F.; Pace, Larry A. Beginning R: an introduction to statistical programming [on line]. 2nd ed. New York (USA): Apress, 2015 [Consultation: 28/05/2024]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=4067975. ISBN 9781484203743.
- Cook, R. Dennis; Weisberg, Sandford. Applied regression including computing and graphics. New York: Wiley, 1999. ISBN 9780471317111.
- Dobson, Annette J.; Barnett, Adrian G. An introduction to generalized linear models. 4th ed. Boca Raton: CRC Press, 2018. ISBN 9781138741515.