Course guide
2500014 - GECPROBEST - Probability and Statistics

Last modified: 19/06/2025

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan, English

LECTURER

Coordinating lecturer: MARÍA ISABEL ORTEGO MARTÍNEZ

Others: MARÍA ISABEL ORTEGO MARTÍNEZ, MIQUEL AGUIRRE FONT

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14392. Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge about: linear algebra; geometry; differential geometry; differential and integral calculation; differential equations and partial derivatives; numerical methods; numerical algorithmic; Statistics and optimization. (Basic training module)

TEACHING METHODOLOGY

The course is given at 4 lecture hours per week. These lecture hours include theory, problems and laboratory sessions and they are not strictly distinguished. Full size, medium size and small teaching groups are combined, following the teaching program.

Statistics has an eminently applied and computational component. Therefore, practical classes, that are taught in the same classroom, should be followed using a laptop. Specific software is used (R + RStudio, among others).

Students should use the support materials that will be available in the virtual campus ATENEA: updated information about subject organization, contents, scheduling of activities, learning assessment and bibliography.

The main language of instruction will be English/Catalan, depending on the group. Teaching materials may be written in any of the three languages (English/Catalan/Spanish).

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

LEARNING OBJECTIVES OF THE SUBJECT

Development of the fundamental concepts and the methodology of Probability and Statistics. Application of non-deterministic analysis methods to problems of Civil and Environmental Engineering: probability, descriptive statistics, random variables, statistical inference. Basic use of specific computer software for the application of these methodologies (R+RStudio and others)
At the end of the semester, students must have:
1 Ability to carry out a data analysis of a problem in Civil Engineering using a computer tool that uses the techniques studied.
2 Ability to perform multiple linear regression analysis through computer programs.
3 Ability to perform data simulations and transformation of random variables, as well as the study of distributions of probability of common use.
And it must have:
4 Knowledge of measurement of uncertainty and probability
5 Knowledge of usual probability models in Civil and Environmental Engineering
6 Basic knowledge of time and interval estimation; Capacity to perform hypotheses contrasts in normal situations.
7 Knowledge of linear regression models of least squares. Ability to apply them to civil engineering problems.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours medium group	22,0	14.67
Hours small group	8,0	5.33

Total learning time: 150 h

CONTENTS

Data exploration

Description:
Scale, support and data transformation. Location and dispersion measures
Graphic representations. Sample distribution.
Multivariate data. Covariance and linear correlation.
Minimum square line fit. Trends

Full-or-part-time: 14h 23m
Theory classes: 4h
Laboratory classes: 2h
Self study : 8h 23m

Elemental Probability

Description:
Definition and properties of probability
Total probability theorem and Bayes theorem.
Probability calculation

Full-or-part-time: 14h 23m
Theory classes: 4h
Practical classes: 2h
Self study : 8h 23m

Univariate probabilistic models

Description:
Random variable
General discrete models. Commonly used discrete models.
Continuous models. Frequently used continuous models.
Normal distribution. LogNormal and logitNormal distributions
Simple transformations of random variables.
Model applications

Full-or-part-time: 26h 24m
Theory classes: 8h
Practical classes: 3h
Self study : 15h 24m

Simulation of random variables

Description:
Elementary simulation methods. Simulation and representation of samples.de mostres. Basic MonteCarlo method.

Full-or-part-time: 4h 48m
Laboratory classes: 2h
Self study : 2h 48m

Multivariate probabilistic models

Description:
Multivariate probabilistic models
Multivariate normal distribution and Central limit theorem

Full-or-part-time: 7h 11m
Theory classes: 3h
Self study : 4h 11m

Evaluation

Full-or-part-time: 24h
Laboratory classes: 10h
Self study : 14h

Parameter estimation

Description:
Statistics. Estimators. Method of moments
Likelihood of a sample. Maximum likelihood method.
Properties of estimators
Applications of point parameter estimation.
Central limit theorem. Distributions of usual statistics.

Full-or-part-time: 16h 48m
Theory classes: 3h
Practical classes: 2h
Laboratory classes: 2h
Self study : 9h 48m

Contrast of statistical hypotheses

Description:
Hypothesis tests
Contrasts in normal context
Contrasts in Normal context
Simulated contrasts. Other contrast statistics

Full-or-part-time: 19h 12m
Theory classes: 3h
Practical classes: 3h
Laboratory classes: 2h
Self study : 11h 12m

Multiple linear regression

Description:
Linear regression least squares model. Hypotheses and assessment of the model
More Linear Model. ANOVA

Full-or-part-time: 16h 48m
Laboratory classes: 7h
Self study : 9h 48m

GRADING SYSTEM

The global mark of the course is obtained as a weighted average of the marks of the continuous assessment activities.

There will be continuous assessment activities of different types, performed individually and in groups. These assessment activities are carried out during the academic year (both in and out of the classroom).

The partial exams consist of two parts: one with theoretical questions, and a second part with a set of application exercises.

The final qualification of the subject is obtained by weighted average of the marks of different assessment activities. Each of the partial exams will consist of two parts, one for assessment of concepts (Theoretical questions) and the other for assessment of applications (Problems):
1. Assessment of concepts: the assimilation of concepts is evaluated through theoretical questions in which both the knowledge of the subject and the capacity for rigor in written expression are valued.
2. Applications to practical cases.
The first partial will correspond approximately to the Probability part of the subject and the second to the Statistics part (non-strict division, depending on the calendar). The second partial exam includes the concepts of the first (the subject's syllabus is cumulative). The mark of this part is the arithmetic mean of the marks of the two partial exams.
3. Course project. The project is assessed considering the assimilation of statistical and probabilistic methods taught in class, such as the use of computing and representation tools. Other transversal competencies, such as working in a group or expression are also considered in the assessment.
4. Self-assessment questionnaires. Several questionnaires are carried out on the subject. For each questionnaire, the materials taught in class in the period prior to the questionnaire are considered.
5. Lab Sessions Deliverables
6. Other activities.
The final grade for the subject (out of 10) is obtained by the weighted sum of the evaluations of each of the five described blocks. The weighted values of the assessment items are
1. Partial exams (average of the marks): 6.5 points
2. Course project evaluation: 2.0 points
3. Lab Sessions Deliverables: 0.5 points
4. Self-assessment quizzes and other activities: 1.0 points

Criteria for re-evaluation qualification and eligibility: Students whose marks have not reached a minimum of five and have a score strictly greater than zero in the assessment activities will have the opportunity of carrying out a re-evaluation exam during the period specified in the academic calendar. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests.

EXAMINATION RULES.

The materials and resources to carry out the tests (calculator, forms ...) will be determined for each exam session. Information will be posted on Atenea.

In the deliverables and practical exercices, it is mandatory to express explicitly if the student has used LLM tools and which content has been generated by the LLM. The original content generated by the student will be valued. In the exams its is explicitly prohibited the use of LLM toos or materials not authorized explicitly

BIBLIOGRAPHY

Basic:

- Kottegoda, N.T.; Rosso, R. Applied statistics for civil and environmental engineers [on line]. 2nd ed. Oxford: Blackwell, 2008 [Consultation: 01/10/2024]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=428240. ISBN 9781405179171.
- Devore, J.L. Probabilidad y estadística para ingeniería y ciencias. 9a ed. México: Cengage Learning, 2016. ISBN 9786075228280.
- Ross, S.M. Introduction to probability and statistics for engineers and scientists. 6th ed. London: Academic Press, 2021. ISBN 9780128243466.
- DeGroot, M.H.; Schervish, M.J. Probability and statistics. 4th ed. Harlow: Pearson Education Limited, 2014. ISBN 9781292025049.
- Ang, A.H-S.; Tang, W.H. Probability concepts in engineering: emphasis on applications in civil & environmental engineering. 2nd ed. New York: Wiley, 2007. ISBN 9780471720645.

Complementary:

- Kabacoff, R.I. R in action: data analysis and graphics with R and Tidyverse [on line]. 3rd ed. Shelter Island, NY: Manning Publications Co., 2022 [Consultation: 08/10/2024]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=7002471. ISBN 9781638357018.
- Pawlowsky-Glahn, V. [et al.] (eds.). Modeling and analysis of compositional data: theory and applications [on line]. Hoboken, N.J.: Wiley, 2015 [Consultation: 01/10/2024]. Available on: https://onlinelibrary.wiley.com/doi/book/10.1002/9781119003144. ISBN 9781119003144.
- Castillo, E. [et al.]. Extreme value and related models with applications in engineering and science. Hoboken, New Jersey: John Wiley & Sons, 2005. ISBN 047167172X.
- Canavos, G.C. Probabilidad y estadística: aplicaciones y métodos. México: McGraw-Hill/ Interamericana de México, 1988. ISBN 9684518560.
- Mood, A.M.; Graybill, F.A.; Boes, D.C. Introduction to the theory of statistics. 3rd ed. New York (N.Y.): McGraw-Hill, 1974. ISBN 0070428646.