

## Course guide

### 820002 - ES - Statistics

Last modified: 30/06/2023

**Unit in charge:** Barcelona East School of Engineering  
**Teaching unit:** 749 - MAT - Department of Mathematics.

**Degree:** BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN ENERGY ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

**Academic year:** 2023    **ECTS Credits:** 6.0    **Languages:** Catalan, Spanish, English

#### LECTURER

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**Coordinating lecturer:** PABLO BUENESTADO CABALLERO - LUIS EDUARDO MUJICA DELGADO

**Others:**

Q1:  
ALEJANDRO CACERES DOMINGUEZ  
MARIA IMMACULADA GALVEZ CARRILLO  
PERE LOPEZ BROSÀ  
JOSE JULIAN RODELLAR BENEDE  
MARGARITA TORRE ALCOCEBA

Q2:  
KEVIN IVAN BARRERA LLANGA  
ALEJANDRO CACERES DOMINGUEZ  
LUIS EDUARDO MUJICA DELGADO  
JOSE JULIAN RODELLAR BENEDE

#### REQUIREMENTS

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Prerequisite  
820007 - CAL - CALCULUS

Precorequisite  
820008 - ACM - ALGEBRA AND MULTIVARIABLE CALCULUS  
820009 - CNED - NUMERICAL CALCULUS. DIFFERENTIAL EQUATIONS

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Specific:**

1. Solve mathematical problems that may arise in engineering. Apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial differential equations; numerical methods; numerical algorithms; statistics and optimisation.

**Transversal:**

2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.

## TEACHING METHODOLOGY

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The teaching methodology is distributed as follows:

- Lectures: 30%
- Practice classes with computer: 10%
- Study of didactic material: 35%
- Resolution of problems: 20%
- Exams 5%

## LEARNING OBJECTIVES OF THE SUBJECT

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Consolidate the fundamental concepts of statistics.

Identify the role of statistics in engineering problems.

Improve the students' skills in applying statistical tools to engineering modeling and problem-solving.

Use statistics to solve engineering problems or establish models.

## STUDY LOAD

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Type	Hours	Percentage
Hours large group	45,0	30.00
Self study	90,0	60.00
Hours small group	15,0	10.00

**Total learning time:** 150 h

## CONTENTS

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### 1. INTRODUCTION

**Description:**

Statistics in engineering.

Objectives of statistics.

Statistical method.

History of statistics.

**Specific objectives:**

Demonstrate the important role of Statistics as a methodology in the study and resolution of various problems in engineering.

Understand and appraise the possibilities of Statistics.

Review the historical evolution of Statistics.

Learn to install and start working with the statistical software R.

**Related activities:**

Practice 1: Introduction to R.

**Full-or-part-time:** 3h

Theory classes: 1h 30m

Laboratory classes: 1h

Self study : 0h 30m

## 2. DESCRIPTIVE STATISTICS

### Description:

Definition of descriptive statistics (exploratory data analysis).

Objectives of descriptive statistics.

General concepts (population, sample, variable, observation).

Types of data.

Frequency distribution.

Graphic representations.

Measures of central tendency.

Measures of variability.

Boxplot.

Sample moments.

Chebyshev inequality.

Measures of skewness and kurtosis.

Linear regression.

### Specific objectives:

Describe a methodology for organizing, representing and summarizing data sets to facilitate their evaluation and interpretation.

Know and appreciate the techniques for obtaining information from data.

Use the R software as a tool for the statistical descriptive analysis of a data set.

Build frequency tables.

Represent frequency tables.

Calculate and interpret the numerical descriptive measures of a data set.

Construct and interpret the boxplot.

Learn to calculate the parameters of the linear regression and evaluate the goodness of fit.

### Related activities:

Practice 2: Descriptive statistics.

Practice 3: Linear Regression.

Questionnaire 1.

### Full-or-part-time: 14h

Laboratory classes: 4h

Self study : 10h

### 3. ELEMENTS OF PROBABILITY

**Description:**

Definition of probability.

Sample space of a random experiment.

Events. Types of events.

Operations with events.

Probability rules.

Conditional probability.

Independent events.

Total probability theorem. Bayes theorem.

Some counting rules: permutations, variations, combinations.

**Specific objectives:**

Describe the outcomes of a random experiment in terms of the sample space.

Define the probability function.

Know the probabilistic elements for modeling random systems.

Understand and apply the concepts of conditional probability and independent events.

Know the main probability rules and apply them judiciously in practical problem-solving.

Describe, motivating through practical examples, many of the concepts needed for the study of statistical inference.

**Related activities:**

Resolution of a report on probability problems.

Partial exam 1.

**Full-or-part-time:** 16h

Theory classes: 6h

Self study : 10h

#### 4. DISCRETE RANDOM VARIABLES AND CONTINUOUS RANDOM VARIABLES

**Description:**

Definition of a discrete random variable.

Probability mass function.

Probability distribution function.

Measures of central tendency.

Measures of dispersion.

Moments of a random variable.

Chebychev theorem.

Transformation of random variables.

Definition of a continuous random variable.

Probability density function.

Probability distribution function.

Measures of central tendency.

Measures of dispersion.

Moments of a random variable.

Chebychev theorem.

Transformation of random variables.

**Specific objectives:**

Present the concept of discrete random variables.

Calculate and interpret the expectation and variance of random variables.

Understand and properly handle discrete random variables.

Relate the new concepts with those studied in descriptive statistics.

Present the concept of continuous random variables.

Calculate and interpret the expectation and variance of random variables.

Understand and properly handle discrete random variables.

Relate the new concepts with those studied in descriptive statistics.

**Related activities:**

Resolution of a report on discrete random variable problems.

Resolution of a report on continuous random variable problems.

Partial exam 1.

**Full-or-part-time:** 20h 30m

Theory classes: 6h

Self study : 14h 30m

## 5. DISCRETE PROBABILISTIC MODELS AND CONTINUOUS PROBABILISTIC MODELS IN ENGINEERING

### Description:

DISCRETE MODELS:

Uniform distribution.

Bernoulli, binomial, negative binomial, and hypergeometric distribution.

Poisson distribution.

CONTINUOUS MODELS:

Uniform distribution.

Exponential distribution.

Normal distribution.

### Specific objectives:

Define and study the probability distributions most commonly used in engineering.

Use the R software as a computational tool for solving problems on probabilities and random variables.

### Related activities:

Resolution of problems on probabilistic models.

Practice 4: Discrete Probabilistic models.

Practice 5: Continuous Probabilistic models.

Questionnaire 2.

**Full-or-part-time:** 24h

Theory classes: 6h

Laboratory classes: 4h

Self study : 14h

## 6. SAMPLING. CENTRAL LIMIT THEOREM

### Description:

Types of sampling.

Statistical distributions.

Laws of large numbers.

Central Limit Theorem.

Distribution of the mean and sum of variables.

Distribution of the sample variance of the normal variable.

### Specific objectives:

Present some basic theoretical elements associated with random sampling and statistical inference.

Know the most common techniques of data collection.

Illustrate different techniques that allow applying the inductive process of statistical inference to obtain useful and reliable results.

Learn some practical applications of the central limit theorem.

Use the normal distribution to approximate some discrete distributions.

### Related activities:

Resolution of a report on sampling problems.

Practice 6: Sampling. Sampling distributions of statistics.  
Questionnaire 2.

Evaluation of the generic competence.

**Full-or-part-time:** 20h

Theory classes: 6h

Laboratory classes: 2h

Self study : 12h

## 7. POINT ESTIMATION AND INTERVAL ESTIMATION

### Description:

Point estimation: method of moments and method of maximum likelihood.

Estimators: definition and properties.

Confidence interval estimation of the mean, variance and proportion.

### Specific objectives:

Estimate the value of a parameter from sample information.

Study the two most common methods for determining point estimates.

Study the most important properties of the estimators.

Know the sampling distributions of the estimators associated with normal, binomial and Poisson random variables.

Explain and apply interval estimation of the mean and variance of normal populations and approximately normal populations.

Use common sampling distributions, such as the Student's T distribution.

Know how to use the tables of the usual distributions associated with interval estimation.

Use the R software for calculating confidence intervals.

### Related activities:

Problems on point estimation.

Partial exam 2.

Evaluation of the generic competence.

Resolution of problems on interval estimation.

Practice 7: Confidence intervals.

### Full-or-part-time: 23h

Theory classes: 9h

Laboratory classes: 2h

Self study : 12h

## 8. HYPOTHESIS TESTING

### Description:

Hypothesis testing of parametric models.

Errors associated with hypothesis testing.

p-value computation.

Statistical power.

Model testing.

### Specific objectives:

Study statistical hypothesis testing and its application to means, proportions and variances.

Be able to apply judiciously the most common statistical tests, appreciating their possibilities and limitations.

Calculate the p-value associated to a hypothesis test.

Understand the decision errors associated with hypothesis testing.

Use the R software as a computational tool to solve problems on statistical hypothesis tests.

### Related activities:

Resolution of problems on statistical hypothesis testing.

Practice 8: Hypothesis testing.

Partial exam 2.

Evaluation of the generic competence.

**Full-or-part-time:** 29h 30m

Theory classes: 10h 30m

Laboratory classes: 2h

Self study : 17h

## GRADING SYSTEM

The subject is declared within a framework of continuous evaluation. The global course mark (GCM) will be computed according to the weighting below. A global course mark 5.0 or higher is required to pass the course:

- 2 exams: 65% (exam 1:25%, exam 2:40%)
- 2 questionnaires related to lab computer sessions with R: 30% (block 1: 10%, block 2: 20%)
- Generic Competence (Oral and written effective communication): 5% (Competence is evaluated on the basis of writing an essay.)

This subject does not have a re-evaluation exam.

## EXAMINATION RULES.

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- The student must provide a detailed solution to the problems (in paper exams).
- Students will not be able to attend the exam with notes, or books, or forms, or statistical tables.
- The faculty will take to the classroom the statements sheets, the exam form and the statistical tables.
- Students can take to the exam a calculator.
- The duration of the each partial exam will be 60-90 minutes in total. The generic competence test will last 30 minutes.
- The exams consist of problems that the students must answer on different sheets. The problems will be delivered separately, so students must write down their name, group and ID on each of the pages, even if they do not answer any of the problems.
- The generic competence test consists of 2 questions related to the text, previously posted in ATENEA. The 2 essays will have a limited space.
- The resolution of the problems forces the student to write the coherent development in the answer sheet.
- Students can not use a pencil or red pen to answer problems.
- Students can only take the test in the assigned classroom.
- The student must bring their passport to the exams.
- Students will not write anything on the form and the statistical tables. This documentation will also be delivered at the end of the test.
- The professors will not answer questions during the exam / test.

## BIBLIOGRAPHY

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### Basic:

- Mújica Delgado, Luis Eduardo; Ruiz Ordoñez, Magda Liliana. Prácticas de estadística utilizando R : aplicaciones en problemas de ingeniería [on line]. Barcelona: Iniciativa Digital Politècnica. Oficina de Publicacions Acadèmiques Digitals de la UPC, 2021 [Consultation: 10/10/2022]. Available on: <https://upcommons.upc.edu/handle/2117/353240>. ISBN 9788498809459.
- Pozo Montero, F. [et al.]. Probabilitat i estadística matemàtica : teoria i problemes resolts [on line]. Barcelona: Iniciativa digital politècnica, 2010 [Consultation: 05/03/2012]. Available on: <http://hdl.handle.net/2099.3/36649>. ISBN 9788476535295.
- Pujol Vázquez, G.; Gibergans Bàguena, J.; García Ciaurri, F. Problemes d'estadística amb aplicació a l'enginyeria. Barcelona: UOC, 2009. ISBN 9788497887748.
- Montgomery, D. C.; Runger, G. C. Applied statistics and probability for engineers. 4th ed. New York [etc.]: John Wiley & Sons, cop. 2006. ISBN 9780471745891.
- Devore, Jay L. Probabilidad y estadística para ingeniería y ciencias. 6ª ed. México [etc.]: Thomson, cop. 2005. ISBN 9706864571.
- Navidi, William; Murrieta Murrieta, Jesús Elmer; Martínez Velasco, Antonieta. Estadística para ingenieros y científicos. Quinta edición. Ciudad de México: McGraw Hill, 2022. ISBN 9781456293147.

### Complementary:

- Gonick, L.; Smith, W. La Estadística en comic. Barcelona: Zendera Zariquiey, 1999. ISBN 8484180417.
- Horra Navarro, J. de la. Estadística aplicada. 3ª ed. Madrid: Díaz de Santos, 2003. ISBN 8479785543.
- Navidi, W.; García Hernández, A. E. Estadística para ingenieros. México [etc.]: McGraw-Hill, cop. 2006. ISBN 9701056299.
- Spiegel, M. R. Probabilidad y estadística. 3a ed. México [etc.]: McGraw-Hill, cop. 2010. ISBN 9786071502704.
- Pérez-Díaz, Sonia; Blasco, Ángel. Modelos aleatorios en ingeniería. Madrid: Paraninfo, cop. 2015. ISBN 9788428337236.
- Delgado de la Torre, R. Probabilidad y estadística para ciencias e ingenierías. Madrid: Delta, cop. 2008. ISBN 8496477746.
- Ipiña, S. L. Inferencia estadística y análisis de datos. Madrid: Pearson Educación, 2008. ISBN 9788483224045.
- Sawitzki, G. Computational statistics : an introduction to R. Boca Raton: CRC Press, cop. 2009. ISBN 9781420086782.
- Dodge, Yadolah. The concise encyclopedia of statistics. New York [etc.]: Springer, [2010]. ISBN 978-1-4419-1390-6.



## RESOURCES

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### Audiovisual material:

- Nom recurs. Resource

### Computer material:

- Probabilitat i estadística matemàtica : teoria i problemes resolts.  
[https://discovery.upc.edu/discovery/fulldisplay?docid=alma991000642479706711&context=L&vid=34CSUC\\_UPC:VU1&lang=ca](https://discovery.upc.edu/discovery/fulldisplay?docid=alma991000642479706711&context=L&vid=34CSUC_UPC:VU1&lang=ca)

### Other resources:

Supporting teaching material that will be shown in ATENEA throughout the course:

NOTES AND SLIDES.

EXPLANATORY VIDEOS OF THE THEORETICAL FUNDAMENTS

SOLVED PROBLEMS

PROPOSED PROBLEMS

PROBLEM RESOLUTION FORUM

QUESTIONNAIRES

COMMUNICATION FORUM

VIDEOS FOR EACH OF LAB COMPUTER SESSION