Course guides
820002 - ES - Statistics

Last modified: 09/07/2021

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: 2021 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer: PABLO BUENESTADO CABALLERO - LUIS EDUARDO MUJICA DELGADO

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REQUIREMENTS

ÀLGEBRA I CÀLCUL MULTIVARIABLE - Precorequisit
CÀLCUL - Prerequisit
CÀLCUL NUMÈRIC - EQUACIONS DIFERENCIALS - Precorequisit

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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

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

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

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

Total learning time: 150 h

CONTENTS

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. (Block 1)

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 in order 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 to evaluate the goodness of fit.

Related activities:
Practice 2: Descriptive statistics. (Block 1)
Practice 3: Linear Regression. (Block 1)
Evaluation block 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 DISCRETE PROBABILISTIC MODELS IN ENGINEERING

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.

MODELS:
Uniform distribution.
Bernoulli, Binomial, Negative Binomial, and Hypergeometric distribution.
Poisson distribution.

Specific objectives:
Present the concept of discrete random variable.

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.

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 a report on discrete random variable problems.

Resolution of problems on probabilistic models.

Partial Exam 2.

Practice 4: Discrets Probabilistic models. (Block 2)
Evaluation block 2.

Full-or-part-time: 24h 30m
Theory classes: 6h
Laboratory classes: 2h
Self study : 16h 30m

5. CONTINUOUS RANDOM VARIABLES AND CONTINUOUS PROBABILISTIC MODELS IN ENGINEERING

Description:
Definition of a Continous 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.

MODELS:
Uniform distribution.
Exponential distribution.
Normal distribution.

Specific objectives:
Present the concept of continous random variable.

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.

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 a report on continous random variable problems.

Resolution of problems on probabilistic models.

Practice 5: Continus Probabilistic models. (Block 2)
Evaluation block 2.

Partial Exam 2.

Full-or-part-time: 20h
Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

6. SAMPLING. CENTRAL LIMIT THEOREM.

Description:
Types of sampling.

Statistical distributions.

Laws of large numbers.

Central Limit Theorem.

Specific objectives:
Present some basic theoretical elements associated to 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 in order to obtain useful and reliable results.

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

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.

Partial Exam 3.

Practice 6: Sampling. Sampling distributions of statistics. (Block 3)
Evaluation block 3.

Full-or-part-time: 20h
Theory classes: 6h
Laboratory classes: 2h
Self study : 12h

7. POINT 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 to normal, binomial and Poisson random variables.

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

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

Use the R software for calculating confidence intervals.

Related activities:
Problems on point estimation.
Partial Exam 3.

Resolution of problems on interval estimation.
Partial Exam 4.

Practice 7: Confidence intervals. (Block 3)
Evaluation block 3.

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 to hypothesis testing.

P-value computation.

Statistical power.

Model testing.

Specific objectives:
Study statistical hypothesis testing and its application to means, proportions, etc.

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. (Block 3)
Evaluation block 3.

Partial exam 4.
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:

- 4 exams: 71% (Exam 1:10%. Exam 2:20%. Exam 3:20%. Exam 4:21%)
- 3 questionnaires related to lab computer sessions with R: 24% (block 1: 8%, block 2: 8%, block 3: 8%)
- Generic Competence (Oral and written effective communication): 5% (Competence is evaluated with a written test al the end of the course)

This subject not has re-evaluation.

EXAMINATION RULES.

- The student must provide a detailed solution of the problems (in 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 with characteristics similar to the one they use in the CNED.

- The duration of the each exam will be 60 minutes in total. The CG test will last 30 minutes.

- The exams consist of problems that the students must answer in different sheets. The problems will be delivered separately, so students must write down their name, group and ID in each of the pages, even if they do not answer any of the problems.

- The GC 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 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

Basic:

- 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.
- Navidi, W.; García Hernández, A. E. Estadística para ingenieros. México [etc.]: McGraw-Hill, cop. 2006. ISBN 9701056299.
- Pujol Vázquez, G.; Gibergans Bàguena, J.; García Ciaurri, F. Problemes d'estadística amb aplicació a l'enginyeria. Barcelona: UOC, 2009. ISBN 9788497887748.
- Spiegel, M. R. Probabilidad y estadística. 3a ed. México [etc.]: McGraw-Hill, cop. 2010. ISBN 9786071502704.
- 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.

Complementary:

- Gonick, L.; Smith, W. La Estadística en comic. Barcelona: Zendrera Zariquiey, 1999. ISBN 8484180417.
- Horra Navarro, J. de la. Estadística aplicada. 3ª ed. Madrid: Díaz de Santos, 2003. ISBN 8479785543.
- 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.

RESOURCES

Audiovisual material:

- Nom recurs. Resource

Computer material:

- Probabilitat i estadística matemàtica : teoria i problemes resolts. http://cataleg.upc.edu/record=b1383269~S1*cat

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