Course guide
320013 - PE - Probability and Statistics

Last modified: 10/07/2023

Unit in charge:	Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit:	749 - MAT - Department of Mathematics.

Degree:	BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
	BACHELOR'S DEGREE IN ELECTRICAL 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 TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Compulsory subject).
	BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2010). (Compulsory subject).

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

LECTURER

Coordinating lecturer:	JOSE GIBERGANS BAGUENA
	VÍCTOR MAÑOSA
Others:	JOSÉ DOMÍNGUEZ
	ANGELA ARAGON

PRIOR SKILLS

As a general rule, students will be expected to have passed Mathematics in the first year to be able to take this subject. Specifically, a basic knowledge of integral calculus is considered essential.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CENG1-DIDP. Ability to solve mathematical problems that may arise in engineering. Aptitude to apply knowledge of: linear algebra; geometry; differential geometry; differential and integral calculus; numerical methods; statistical techniques. (Basic training module).
CE01-INDUS. Ability to solve mathematical problems that may arise in engineering. Aptitude to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential and partial differential equations; numerical methods; numerical algorithms; statistics and optimization. (Basic training module)

Transversal:
CT06 N2. Self-directed learning - Level 2Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.

Basic:
CB2. That students can apply their knowledge to their work or vocation in a professional manner and possess the competencies typically demonstrated through the development and defense of arguments and problem-solving within their field of study.

TEACHING METHODOLOGY

In the lectures, the lecturer will introduce the theoretical fundamentals of the subject, concepts, methods and results, which will be illustrated with relevant examples to facilitate their understanding. Sessions will be devoted to solving exercises manually and using software. Students will be expected to study in their own time so that they are familiar with concepts and are able to solve the exercises set, whether manually or with the help of a computer.

LEARNING OBJECTIVES OF THE SUBJECT

Familiarise students with techniques and methods used in statistics, probability and modelling by means of random variables. Teach students to use their sound judgement in applying these techniques to solve the practical, everyday problems that engineers encounter, for which a probabilistic-statistical type of model may give a more suitable practical solution than a deterministic model. Use appropriate software to find solutions to problems examined on the course. Build on the specific and transversal competences associated with coursework, as described below.

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours large group	30,0	20.00
Hours medium group	30,0	20.00

Total learning time: 150 h

CONTENTS

TOPIC 1: DESCRIPTIVE STATISTICS

Description:
1.1. The concept of the sample and the populations.
1.2. Centralised and dispersed measurements.
1.3. Histograms, bar graphs, frequency polygons.
1.4. Detection of abnormal values. Boxplots

Specific objectives:
For students to:
- Use a statistics package as a tool for the descriptive analysis of a dataset.
- Make absolute, relative and cumulative frequency tables.
- Draw frequency tables.
- Interpret tables and graphs.
- Draw and interpret a stem-and-leaf plot.
- Calculate and interpret the numerical descriptive measures of a dataset.
- Draw and interpret a boxplot.
- Study the relationship between two quantitative variables using contingency tables and graphs.

Full-or-part-time: 20h
Theory classes: 4h
Practical classes: 4h
Self study : 12h

TOPIC 2: PROBABILITY

Description:
2.1 The concept of probability. Axioms and properties.
2.2 Conditional probability. Independence
2.3 The law of total probability and Bayes' theorem

Specific objectives:
For students to:
- Describe the result of a random experiment in terms of the sample space and its subsets.
- Define the function of probability.
- Apply the properties of the probability function.
- Understand the concept of conditional probability and independent events, and how to work with them.
- Apply the law of total probability and Bayes' theorem properly.

Full-or-part-time: 22h
Theory classes: 4h
Practical classes: 4h
Self study : 14h

TOPIC 3: ONE-DIMENSIONAL RANDOM VARIABLES

Description:
3.1. Definition. Functions of probability, density and distribution
3.2 Typical expectation, variance and deviation
3.3 Discrete distributions: binomial and Poisson
3.4 Continuous distributions: normal, exponential and uniform
3.5 Approximation for normal distribution in binomial and Poisson distributions

Specific objectives:
For students to:
- Understand the basic characteristics of probability models and acquire a working knowledge of how they work.
- Interpret expectation and variance from a random variable.
- Work with random variables.
- Understand and have a working knowledge of binomial, Poisson, normal, exponential and uniform models.
- Use a statistics package as a tool for calculating probability and solving inverse problems using random variables.
- Apply a version of the central limit theorem to approximate binomial and Poisson distributions to a normal distribution.

Full-or-part-time: 30h
Theory classes: 6h
Practical classes: 6h
Self study : 18h

TOPIC 4: MULTIDIMENSIONAL RANDOM VARIABLES

Description:
4.1. Joint distribution of two variables. Marginal distributions
4.2. Expected value. Covariance. Correlation coefficient
4.3. Conditional distributions. Independence of two variables

Specific objectives:
For students to:
- Understand the characteristics and parameters normally used to study multidimensional random variables, particularly in the case of two random variables.
- Understand the concept of conditional expectation and independence in random variables.

Full-or-part-time: 15h
Theory classes: 3h
Practical classes: 3h
Self study : 9h

TOPIC 5: ESTIMATING PARAMETERS

Description:
5.1. Sampling
5.2. Efficient unbiased estimators
5.3. Point estimation
5.4. Laws of large numbers and the central limit theorem
5.5. Confidence intervals and associated distributions

Specific objectives:
For students to:
- Understand the concept of the efficient unbiased estimator, the laws of large numbers and the central limit theorem.
- Estimate the value of a parameter based on a data sample.
- Assess the error made in an estimation by means of confidence intervals.
- Ascertain the confidence intervals for parameters in normal and approximately normal populations.
- Calculate the size of a sample to reduce the margin of error.
- Use a statistics package to calculate confidence intervals.

Full-or-part-time: 15h
Theory classes: 3h
Practical classes: 3h
Self study : 9h

TOPIC 6: COMPARISON OF HYPOTHESES

Description:
6.1. Statistical hypotheses
6.2. Types of errors
6.3. Critical regions
6.4. The power function
6.5. Tests for normal populations

Specific objectives:
For students to:
- Establish the decision problem in accurate terms, apply it to normal populations and assess the various associated risks.
- Use a statistics package to compare hypotheses.

Full-or-part-time: 15h
Theory classes: 3h
Practical classes: 3h
Self study : 9h

TOPIC 7: LINEAR REGRESSION

Description:
7.1. The regression model
7.2. Estimation of parameters
7.3. Comparison of regression techniques
7.4. Analysis of waste

Specific objectives:
For students to:
- Formulate and interpret linear adjustment from a modelling point of view.
- Be able to perform a regression analysis with the help of a statistics package.

Full-or-part-time: 15h
Theory classes: 3h
Practical classes: 3h
Self study : 9h

TOPIC 8: ASSESSMENT

Description:
The assessments consist of two partial examinations consisting in classroom evaluation events (with a weight of 35% and 50% respectively) and other reports or tasks (with a total weight of 15%).

Specific objectives:
Assessed activities are designed to ensure that students have met the specific learning objectives for the topics covered by the assessment.

Related activities:

Full-or-part-time: 4h
Theory classes: 4h

TOPIC 9: COMPUTER-ASSISTED WORK

Description:
During the course, students will be required to use a statistical software to perform computations and to obtain graphic displays. Students will work independently or under the direction of the teacher to complete exercises and solve problems designed to consolidate their understanding of specific concepts.

All software is available in the computer room.

The scripts and lists of problems are available on the ATENEA platform and/or at the reprography service.

Specific objectives:
Those listed for the topics covered in the computer-assisted activities.

Related activities:

Full-or-part-time: 14h
Practical classes: 4h
Self study : 10h

GRADING SYSTEM

The continuous assessment consists of:

- 1st partial exam: 35%
- 2o partial exam: 50%
- Another tasks to be delivered during the course: 15%

The grade of the first partial exam can be re-conducted with a second-chance examination that will be done on the same date and time of the second partial. Any student enrolled may be admitted to this test. The final qualification of the first partial will be the maximum of the one of the first partial exam and that of the second-chance examination.

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace all the grades obtained during the course.

If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

Requirements for accessing the re-evaluation: final grade greater than or equal to 2.0 but less than 5.0 during the teaching period.

The re-evaluation can not be accessed with a final grade of Not Presented.

EXAMINATION RULES.

Partial exams consist of classroom assessment events. The other reports will include tasks to be delivered or done on a specific date. Tests and deliverables are part of the continuous evaluation. If any of the events or activities are not done, they will by qualified to zero.

BIBLIOGRAPHY

Basic:
- Forcada, Santiago. Elements d'estadística [on line]. 1a. Barcelona: Edicions UPC, 2007 [Consultation: 06/05/2020]. Available on: http://hdl.handle.net/2099.3/36675. ISBN 9788483019269.
- Rodríguez, L.J.; Tomeo, V.; Uña, I. Métodos estadísticos para ingeniería. Madrid: Garceta, 2011. ISBN 9788492812332.
- Devore, Jay L. Probabilidad y estadística para ingeniería y ciencias. 7a ed. México: Cengage Learning, 2008. ISBN 978-970-686-831-2.
- Montgomery, Douglas C. Probabilidad y estadística aplicadas a la ingeniería. 2a ed. México: Limusa, 2002. ISBN 9789681859152.

Complementary:
- Peña Sánchez de Rivera, Daniel. Regresión y diseño de experimentos. Madrid: Alianza, 2002. ISBN 8420686956.
- Canavos, George C. Probabilidad y Estadística: aplicaciones y métodos. México: McGraw-Hill, 1988. ISBN 9684518560.

RESOURCES

Audiovisual material:
- Apunts i presentacions disponibles a ATENEA. Notes and presentations available at the virtual campus ATENEA

Computer material:
- Programa Minitab amb llicència disponible pels alumnes.. Minitab licensed program available to students.

Other resources:
· Lists of exercises available in the virtual campus ATENEA.
· S. Forcada. Online Course for using MINITAB software for problem solving.
· Topics of Probability of The Open University (video, V.519.2.Pro, available at the library).
· Statistical tables available in the virtual campus ATENEA.