

## 320013 - PE - Probability and Statistics

Coordinating unit:	205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit:	749 - MAT - Department of Mathematics
Academic year:	2019
Degree:	BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2010). (Teaching unit Compulsory) BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory) BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory) BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Teaching unit Compulsory) BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory) BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits:	6
Teaching languages:	Catalan, Spanish

### Teaching staff

Coordinator:	V. Mañosa.
Others:	D. Domínguez, S. Forcada, J. Gibergans, V. Mañosa,

### Opening hours

Timetable:	Shall be communicated by the faculty in due time.
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### 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:

1. (ENG) Capacitat per a la resolució dels problemes matemàtics que puguin platenjar-se a l'enginyeria. Aptitud per aplicar els coneixements sobre: àlgebra lineal; geometria, geometria diferencial; càlcul diferencial i integral; equacions diferencials i amb derivades parcials; mètodes numèrics; algorítmica numèrica; estadística i optimització.

Transversal:

2. SELF-DIRECTED LEARNING - Level 2: Completing 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.

### 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

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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

Total learning time: 150h	Hours large group:	30h	20.00%
	Hours medium group:	30h	20.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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### Content

#### TOPIC 1: DESCRIPTIVE STATISTICS

Learning time: 20h

Theory classes: 4h  
Practical classes: 4h  
Self study : 12h

##### 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.

#### TOPIC 2: PROBABILITY

Learning time: 22h

Theory classes: 4h  
Practical classes: 4h  
Self study : 14h

##### 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.

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<p><b>TOPIC 3: ONE-DIMENSIONAL RANDOM VARIABLES</b></p>	<p>Learning time: 30h Theory classes: 6h Practical classes: 6h Self study : 18h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>3.1. Definition. Functions of probability, density and distribution</li> <li>3.2 Typical expectation, variance and deviation</li> <li>3.3 Discrete distributions: binomial and Poisson</li> <li>3.4 Continuous distributions: normal, exponential and uniform</li> <li>3.5 Approximation for normal distribution in binomial and Poisson distributions</li> </ul> <p>Specific objectives:</p> <p>For students to:</p> <ul style="list-style-type: none"> <li>- Understand the basic characteristics of probability models and acquire a working knowledge of how they work.</li> <li>- Interpret expectation and variance from a random variable.</li> <li>- Work with random variables.</li> <li>- Understand and have a working knowledge of binomial, Poisson, normal, exponential and uniform models.</li> <li>- Use a statistics package as a tool for calculating probability and solving inverse problems using random variables.</li> <li>- Apply a version of the central limit theorem to approximate binomial and Poisson distributions to a normal distribution.</li> </ul>	
<p><b>TOPIC 4: MULTIDIMENSIONAL RANDOM VARIABLES</b></p>	<p>Learning time: 15h Theory classes: 3h Practical classes: 3h Self study : 9h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>4.1. Joint distribution of two variables. Marginal distributions</li> <li>4.2. Expected value. Covariance. Correlation coefficient</li> <li>4.3. Conditional distributions. Independence of two variables</li> </ul> <p>Specific objectives:</p> <p>For students to:</p> <ul style="list-style-type: none"> <li>- Understand the characteristics and parameters normally used to study multidimensional random variables, particularly in the case of two random variables.</li> <li>- Understand the concept of conditional expectation and independence in random variables.</li> </ul>	

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<p>TOPIC 5: ESTIMATING PARAMETERS</p>	<p>Learning time: 15h Theory classes: 3h Practical classes: 3h Self study : 9h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>5.1. Sampling</li> <li>5.2. Efficient unbiased estimators</li> <li>5.3. Point estimation</li> <li>5.4. Laws of large numbers and the central limit theorem</li> <li>5.5. Confidence intervals and associated distributions</li> </ul> <p>Specific objectives:</p> <p>For students to:</p> <ul style="list-style-type: none"> <li>- Understand the concept of the efficient unbiased estimator, the laws of large numbers and the central limit theorem.</li> <li>- Estimate the value of a parameter based on a data sample.</li> <li>- Assess the error made in an estimation by means of confidence intervals.</li> <li>- Ascertain the confidence intervals for parameters in normal and approximately normal populations.</li> <li>- Calculate the size of a sample to reduce the margin of error.</li> <li>- Use a statistics package to calculate confidence intervals.</li> </ul>	
<p>TOPIC 6: COMPARISON OF HYPOTHESES</p>	<p>Learning time: 15h Theory classes: 3h Practical classes: 3h Self study : 9h</p>
<p>Description:</p> <ul style="list-style-type: none"> <li>6.1. Statistical hypotheses</li> <li>6.2. Types of errors</li> <li>6.3. Critical regions</li> <li>6.4. The power function</li> <li>6.5. Tests for normal populations</li> </ul> <p>Specific objectives:</p> <p>For students to:</p> <ul style="list-style-type: none"> <li>- Establish the decision problem in accurate terms, apply it to normal populations and assess the various associated risks.</li> <li>- Use a statistics package to compare hypotheses.</li> </ul>	

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<p><b>TOPIC 7: LINEAR REGRESSION</b></p>	<p>Learning time: 15h Theory classes: 3h Practical classes: 3h Self study : 9h</p>
<p>Description: 7.1. The regression model 7.2. Estimation of parameters 7.3. Comparison of regression techniques 7.4. Analysis of waste</p> <p>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.</p>	
<p><b>TOPIC 8: ASSESSMENT</b></p>	<p>Learning time: 4h Theory classes: 4h</p>
<p>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%).</p> <p>Related activities:</p> <p>Specific objectives: Assessed activities are designed to ensure that students have met the specific learning objectives for the topics covered by the assessment.</p>	

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<p>TOPIC 9: COMPUTER-ASSISTED WORK</p>	<p>Learning time: 14h Practical classes: 4h Self study : 10h</p>
<p>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.</p> <p>All software is available in the computer room.</p> <p>The scripts and lists of problems are available on the ATENEA platform and/or at the reprography service.</p> <p>Related activities:</p> <p>Specific objectives: Those listed for the topics covered in the computer-assisted activities.</p>	

### Qualification system

The continuous assessment consists of:

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

The note 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.

### Regulations for carrying out activities

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 be qualified to zero.

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### Bibliography

#### Basic:

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.

Forcada, Santiago. Elements d'estadística [on line]. 1a. Barcelona: Edicions UPC, 2007 [Consultation: 10/07/2017]. 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.

#### 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.

#### Others 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.

#### 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.