



## IDENTIFYING DATA

### Mathematics: Probability and Statistics

|                     |                                                                                                                                                                                  |                 |      |            |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------|------------|
| Subject             | Mathematics:<br>Probability and<br>Statistics                                                                                                                                    |                 |      |            |
| Code                | V05G300V01204                                                                                                                                                                    |                 |      |            |
| Study programme     | (*)Grao en<br>Enxeñaría de<br>Tecnoloxías de<br>Telecomunicación                                                                                                                 |                 |      |            |
| Descriptors         | ECTS Credits                                                                                                                                                                     | Choose          | Year | Quadmester |
|                     | 6                                                                                                                                                                                | Basic education | 1st  | 2nd        |
| Teaching language   | Spanish                                                                                                                                                                          |                 |      |            |
| Department          |                                                                                                                                                                                  |                 |      |            |
| Coordinator         | Fernández Bernárdez, José Ramón                                                                                                                                                  |                 |      |            |
| Lecturers           | Alonso Alonso, Ignacio<br>Comesaña Alfaro, Pedro<br>Curty Alonso, Marcos<br>Fernández Bernárdez, José Ramón<br>Mojón Ojea, Artemio<br>Santalla del Río, María Verónica           |                 |      |            |
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| Web                 | <a href="http://fatic.uvigo.es">http://fatic.uvigo.es</a>                                                                                                                        |                 |      |            |
| General description | In this subject we review some basic concepts of statistics, probability and random processes. These concepts are necessary in order to easily follow other subsequent subjects. |                 |      |            |

## Competencies

|      |                                                                                                                                                                                                                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Code |                                                                                                                                                                                                                                                                                                                     |
| A3   | CG3: The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations                                                                                                         |
| A4   | CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.                                                                |
| A10  | CE1/FB1: The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about linear algebra, geometry, differential geometry, differential and integral calculus, differential and partial derivatives equations; numerical methods, numerical algorithms, statistics and optimization |
| B1   | The ability for critical reading of scientific papers and docs.                                                                                                                                                                                                                                                     |

## Learning aims

|                                                                                                                                                                                                        |                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Expected results from this subject                                                                                                                                                                     | Training and Learning Results |
| The ability to solve mathematical problems in Engineering. The aptitude to apply knowledge about statistics.                                                                                           |                               |
| The knowledge of basic subjects and technologies that capacitates the student to learn new methods and technologies, as well as to give him great versatility to confront and update to new situations | A3                            |
| The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills.                                                                        | A4                            |
| The ability for critical reading of scientific docs.                                                                                                                                                   | B1                            |

## Contents

|       |
|-------|
| Topic |
|-------|

|                                  |                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Probability theory               | Concept of probability.<br>Axiomatic definition.<br>Conditional probability, total probability and Bayes theorems.<br>Independence.                                                                                                                                                                                                           |
| One-dimensional random variables | Concept of random variable (RV). Classification.<br>Cumulative distribution function (CDF) and properties.<br>Discrete random variables: probability mass function.<br>Continuous random variables: density function.<br>Functions of RV. CDF and discrete RV.<br>Transformation of continuous RV: fundamental theorem.<br>Mean and variance. |
| Random vectors                   | CFD and continuous RV.<br>Marginals. Point and line masses.<br>Conditional density. Continuous versions of Bayes and total probability theorems.<br>Two-dimensional transformations: fundamental theorem.<br>Changes of dimension.<br>Correlation and regression.                                                                             |
| Estimation and limit theorems    | Sample and population.<br>Estimators.<br>Estimation of mean and variance.<br>Sequences of RV. Laws of the large numbers.<br>Central limit theorem.                                                                                                                                                                                            |
| Stochastic processes             | Description of a stochastic process.<br>Statistics of a stochastic process.<br>Stationarity.<br>Examples.                                                                                                                                                                                                                                     |

## Planning

|                                                          | Class hours | Hours outside the classroom | Total hours |
|----------------------------------------------------------|-------------|-----------------------------|-------------|
| Master Session                                           | 24          | 24                          | 48          |
| Troubleshooting and / or exercises                       | 13.5        | 28                          | 41.5        |
| Practice in computer rooms                               | 14          | 7                           | 21          |
| Troubleshooting and / or exercises                       | 1           | 4                           | 5           |
| Multiple choice tests                                    | 0.5         | 2                           | 2.5         |
| Practical tests, real task execution and / or simulated. | 0.5         | 2                           | 2.5         |
| Jobs and projects                                        | 0           | 6                           | 6           |
| Other                                                    | 0.5         | 1                           | 1.5         |
| Long answer tests and development                        | 2           | 20                          | 22          |

\*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

## Methodologies

|                                    | Description                                                                                                                                                                                                                                                              |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Master Session                     | The course is divided in five main topics. Each topic will have a theoretical part that will be exposed by the teacher in big group.<br>The students will be required to perform a previous reading of the contents.                                                     |
| Troubleshooting and / or exercises | Each topic will be complemented with problem resolution.<br>The problems could be developed and solved in big or small group.<br>The students will be required to work previously on these problems.                                                                     |
| Practice in computer rooms         | Each topic will be completed with one or several sessions of computer practices.<br>For this, a software developed by the teachers and specific questionnaires for each topic will be used. The students will be required to perform a previous reading of the contents. |

## Personalized attention

| Methodologies                      | Description                                                                                                                                                                                                                    |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Master Session                     | Students will have the chance to attend tutorial sessions at the teacher's office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website. |
| Troubleshooting and / or exercises | Students will have the chance to attend tutorial sessions at the teacher's office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website. |

Practice in computer rooms Students will have the chance to attend tutorial sessions at the teacher's office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website.

| Tests             | Description                                                                                                                                                                                                                    |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Jobs and projects | Students will have the chance to attend tutorial sessions at the teacher's office. Teachers will establish timetables for this purpose at the beginning of the course. This schedule will be published on the subject website. |

| Assessment                                               |                                                                                                                                                                           |               |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
|                                                          | Description                                                                                                                                                               | Qualification |
| Troubleshooting and / or exercises                       | Twice the semester, students must solve a problem.                                                                                                                        | 15            |
|                                                          | In this proof the skills A10, A3 and A4 are evaluated                                                                                                                     |               |
| Multiple choice tests                                    | The students must answer a test.                                                                                                                                          | 10            |
|                                                          | In this proof the skills A10, A3 and A4 are evaluated                                                                                                                     |               |
| Practical tests, real task execution and / or simulated. | In group B class, students must answer a questionnaire. The use of computer is allowed. Students can be distributed in pairs. Each couple answers a unique questionnaire. | 10            |
|                                                          | In this proof the skills A10, A3 and A4 are evaluated                                                                                                                     |               |
| Jobs and projects                                        | The students, in groups of 3 or 4, should propose four test questions on a particular topic.                                                                              | 10            |
|                                                          | In this proof the skills A4 and B1 are evaluated                                                                                                                          |               |
| Other                                                    | At the end of a group B class, each student will correct a problem made by somebody else.                                                                                 | 5             |
|                                                          | In this proof the skill B1 is evaluated                                                                                                                                   |               |
| Long answer tests and development                        | Final exam.                                                                                                                                                               | 50            |
|                                                          | In this proof the skills A10, A3 and A4 are evaluated                                                                                                                     |               |

### Other comments on the Evaluation

Following the guidelines of the studies, two evaluation systems will be offered to the students inscribed on this subject: continuous evaluation and evaluation at the end of the semester.

The continuous evaluation consists of several tasks.

A student follows the continuous evaluation system if she/he participates in task 3 (approximately in the seventh week of the semester) or any later task. Tasks 1 and 2 may be performed without opting for the continuous evaluation.

#### Students who choose continuous evaluation:

Several tasks are evaluated. The approximate task calendar and the weight of each task in the final grade are listed below.

Task 1: Individual resolution of a problem. Weight 5%. Week 4

Task 2: Correction of the task 1 from somebody else. Weight 5%. Week 5

Task 3: Development of a test. This is done in groups of 4. Weight 10%. Week 7

Task 4: Individual resolution of a test. Weight 10%. Week 10

Task 5: Individual resolution of a problem. Weight 10%. Week 12

Task 6: Answer a questionnaire by couples with the help of the computer. Weight 10%. Week 14

The last task of the continuous evaluation will be a final exam. This will be a smaller version of the exam to be carried out by students who do not opt for continuous evaluation. The weight of the examination in the final grade will be 50 %

Before the completion or delivery of each task, the date and procedure for the review of the obtained marks will be indicated. Students will have the option to know the status of each task and review the correction within a reasonable period of time (a week, generally).

These tasks are not recoverable, what means that if a student cannot fulfill them in the stipulated period, teachers will not

be committed to repeat them.

The obtained grade will be valid only for the current academic course.

If a student has participated in continuous evaluation and does not pass the course he/she will receive a grade of fail, regardless of he/she takes the final exam or not.

The final grade for students who opt for continuous evaluation will be calculated as the average between the final exam and the previous tasks marks. To minimize the impact of a possible miss on a task, the average of these will be computed excluding the worst obtained grade. Taking into account that tasks 1 and 2 are two parts of the same exercise, and that jointly weigh 10%, they will be considered as a whole for the purpose of excluding the worst mark.

#### **Students who choose for evaluation at the end of the semester:**

The possibility of a final examination will be provided to students who do not opt for the continuous evaluation. This exam will be rated between 0 and 10, and this will be the final grade obtained.

#### **Retake in the July session**

Previously to the exam (or at its beginning), students will be asked to choose to be evaluated by continuous evaluation system (described before) or only by the final exam.

The subject is considered passed if the final grade obtained is equal to or greater than 5.

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#### **Sources of information**

H. Stark y J.W. Woods, **Probability, Random Processes, and estimation theory for engineers**, 2,

X. Rong Li, **Probability, Random Signals and Statistics**, 1,

R. Cao y otros, **Introducción a la estadística y sus aplicaciones**, 1,

P. Peebles, **Principios de probabilidad, variables aleatorias y señales aleatorias**, 4,

A. Papoulis, **Probability, random variables and stochastic processes**, 4,

D. Peña, **Estadística, modelos y métodos. Tomo 1: Fundamentos**, 2,

- Notes of the course

- Questionnaires for laboratory

- They include the theoretical contents of the course.

- At the end of each chapter there is a set of problems belonging to any of the books listed in the bibliography and recommended readings. In general these problems are somewhat easier than those from bulletins.

Bulletins of problems contain useful exercises to understand the subject.

Questionnaires for the laboratory include the statements and each practice problems and also some theoretical content. It is very important to read them in advance to carry out the practice.

This material is available through faiTIC platform (<http://faitic.uvigo.es>)

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#### **Recommendations**

##### **Subjects that continue the syllabus**

Data Communication/V05G300V01301

Computer Networks/V05G300V01403

Signal Transmission and Reception Techniques/V05G300V01404

Fundamentals of Bioengineering/V05G300V01915

##### **Subjects that are recommended to be taken simultaneously**

Mathematics: Calculus II/V05G300V01203

##### **Subjects that it is recommended to have taken before**

Mathematics: Linear Algebra/V05G300V01104

Mathematics: Calculus I/V05G300V01105