COURSE SYLLABUS
2016-2017

GENERAL INFORMATION

Course information	
Name	Statistics I
Code	DOI-GITT-222
Degree	Grado en Ingeniería en Tecnologías de Telecomunicación (GITT), Doble Grado en Ingeniería en Tecnologías de Telecomunicación y ADE (GITT-ADE)
Year	2nd
Semester	2nd (Spring)
ECTS credits	6 ECTS
Type	Compulsory
Department	Industrial Management
Area	Statistics and Operations Research
Coordinator	Eugenio Sánchez Úbeda

Instructor	
Name	Carlos Maté
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DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

Engineers are very often involved in decision-making processes where decisions may be taken from the analysis of data. In these situations, statistics become essential because they provide the engineer with both descriptive and analytical methods for dealing with the variability in observed data.

The main objective of this basic course on statistics is to learn and apply basic statistical methods for the analysis of data. By the end of the course, students will understand the basic principles behind statistics and probability. More specifically, the main contributions of this course to the professional profile are the following:

- Learning the main concepts and methods of descriptive statistics for data summary, reporting and data analysis
- Learning the basics of probability theory for dealing with uncertainty given in terms of probabilities
- Learning how to use data to estimate parameters of interest as part of the engineering problem-solving process.
- Learning the main concepts and methods concerned with using data to test the plausibility of a specified hypothesis and to draw conclusions from data.

Prerequisites

Basic knowledge of Calculus and Algebra is required.

CONTENTS

Contents

PART 1- DESCRIPTIVE STATISTICS AND PROBABILITY

Chapter 1. Descriptive statistics and data analysis

1.1 Tables and graphs for one set of data
1.2 Summary statistics for univariate data
1.3 Tables, graphs and summary statistics for multidimensional data
1.4 Linear Transformations of Variables
1.5 Statistical software

Chapter 2. Elements of probability

2.1 Definition and calculation of probabilities of events
2.2 Conditional probability and independence
2.3 The law of total probability and the Bayes' theorem

Chapter 3. Discrete Probability Models

3.1 Probability distribution of a one-dimensional discrete random variable. Expectation and variance
3.2 Basic discrete distributions.
3.3 Two-dimensional random variable: marginal and joint distributions.
3.4 Linear combination of discrete random variables.

Chapter 4. Continuous Probability Models

4.1 Probability distribution of a one-dimensional continuous random variable. Expectation and variance.
4.2 Basic continuous distributions.
4.3 Linear functions of random variables: Central Limit Theorem.
4.4 Multivariate normal distribution.
4.5 Stochastic processes.

PART II – STATISTICAL INFERENCE

Chapter 5. Sampling

5.1 Simple random sample.
5.2 Statistics.
5.3 Distributions of the statistics used in inference.

Chapter 6. Point estimation and confidence intervals

6.1 Methods of point estimation of population parameters.
6.2 Properties of point estimates.
6.3 Sampling distribution of relevant statistics.
6.4 Confidence interval estimators.
6.5 Confidence intervals for parameters of Normal populations.

Chapter 7. Hypothesis testing

7.1 Types of hypothesis and errors.
7.2 Setting up a hypothesis test. Rejection region and P-value.
7.3 Basic parametric tests.
7.4 Basic non-parametric tests.

Chapter 8. Probability distribution fitting

8.1 Techniques of distribution fitting.
8.2 Random number generation.
8.3 Inverse transform sampling and convolution methods.

Competences and Learning Outcomes

Competences

Basic and General Competences

CG3.	Knowledge of basic materials and technologies that will enable you to learn new methods and technologies as well as that feat versatility to adapt to new situations.
CG4.	Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, abilities and skills, understanding the ethical and professional responsibility of the activity of Telecommunications Engineer.

Specific Competences

CFBT1	Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge of linear algebra; geometry; differential geometry; differential and integral calculus; differential equations and partial differential equations; numerical methods; numerical algorithms; statistics and optimization.
CFBT2	Basic knowledge of the use and programming of computers, operating systems, databases and software with applications in engineering.

Learning outcomes:

RA 1.	Identify and describe the nature and fundamental statistical characteristics of a data sample.
RA 2.	Compute probabilities in the context of experiments with events of different nature by applying appropriate formulas and procedures.
RA 3.	Indentify and describe the fundamental characteristics and properties of the main discrete and continuous probability distributions.
RA 4.	Estimate parameters of interest of the population.
RA 5.	Test the plausibility of a specified hypothesis and draw conclusions.
RA 6.	Determine the most appropriate probability distribution model for a particular set of data.
RA 7.	Demonstrate practical experience in the use of descriptive statistics and statistical inference techniques by using statistical software.

TEACHING METHODOLOGY

General methodological aspects

The teaching method focus on easing the learning of both theoretical and practical knowledge. Teaching objectives require the active participation of the student. In addition, the in-class activity should be complemented by the individual student work performed out of class. Both aspects are taken into account in the evaluation method.

In-class activities	Competences
▪ **Lectures and problem-solving sessions (52 hours)**: The lecturer will introduce the fundamental concepts of each chapter, along with some practical recommendations, and will go through worked examples to support the explanation. Active participation will be encouraged by raising open questions to foster discussion and by proposing short application exercises to be solved in class.	CFBT1
▪ **Practice sessions (2 hours):** Under the instructor's supervision, students, divided in small groups, will apply the concepts and techniques covered in the lectures to real problems.	CFBT2
▪ **Assessment (3 hours):** Two in-class quizzes and one mid-term exam will provide backfitting to the students prior to the final exam.	CG3, CG4
▪ **Tutoring** for groups or individual students will be organized upon request.	CG3, CG4
Out-of-class activities	**Competences**
▪ Personal study of the course material and resolution of the proposed exercises (85 hours).	CFBT1
▪ Practices (38 hours). Students, divided in small groups, will apply the concepts and techniques covered in the lectures to real problems. The results will be included in a final report.	CG3, CG4, CFBT1, CFBT2

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
Mid-term exam	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem solving. ▪ Analysis and interpretation of results.	20%
Final exam	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem solving. ▪ Analysis and interpretation of results.	50%
In-class quizzes	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem solving. ▪ Analysis and interpretation of results.	15%
Practices	▪ Understanding of the theoretical concepts. ▪ Application of theoretical concepts to problem solving. ▪ Analysis and interpretation of the obtained results. ▪ Comparison of results using different techniques ▪ Use of statistical software. ▪ Writing presentation.	15%

GRADING AND COURSE RULES

Grading

Regular assessment

- **Exams** will account for 70%, of which:
  - Mid-term: 20%
  - Final exam: 50%
- I**n-class quizzes** will account for 15%
- **Mandatory Practices** will account for the remaining 15%,
- In case that the *final exam mark* is equal or lower than 4, the final grade will be the *final exam mark*. Otherwise, the final grade is computed weighting the different marks as the previously shown percentages. In order to pass the course, the final grade should be greater or equal to 5.0.
- Optional practices as well as continuous assessment, in terms of active participation, will be used to increase the final grade up to 1 additional point.

Retakes

- **Continuous assessment** will account for 30%, of which:
  - Mandatory practices: 6%
  - In-class quizzes: 9%
  - Mid-term: 15%
- **Extraordinary** exam will account for 70%
- In case that the *extraordinary exam mark* is equal or lower than 4, the final grade will be the *extraordinary exam mark*. Otherwise, the final grade is computed weighting the different marks

as the previously shown percentages, or given by the extraordinary exam mark if it is better. In order to pass the course, the final grade should be greater or equal to 5.0.

Course rules

- Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Academicas) of the ICAI School of Engineering. Not complying with this requirement may have the following consequences:
  - Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.

Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

WORK PLAN AND SCHEDULE[1]

In and out-of-class activities	Date/Periodicity	Deadline
Mid-term exam	Week 8	
Final exam	April-May	
In-class quizzes	Weeks 4 and 12	
Review and self-study of the concepts covered in the lectures	After each chapter	–
Problem-solving	After each chapter	–
Practices	Weeks 3, 4, 12 and 13	–
Report writing	Weeks 5 and 14	–
Final exam preparation	April-May	–

STUDENT WORK-TIME SUMMARY			
IN-CLASS HOURS			
Lectures	**Problem-solving**	**Lab sessions**	**Assessment**
30	22	2	3
OUT-OF-CLASS HOURS			
Self-study	**Problem solving**	**Practice**	**Report writing**
40	45	28	10
		ECTS credits:	**6 (180 hours)**

[1] A detailed work plan of the subject can be found in the course summary sheet (see following page). Nevertheless, this schedule is tentative and may vary to accommodate the rhythm of the class.

BIBLIOGRAPHY

Basic bibliography

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Complementary bibliography

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- Sarabia A., Maté C., (1993). Problemas de Probabilidad y Estadística. Elementos Teóricos. Cuestiones. Aplicaciones con STATGRAPHICS. Ed. Clagsa. Madrid, España.

	In-class activities			Out-of-class activities			Learning outcomes
Week	Time [h]	Lecture & Problem-solving	Assessment	Time [h]	Self-study	Other activities	Code
1	4	Course presentation (1h) C1: Descriptive statistics (3h)		3	Review and self-study (3h)		RA1
2	4	C1: Descriptive statistics– Lab session (2h) C2: Elements of probability (2h)		4	Review and self-study (4h)	Optional practice 0 (2h)	RA1, RA2, RA7
3	4	C2: Elements of probability (2h) C3: Discrete Probability Models (2h)		13	Review and self-study (6h)	Mandatory practice 1 (7h)	RA2, RA3, RA7
4	4	C3: Discrete Probability Models (2h) C4: Continuous Probability Models (1h)	In-class quiz 1	13	Review and self-study (6h)	Mandatory practice 1 (7h)	RA2, RA3, RA7
5	4	C4: Continuous Probability Models (4h)		11	Review and self-study (6h)	Mandatory practice 1 (5h)	RA3, RA7
6	4	C4: Continuous Probability Models (4h)		6	Review and self-study (6h)		RA3
7	4	C4: Continuous Probability Models (4h)		6	Review and self-study (6h)	Optional practice 1 (4h)	RA3, RA7
8	1		Mid-term exam	6	Review and self-study (6h)		RA1, RA2, RA3
9	4	C5: Sampling (4h)		6	Review and self-study (6h)		RA4
10	4	C6: Point estimation and confidence intervals (4h)		6	Review and self-study (6h)		RA4
11	4	C6: Point estimation and confidence intervals (4h)		6	Review and self-study (6h)		RA4
12	4	C7: Hypothesis testing (3h)	In-class quiz 2	13	Review and self-study (6h)	Mandatory practice 2 (7h)	RA5, RA7
13	4	C7: Hypothesis testing (4h)		13	Review and self-study (6h)	Mandatory practice 2 (7h)	RA5, RA7
14	4	C8: Probability distribution fitting (4h)		11	Review and self-study (6h)	Mandatory practice 2 (5h)	RA6, RA7
15	4	C8: Probability distribution fitting (2h) Course Review (2h)		6	Review and self-study (6h)		RA1, RA2, RA3, RA4, RA5, RA6