# Statistics

**Academic Year: ( 2020 / 2021 )** **Review date: 05-07-2020**

**Department assigned to the subject: Statistics Department**

**Coordinating teacher: ALONSO FERNANDEZ, ANDRES MODESTO**

**Type: Compulsory ECTS Credits : 6.0**

**Year : 3 Semester : 1**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is advisable to have successfully completed the subjects of Probability and Differential, Integral and Vector Calculus.

## OBJECTIVES

CB1.Students have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study
CB2.Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
CB3.Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
CB4.Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
CB5.Students have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy
CG1.Students are able to demonstrate knowledge and understanding of concepts in mathematics, statistics and computation and to apply them to solve problems in science and engineering with an ability for analysis and synthesis.
CG2.Students are able to formulate in mathematical language problems that arise in science, engineering, economy and other social sciences.
CG5.Students can synthesize conclusions obtained from analysis of mathematical models coming from real world applications and they can communicate in verbal and written form in English language, in an clear and convincing way and with a language that is accessible to the general public.
CG6.Students can search and use bibliographic resources, in physical or digital support, as they are needed to state and solve mathematically and computationally applied problems arising in new or unknown environments or with insufficient information.
CE1.Students have shown that they know and understand the mathematical language and abstract-rigorous reasoning as well as to apply them to state and prove precise results in several areas in mathematics.
CE20.Students have shown that they understand the fundamentals of bayesian statistics and that they have learnt the different computational intensive techniques to implement inference and bayesian prediction, as well as techniques used in machine learning.
CE22.Students have shown that they understand the concept of random phenmena, and that they can apply the basic principles of probability calculus and the statistic inference, recognizing their applicability to real problems.
CE23.Students have shown that they understand the concepts of stochastic processes and queuing theory to model real world processes as well as to simulate them in a computer.
RA1.To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them;
RA2.To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking;
RA3.To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study;
RA5.To be able to communicate, in a precise and clear manner, knowledge, methodologies, ideas,

problems and solutions in their field or specialty to any kind of audience (specialist or not);

SPECIFIC SKILLS:
Students will acquire knowledge and skills necessary to:
1. Define populations for a statistical study.
2. Compute point estimators and confidence intervals for population parameters.
3. Build Hypothesis about a distribution.
4. Test hypothesis about the parameters of the chosen model.
5. Evaluate how well does the model fit to reality.
6. Understand the limitations of the methods that have been studied and the conditions under which they lead to wrong conclusions.
7. Carry out the abovementioned analyses in statistical software.

## DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to Statistical inference.
1.0. Elements of descriptive statistics.
1.1. Population and sample.
1.2. Random sampling.
1.3. Main distributions in sampling.
1.4. Point estimation of parameters.
1.4.1. Definitions and properties.
1.4.2. Method of moments.
1.4.3. Maximum likelihood estimation

2. Confidence intervals.
2.1. Introduction
2.1.1. Pivotal quantities.
2.2. Confidence intervals for the mean and variance in a normal population.
2.3. Confidence intervals for the mean in non-normal populations.
2.4. Confidence intervals for two populations.
2.5. Bootstrap confidence intervals.

3. Contraste estadístico de hipótesis.
3.1. Introducción.
3.2. Errores Tipo I y Tipo II.
3.3. Potencia de un contraste.
3.4. Contraste de hipótesis para la media.
3.5. Contraste de hipótesis para la proporción.
3.6. Contraste de hipótesis para la varianza.
3.7. Contrastes de hipótesis para dos poblaciones.

3. Hypothesis statistical testing.
3.1. Introduction
3.2. Type I and Type II Errors.
3.3. Power of a statistical test.
3.4. Hypothesis test for the mean.
3.5. Hypothesis test for the proportion.
3.6. Hypothesis test for the variance.
3.7. Hypothesis test for two populations.

4. Non-parametric contrasts.
4.1. Introduction.
4.2. Goodness-of-fit test.
4.2.1. Test ¿2.
4.2.2. Kolmogorov-Smirnov Test.
4.2.3. Lilliefors Test.
4.2.4. Graphical tools.
4.3. Tests based on the binomial distribution.
4.4. Tests based on ranks.
4.5 Tests of independence and homogeneity.

5. Linear regression.
5.1. Introduction.
5.2. Simple linear regression
5.3. Multiple linear regression

## LEARNING ACTIVITIES AND METHODOLOGY

AF1.THEORETICAL-PRACTICAL CLASSES. Knowledge and concepts students must acquire. Student receive course notes and will have basic reference texts to facilitatefollowing the classes and carrying out follow up work. Students partake in exercises to resolve practical problems and participate in workshops and an evaluation tests, all geared towards acquiring the necessary capabilities.
AF2.TUTORING SESSIONS. Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.
AF3.STUDENT INDIVIDUAL WORK OR GROUP WORK.
AF8.WORKSHOPS AND LABORATORY SESSIONS.
MD1.THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject`s main concepts are developed, while providing material and bibliography to complement student learning.
MD2.PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group.
MD3.TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor.
MD6.LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

- Lectures will be taught synchronously and interactively online through Blackboard collaborate: introducing the theoretical concepts and developments with examples, 2.2 ECTS
- Problem solving sessions: 2.2 ECTS
- Computer (practical) sessions: 0.6 ECTS
- Evaluation sessions (continuous evaluation and final exam): 1 ECTS

## ASSESSMENT SYSTEM

SE1.FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course.
SE2.CONTINUOUS EVALUATION. Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course.

50% of the final qualification is obtained in a final exam. The remaining 50% is the result of continuous evaluation based on the acquired abilities of the student by two midterm exams (40%), carry out practical data analyses, computer labs and explain the results they have obtained (10%).

In the extraordinary examination, the final grade will be the maximum between the previous system and 100% of the final exam.

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| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

## BASIC BIBLIOGRAPHY


- MONTGOMERY, D.C., RUNGER, G.C. Applied Statistics and Probability for Engineers, John Wiley & Sons, 2003
- NAVIDI, W. Statistics for Engineers and Scientists., McGraw-Hill, 2006
- NEWBOLD, P., CARLSON, W.L., THORNE, B. Statistics for Business and Economics., Prentice-Hall, 2013
- WACKERLY, D.D., MENDENHALL, W., SCHEAFFER, R.L. Mathematical statistics with applications, Thomson, 2008


## ADDITIONAL BIBLIOGRAPHY


- ARNOLD, S.F. Mathematical Statistics, Prentice Hall, 1990
- CASELLA, G., BERGER, R.L. Statistical Inference, Duxbury, 2002
- CONOVER, W.J. Practical nonparametric statistics, John Wiley & Sons, 1999
- PEÑA, D. Fundamentos de Estadística, Alianza Editorial, 2001
- PEÑA, D. Regresión y Diseño de Experimentos, Alianza Editorial, 2002