Statistics

Academic Year: (2023 / 2024) **Review date: 09-02-2024**

Department assigned to the subject: Statistics Department

Coordinating teacher: MEILAN VILA, ANDREA

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 following courses:
Differential calculus (Course 1 - Semester 1)
Integral calculus (Course 1 - Semester 2)
Vector calculus (Course 1 - Semester 2)
Probability (Course 2 - Semester 2)

SKILLS AND LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary 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. Students must have acquired advanced cutting-edge knowledge and demonstrated indepth understanding of the theoretical and practical aspects of working methodology in the area of applied mathematics and computing.
RA2. Through sustained and well prepared argument and procedures, students will be able to apply their knowledge, their understanding and the capabilities to resolve problems in complex specialized professional and work areas requiring the use of creative and innovative ideas.

RA3. Students must have the capacity to gather and interpret data and information on which they base their conclusions, including where relevant and necessary, reflections on matters of a social, scientific, and ethical nature in their field of study.
RA5. Students must know how to communication with all types of audiences (specialized or not) their knowledge, methodology, ideas, problems and solutions in the area of their field of study in a clear and precise way.

OBJECTIVES

To acquire knowledge about the fundamental principles of descriptive statistics.
To acquire knowledge about the fundamental principles of statistical inference.
To become acquainted with the basic techniques related to the linear regression model.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Descriptive statistics.
1.1. Introduction.
1.2. Population and sample.
1.3. Statistical variables.
1.4. Statistical tables.
1.5. Statistical graphics.
1.6. Descriptive measures.
1.6.1. Measures of location.
1.6.2. Measures of dispersion.
1.6.3. Measures of shape.

2. Sampling
2.1. Introduction.
2.2. Sampling methods.
2.3. Statistics.
2.4. Sampling distributions.
2.5.1. Sampling distributions for normal populations.
2.5.2. Sampling distributions for large sample sizes.

3. Point estimation.
3.1. Introduction.
3.2. Estimation methods.
3.2.1. Method of moments.
3.2.2. Maximum likelihood estimation.

4 Confidence intervals.
4.1. Introduction.
4.1.1. Pivotal quantities.
4.2. Confidence intervals under the normal distribution.
4.2.1. Confidence intervals for one population.
4.2.2. Confidence intervals for two populations.
4.3. Asymptotic confidence intervals.

5. Hypothesis testing.
5.1. Introduction.
5.2. Type I and type II errors.
5.3. Power of a test.
5.4. p-value of a test.
5.5. Hypothesis testing under the nomal distribution.
5.5.1. Tests for one populations.
5.5.2. Tests for two populations.
5.6. Asymptotic tests.

6. Nonparametric tests.
6.1. Introduction.
6.2. Goodness-of-fit tests.
6.2.1. Graphical tools.
6.2.2. Chi square test.
6.2.3. Kolmogorov-Smirnov test.
6.2.4. Lilliefors test.
6.3. Tests of independence.
6.4. Tests of homogeneity.

7. Linear regression.
7.1. Introduction.
7.2. Simple linear regression.
7.2.1. Formulation of the model.
7.2.2. Model assumptions.
7.2.3. Parameter estimators.
7.2.4. The F test.
7.2.5. Model validation.
7.2.6. Transformations.
7.3. Multiple linear regression.
7.3.1. Formulation of the model.
7.3.2. Model assumptions.
7.3.3. Parameter estimators.
7.3.4. Diagnostic techniques.
7.3.5. Construction of regression models.

LEARNING ACTIVITIES AND METHODOLOGY

THEORETICAL-PRACTICAL CLASSES. [44 hours with 100% classroom instruction, 1.67 ECTS]
Knowledge and concepts students must acquire. Student receive course notes and will have basic reference texts to facilitate following the classes and carrying out follow up work. Students partake in exercises to resolve practical problems and participate in workshops and evaluation tests, all geared towards acquiring the necessary capabilities.

TUTORING SESSIONS. [4 hours of tutoring with 100% on-site attendance, 0.15 ECTS]
Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher.

STUDENT INDIVIDUAL WORK OR GROUP WORK [98 hours with 0 % on-site, 3.72 ECTS]

WORKSHOPS AND LABORATORY SESSIONS [8 hours with 100% on site, 0.3 ECTS]

FINAL EXAM. [4 hours with 100% on site, 0.15 ECTS]
Global assessment of knowledge, skills and capacities acquired throughout the course.

METHODOLOGIES

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.

PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group.

TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with a teacher as tutor.

LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

ASSESSMENT SYSTEM

60% of the final qualification is obtained in a final exam. The remaining 40% is the result of continuous evaluation based on the acquired abilities of the student by two mid-term exams (20% each of them).
In the extraordinary examination, the final grade will be the maximum between the previous system and 100% of the final exam.

% 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