Probability

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

Department assigned to the subject: Statistics Department

Coordinating teacher: ARRIBAS GIL, ANA

Type: Basic Core ECTS Credits : 6.0

Year : 2 Semester : 2

Branch of knowledge: Social Sciences and Law

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Differential Calculus (1st year - 1st term)
Integral Calculus (1st year - 2nd term)
Vector Calculus (1st year - 2nd term)
Integration and Measure (2nd year - 1st term)

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

1. Knowing the theoretical foundations and calculus rules of Probability Theory.
2. Resolution of problems of Probabilistic Nature.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Probability and random phenomena.
1.1 Random phenomena, sample space, events.
1.2 Axioms of Probability and elementary properties.
1.3 Conditional probability and independence.
1.4 Total probability rule and Bayes¿ formula.

2. Random variables.
2.1 Definition of random variable.
2.2 Expectation, characteristic features, and moments of a random variable.
2.3 Discrete probability models.
2.4 Continuous probability models.
2.5 Transformations of random variables.

3. Jointly distributed random variables
3.1 Definition of random vector, joint, marginal, and conditional distributions.
3.2 Independent random variables.
3.3 Some multivariate distribution models.
3.4 Transformations.

4. Properties of the expectation.
4.1 Expectations of transformation of random variables.
4.2 Covariance, variance of sums, and correlation.
4.3 Conditional expectation.
4.4 Moment generating functions.

5. Limit Theorems.
5.1 Chebyshev¿s inequality.
5.2 Convergence in probability, the Weak Law of Large Numbers.
5.3 Almost sure convergence, the Strong Law of Large Numbers.
5.4 Convergence in distribution, the Central Limit Theorem.

LEARNING ACTIVITIES AND METHODOLOGY

THEORETICAL-PRACTICAL CLASSES. [44 hours with 100% classroom instruction, 1.76 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, 0.16 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, 3.92 ECTS]

FINAL EXAM. [4 hours with 100% on site, 0.16 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

SE1 - FINAL EXAM. [40 %]
Global assessment of knowledge, skills and capacities acquired throughout the course.

SE2 - CONTINUOUS EVALUATION. [60 %]
Assesses papers, projects, class presentations, debates, exercises, internships and workshops throughout the course.

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

BASIC BIBLIOGRAPHY

- Dimitri Bertsekas and John Tsitsiklis Introduction to Probability. 2nd edition, Athena Scientific, 2008
- Jeffrey S. Rosenthal A First Look at Rigorous Probability Theory, .World Scientific Publishing, 2006
- Rohatgi, V.K. and Ehsanes Saleh, A.K.Md. An Introduction to Probability and Statistics, Wiley, 2001
- Sheldon M. Ross A First Course in Probability, Prentice Hall, 2010

ADDITIONAL BIBLIOGRAPHY

- Feller, W. An Introduction to Probability Theory and Its Applications, vol.1, Wiley, 1968