COURSE DATA

Data Subject	
Code	34166
Name	Probability
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1107 - Degree in Mathematics	Faculty of Mathematics	3	First term

Subject-matter

Degree	Subject-matter	Character
1107 - Degree in Mathematics	10 - Probability and statistics	Obligatory

Coordination

Name	Department
ARMERO CERVERA, MARIA CARMEN	130 - Statistics and Operational Research
IÑIGUEZ HERNANDEZ, MARIA DEL CARMEN	130 - Statistics and Operational Research

SUMMARY

The Probability is the part of Mathematics that deals with the formal study of uncertainty. Our world is full of elements with uncertainty: accidents, epidemics, storms, climate change, financial market movement, migration, disease, and so on. And it’s also full of data. Probabilistic models are key for analysing data and making scientifically sound predictions and estimates. Probability is the basis of stochastic simulation and provides reference tools for the treatment of uncertainty and randomness in territories such as artificial intelligence or data science.

The vast majority of the knowledge that Mathematics students learn falls within the scope of Exact Mathematics. The only subject in which the Mathematics student encounters non-exact Mathematics, Probability, is the first basic Statistics subject, with a small section dedicated to Probability, which is presented mainly in an instrumental and applied way.

This subject is dedicated exclusively to the learning of Probability. The subject uses in the theoretical classes the traditional format "definition-theorem-proof" that guarantees the rigorous and mathematically

precise introduction of the material, but will always be accompanied by an intuitive and critical explanation that enhances the map of probabilistic concepts and the relationship between them. The practical classes and seminars give full prominence to the students with the aim that they can consolidate the learning of the subject.

The course covers all the basic concepts of probability, including the axiomatic definition of probability and its frequency interpretation, random variables and vectors and associated basic characteristics, R programming environment and the main probabilistic models and their usefulness as models for others. disciplines that are essential in their scientific studies.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

Necessary: Análisis Matemático I , convenient: Análisis Matemático II

OUTCOMES

1107 - Degree in Mathematics

- Possess and understand the mathematical knowledge.
- Apply the knowledge in the professional world.
- Argue logically in decision-making.
- Reason logically and identify errors in the procedures.
- Capacity of abstraction and modeling.
- Participate in the implementation of software and learn mathematical software.

LEARNING OUTCOMES

The learning outcomes for this Probability course are:

• Understand the meaning of random experiments and probability.

• Use the probability axioms to obtain probabilities associated with derived random events.

• Understand the meaning of the frequentist interpretation of probability and its relation to the simulation of random events.

• Understand the meaning of conditional probability and its relation to the reduction of the sample space.

• Understand the concept of random variable and random vector

• Distinguish between discrete, continuous, and mixed random variables and be able to represent them through probability functions, density functions, and distribution functions.

• Partially characterize a distribution through its mean, variance and other moments

• Distinguish the concepts of independence and incorrect variables.

• Represent joint distributions of random vectors.

• Obtain the distribution of functions of random variables and random vectors.

• Identify and know the different discrete and continuous distributions studied and approach the random phenomena of other disciplines that use them in their scientific studies.

• Connect data and probability distributions through the simulation of random variables.

• Know the main functions of the R program and its usefulness in probabilistic environments.

• Use moment generating functions to work with sums of independent variables.

• Know the concept of succession of random variables and distinguish between the different types of convergence of random variables.

• Understand the limit theorems and, in particular, the central limit theorem.

DESCRIPTION OF CONTENTS

1. Experiment and probability

1.1. Random experiment.
1.2. Measure of probability. Probability space.
1.3. Basic properties of Probability.
1.4. Conditional probability. Independence.
1.5. Total probability and Bayes theorems.

2. Random variables

2.1. Random variable: definition and properties.
2.2. Discrete and continuous distributions of random variables.
2.3. Cumulative distribution function.
2.4. Expectation, variance and standard deviation. Other moments.
2.5. Function of a random variable.

3. Special distributions.

3.1. Discrete distributions: Bernouilli, binomial, negative binomial, hypergeometric and Poisson.
3.2. Continuous distributions: Uniform, exponential and gamma.
3.3. Normal and derived distributions.
3.4. Random variables simulation.

4. Random vectors.

4.1. Random vector. Definition and properties.
4.2. Continuous and marginal distributions. Independence of random variables.
4.3. Conditional distribution.
4.4. Expectation, variance, covariance and correlation. Moments
4.5. Functions of random vectors.

5. Convergence of sequences of random variables.

5.1. Weak convergence in probability and almost sure.
5.2. Weak and strong law of large numbers.
5.3. Central limit theorem.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	37,50	100
Computer classroom practice	22,50	100
Other activities	7,50	100
Development of group work	5,00	0
Development of individual work	5,00	0
Study and independent work	10,00	0
Readings supplementary material	2,50	0
Preparation of evaluation activities	20,00	0
Preparing lectures	20,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

Theoretical activities. Exposition of the concepts with the enrollment of the student by solving punctual questions.

Practical activities. Learning by solving problems, exercises and lab work in which competences will be acquired on the different aspects of the subject. These activities will be developed individually or in small groups, will be carried out in the computer room (practical classes) or at the classroom (seminars).

EVALUATION

The evaluation of the subject will be based on three elements:

- Practices. Individual tasks collected in the practice classes. Percentage of the total mark: 10%.

- Seminars. A group task based on a topic related to probability. Percentage of the total mark: 10%.

- Exam. Percentage of the total mark 80%.

In order to pass the course, it will be necessary, but not enough, for the student to obtain a minimum grade of 3.2 in the exam, scored out of 8, and a minimum grade of 0.8 in the joint evaluation of the practices and seminars, scored together on 2.

Those students who in the first call do not reach the minimum established in the set of practices and seminars must take an exam in the second call on both contents.

Students who reached the minimum mark in practices and seminars, but not in the exam, will be able to keep their mark of practices and seminars in the second call.

Students who have failed the first call, whether or not they have a minimum mark in the exam, will have to retake it in the second call.

Attendance at theory classes, seminars or internships will not be mandatory. The only exception is the internship sessions in which some evaluable task is requested. Such situations will be reported to students in advance.

REFERENCES

Basic

- Referència b1: M. H. DeGroot and M. J Schervish. Probability and Statistics. Fourth Ed. Addison Wesley (2012).

  Referència b2: D. Stirzaker. Elementary Probability. Cambrideg. Second Edition (2010)

  Referència b3: K. Baclawski. Introduction to probability with R. Chapman & Hall (2008).

Referència b4: V.K. Rohatgi and A.K. Ehsanes Saleh. An Introduction to Probability and Statistics. Wiley Series in Probability and Statistics. Third Edition (2015)

Additional

- Referència c1: G.R. Grimmett and D.R. Stirzaker.One Thousand Exercises in Probability.Oxford University Press. Third Edition. (2020).

  Referència c2: S. M. Ross. Introduction to Probability Models. Twelfth Edition. Academic Press. (2019)

  Referència c3: D. Rumsey. Probability for Dummies.Wiley. (2006)

  Referència c4: G. Ayala y F. Montes. Probabilidad. Notas de clase (2017).