Universidad Zaragoza

Academic Year/course: 2021/22

29708 - Statistics

Syllabus Information

Academic Year: 2021/22
Subject: 29708 - Statistics
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 434 - Bachelor's Degree in Mechanical Engineering
ECTS: 6.0
Year: 1
Semester: 434-First semester o Second semester
107-Second semester
Subject Type: Basic Education
Module:

1. General information

1.1. Aims of the course

This course covers aspects of data collection, presentation, analysis and treatment, as well as drawing conclusions from the information they provide. Statistical inference plays an important role in the application of many statistical techniques that may be useful in the professional practice of the mechanical engineer. Furthermore, the student learns to model real situations in the presence of uncertainty. Finally, elementary optimization aspects are introduced that play a determining role in decision making.

The final objective is that the student integrates the knowledge that is taken in the subject in the training context of the degree and, to the extent possible, is self-sufficient in the use of statistical techniques in the development of their professional work.

All the training provided by this subject (theoretical and practical) contributes in a transversal way to the AGENDA 2030 and ODS since its training enables the student to contribute to the development and management of the 245 indicators of the ODS proposed by PNUMA.

1.2. Context and importance of this course in the degree

The subject is compulsory and is part of the basic training of the students. It is located in the second semester of the first year, once the student has acquired a basic training in Mathematics. It is taught simultaneously with the subjects of Fundamentals of Computing, Mathematics II and Physics II of basic training and Environmental Engineering, specific to the industrial branch.

The course will be useful for the future graduate in Mechanical Engineering by providing him with a scientific base that will guide him in decision-making when analyzing information from databases such as, for example, those taken in subjects such as Fundamentals of materials engineering or of Resistance of materials that the student will study in second, in Manufacturing Technologies of third course and in Organization and management of fourth companies, among others. It also provides a solid basis for modeling real situations of a random nature.

The improvement of quality, the design of new products and manufacturing processes and the improvement of existing systems are the activities of a mechanical engineer. Statistical techniques are an essential tool to carry them out as they provide descriptive and analytical methods to approach data processing, transforming them into information. The analysis of the reliability of components and systems has relevance by itself when designing a new product. An important aspect is the guarantee to be offered, associated with the analysis of the distribution of life time, a concept that is studied in this subject.

1.3. Recommendations to take this course

Students are advised to study the subject constantly throughout the semester. Students who continue the subject continuously must pass the assessment tests scheduled throughout the course. Those who do not follow the subject continuously must pass a final evaluation test referring to all content modules.

It is recommended that the student possess basic knowledge of integral and differential calculus.

2. Learning goals

2.1. Competences

Specific competences:

C12: Ability to solve mathematical problems that may arise in engineering. Ability to apply statistical and optimization knowledge.

Generic skills:

C4: Ability to solve problems and make decisions with initiative, creativity and critical reasoning.

C5: Ability to communicate and transmit knowledge, abilities and skills in Spanish.

2.2. Learning goals

1. Apply data analysis and treatment techniques.
2. Know the concepts, applications and fundamental results of probability.
3. Understand the concepts of one-dimensional and multidimensional random variable.
4. Master the modeling of engineering environments under a stochastic nature using random variables and their applications in situations of uncertainty.
5. Know the sampling and estimation techniques.
6. He knows how to use statistical hypothesis tests and their application in decision making.
7. It has the capacity to prepare, understand and critique reports based on statistical analysis.
8. You have the ability to identify and formulate optimization problems.

2.3. Importance of learning goals

This course teaches the basic principles of decision making in the presence of uncertainty. Students develop skills to tackle real problems and to work with real data and learn to recognize and manage models that serve to solve different situations in the presence of randomness.

A mechanical engineer must regularly handle information from databases and must be able to make decisions based on its analysis. Decision making requires an exploratory treatment of the data as well as the establishment of hypothesis tests, with which statistical techniques are essential.

Students learn to pose and solve simple optimization problems.

In addition, students work in groups and with real data, so they also develop team collaboration skills in solving real problems.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

Global evaluation:

The global evaluation of the subject includes the following activities carried out continuously throughout the course:

1. A written test carried out individually by the entire group of students, during the teaching period of the subject, referring to the Probability Distribution Models module. (Learning outcomes 2, 3 and 4).

2. A written test carried out individually by the entire group of students, in the official announcement of the subject, referring to the Sampling, estimation and hypothesis testing module. (Learning outcomes 5 and 6).

3. A written test carried out individually by the entire group of students regarding the contents developed in the practical classes of the subject in a computer laboratory to be carried out during the teaching period of the subject and / or in the official call. (Learning outcomes 1, 2, 3, 4, 5, 6, 7, and 8).

4. A statistical report made by the complete group of students, where they apply some of the different statistical techniques studied throughout the course, and to be carried out before the official announcement. (Learning outcomes 1, 2, 3, 4, 5, 6, 7, and 8).

Students who do not take the test proposed in point 1 above scheduled during the course, corresponding to the global assessment, must take it in the official call for the course.

Evaluation criteria:

The following aspects will be considered in the evaluation:

- The problem must be correctly stated.
- They must correctly define the variables used in the problem posed.
- The probability distribution model assigned to each random variable must be duly justified.
- Serious errors in basic concepts of the subject will mean the cancellation of the score given to the corresponding question or problem.

Requirement levels:

The test corresponding to the Probability distribution models module represents 40% of the final grade and the test

corresponding to the Sampling, estimation and hypothesis testing module represents 20% of the final grade. To overcome the 60% that both represent, the student must obtain a grade of at least 4 points (out of 10) in each of them and a weighted average of at least 4.5 points (out of 10).

Learning outcomes related to the skill in statistical data analysis will be assessed with the joint score of the Statistical Report (20% of the final grade) and a written test (20% of the final grade). To overcome the 40% that both represent, the student must obtain at least 4 points (out of 10) in each of them and an average of at least 5 points (out of 10) in these activities.

To pass the course, the student must obtain a final grade of at least 5 points, out of 10.

The global evaluation test will consist of a compulsory written test equivalent to the tests described in points 1, 2 and 3, in addition to the completion of the Statistical Report referred to in point 4. The percentage of the final mark for test 1 it is 40% and that of each of the three remaining tests is 20%. The test corresponding to the Statistical Report will take place during the examination period set by the EINA.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. It is based on participation and the active role of the student favours the development of communication and decision-making skills. A wide range of teaching and learning tasks are implemented, such as lectures, guided assignments, laboratory sessions, autonomous work and tutorials.

Students are expected to participate actively in the class throughout the semester.

Classroom materials will be available via Moodle. These include a repository of the lecture notes used in class, the course syllabus, as well as other course-specific learning materials.

Further information regarding the course will be provided on the first day of class. The proposed methodology seeks to encourage the student's continued work and focuses on the most Practices of Statistics: the work with real data.

In the sessions with the complete group, theoretical aspects are treated in the form of a Lecture, that complements each other with its application to solve problems of real nature in the classes of problems in small groups.

The processing of real data is done in sessions in the computer lab using computer programs, and, in addition, basic problems of Optimization are solved by the computer.

The evaluation focuses on both theoretical and applied aspects according to the evaluation criteria established.

4.2. Learning tasks

The course includes 6 ECTS organized according to:

- Lectures (3 ECTS): 30 hours.
- Laboratory sessions (1.5 ECTS): 15 hours.
- Guided assignments (1.5 ECTS): 15 hours.
- Autonomous work: 90 hours.
- Tutorials: 6 hours/week

Lectures: the professor will explain the theoretical contents of the course and solve illustrative applied problems. These problems and exercises can be found in the problem set provided at the beginning of the semester. Lectures run for 2 weekly hours. Although it is not a mandatory activity, regular attendance is highly recommended.

Laboratory sessions: sessions will take place every 2 weeks (6 sessions in total) and last 2.5 hours each. Students will work together in groups actively doing tasks such as practical demonstrations, measurements, calculations, and the use of graphical and analytical methods.

Guided assignments: students will complete assignments, problems and exercises related to concepts seen in laboratory sessions and lectures. Guided assignments run for 1 weekly hour. They will be submitted at the beginning of every laboratory sessions to be discussed and analyzed. If assignments are submitted later, students will not be able to take the assessment test.

Autonomous work: students are expected to spend about 90 hours to study theory, solve problems, prepare lab sessions, and take exams.

Tutorials: the professor's office hours will be posted on Moodle and the degree website to assist students with questions and doubts. It is beneficial for the student to come with clear and specific questions.

4.3. Syllabus

The course will address the following topics:

Sections

Section 1: Exploratory data analysis in the computer laboratory.

Section 2: Models of the probability distribution.

Section 3: Sampling, estimation and hypothesis tests.

Section 4: Introduction to Optimization.

Section 1: Exploratory Data Analysis

Descriptive statistics

Basic concepts. Types of variables.

Data organization. Frequency table.

Graphic descriptions of a variable.

Numerical descriptions of a variable. Box-plot.

Bidimensional distributions. Bidimensional table.

Marginal and conditional distributions.

Measures of association. Regression and correlation.

Section 2: Models of the probability distribution

Basic concepts. Sample space and events, algebra of events. Random and deterministic experiments.

Interpretations of probability.

Kolmogorov axiomatic definition.

Conditional probability. Independence of events.

Partition of a sample space, law of total probability and Bayes theorem.

Reliability of systems.

Random variables

Definition of random variable. Classification.

Discrete random variable, probability function, distribution function.

Continuous random variable, density function, distribution function.

Expectation of a random variable and of a function of a random variable.

Basic properties of expectation and variance

Moments of a random variable.

Other measures of central tendency and dispersion.

Chebyshev inequality.

Main discrete distributions: Bernoulli, binomial, Poisson, geometric, hypergeometric.

Main continuous distributions: uniform, exponential, normal.

Reproductivity of random variables.

Poisson process: relationship to exponential distribution.

Approximations between random variables.

Two-dimensional distributions. Calculation of expectations and variances of a linear combination of independent random variables.

Section 3: Sampling, estimation and hypothesis tests

Sampling and Estimation

Introduction. Basic concepts associated with sampling distributions in normal populations: chi-square, Student's t, F.

Distributions important statistical sampling: Central Limit Theorem and Fisher theorem.

Confidence interval estimation. Intervals for means, variances and proportions. Calculation of the minimum sample size.

Hypothesis tests: null and alternative hypothesis, level of significance.

Relationship between confidence intervals and hypothesis tests.

Calculating the p-value.

Hypothesis testing for means, variances and proportions.

Chi-square and tests of contingency tables.

Section 4: Introduction to Optimization

Optimization problems

Decision variables, objective function and constraints.

Linear programming problems: graphic resolution.

Contents of Practical classes in the computer laboratory

? Uni-dimensional descriptive statistics.

? Instructions for implementation of the Statistical Report.

? Two-dimensional Descriptive Statistics. Regression and correlation.

? Probability distributions of discrete and continuous random variables.

? Test goodness of fit.

? Hypothesis testing for means, variances and proportions.

? Introduction to Optimization.

4.4. Course planning and calendar

For further details concerning the timetable, classroom and further information regarding this course please refer to the "Escuela de Ingeniería y Arquitectura " website (https://eina.unizar.es/)

4.5. Bibliography and recommended resources

The updated bibliography is in the BR of the BUZ