
DEGREE CURRICULUM

# STATISTICS AND OPTIMIZATION

Coordination: LOPEZ LORENZO, IGNACIO

Academic year 2023-24

# STATISTICS AND OPTIMIZATION 2023-24

## Subject's general information

<table>
<tr><td>Subject name</td><td>STATISTICS AND OPTIMIZATION</td></tr>
<tr><td>Code</td><td>102006</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Computer Engineering</td><td>1</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
<tr><td>Double bachelor's degree: Degree in Computer Engineering and Degree in Business Administration and Management</td><td>1</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
<tr><td>Programa Acadèmic de Recorregut Successiu - Enginyeria Informàtica</td><td>1</td><td>COMMON/CORE</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>9</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>4.5</td><td>4.5</td></tr>
<tr><th>Number of groups</th><td>3</td><td>2</td></tr>
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<tr><td>Coordination</td><td>LOPEZ LORENZO, IGNACIO</td></tr>
<tr><td>Department</td><td>MATHEMATICS</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>225 total work hours<br>90 lecture attendance hours (partly provided virtually)<br>135 autonomous work hours</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Catalan or spanish, depending on teacher.</td></tr>
</table>

# STATISTICS AND OPTIMIZATION 2023-24

| Teaching staff | E-mail addresses | Credits taught by teacher | Office and hour of attention |
|---|---|---|---|
| CERESUELA TORRES, JESUS MIGUEL | jesusmiguel.ceresuela@udl.cat | 7,5 | |
| LOPEZ LORENZO, IGNACIO | nacho.lopez@udl.cat | 6 | |
| PUJOLAS BOIX, JORDI | jordi.pujolas@udl.cat | 9 | |

## Subject's extra information

Previous knowledge/skills on basic mathematics (General Upper Secondary Education level) are recommended.

The course is part of the academic plan. This subject is given during the second semester in the first course. It corresponds to the basic training modulus.

## Learning objectives

The learning outcomes that the student must achieve in this subject are:

- Know the numerical sets and their properties.
- Manipulate equations and inequalities with real numbers.
- Know the binomial, Cartesian, and polar representations of complex numbers.
- Know the types of matrices with elements on a body.
- Manipulate matrix equations.
- Calculate the inverse matrix.
- Calculate the rank of a matrix.
- Know the definition of the determinant of a square matrix.
- Calculate a determinant effectively.
- Know the types of systems of linear equations.
- Determine the solutions of a system of linear equations.
- Know the successions, series, and their convergence.
- Resolve indeterminacies in the calculation of succession limits.
- Apply criteria to determine the convergence of a numerical series.
- Know the Riemann integral.

- Properly use integration methods by variable change and by parts.
- Calculate the Fourier series coefficients.
- Know Dirichlet's Theorem and apply it correctly.
- Distinguish the type of feature that a data set represents.
- Represent graphically and calculate the most representative values of a data set.
- Calculate probabilities by applying Laplace's formula, the total probability theorem, and Bayes' theorem.
- Determine the distribution model of the random variable associated with a random experiment and make calculations.

## Competences

**Specific competences**

- GII-FB1 - Capacity to solve mathematical problems arisen in the engineering field. Aptitude to apply knowledge on: linear algebra; differential and integral calculus; numerical methods; algorithmic, numerical; statistics and optimisation.
- GII-FB3 - Capacity to understand and master the basic concepts of discreet mathematics, logical, algorithmic and computational complexity, and its application to solve engineering problems.

**Cross-disciplinary competences**

- EPS1 - Capacity to solve problems and prepare and defence arguments inside the area of studies.
- EPS5 - Capacity of abstraction and of critical, logical and mathematical thinking.

**University strategic competences**

- CT5 - Acquire knowledge in scientific thinking.

## Subject contents

**Part I: Optimization (2/3)**

1. Real and complex numbers.

    1. Real numbers: absolute value.
    2. Representations of complex numbers.
    3. Operations with complex numbers. Roots.

2. Matrices, determinants, and systems of linear equations.

    1. Definition and operations. Types of matrices.
    2. Equivalent matrices and rank of a matrix.
    3. Determinant of a square matrix. Properties.
    4. Effective calculation of a determinant.
    5. Systems of linear equations. Matrix formulation.
    6. Resolution methods.

3. Sequences and numerical series

1. Successions. Limits and convergence.
2. Successive operations. Indeterminacies.
3. Numerical series. Convergence.

4. Fourier integration and Fourier series

1. Riemann integral.
2. Calculation of primitives.
3. Definition and coefficients of the Fourier series.
4. Dirichlet's theorem.

**Part II: Statistics (1/3)**

1. Univariate data analysis.

1. Qualitative variables and quantitative variables.
2. Tabulation. Box diagram, stem-leaf diagram, histogram. Representative values.

2. Probability calculation.

1. Experiments and random events. Concept of independence.
2. Concepts of probability. Properties.
3. Laplace's rule. Conditional probability. Total probability theorem. Bayes' theorem.

4. Random variables.

1. Discrete random variables. The function of probability, hope, and variance.
2. Discrete models.
3. Continuous random variables. Density function.
4. Continuous models.

## Methodology

Theoretical and practical contents are mixed to combine basic aspects with illustrative examples. Practical lectures include joint student-lecturer sessions and individual-group sessions, and also sessions with the open symbolic packages Sagemath and R.

## Development plan

**OPTIMITZATION**

| Description | Face-to-face activities | Student Workload | Timing |
|---|---|---|---|
| Chapter 1. Real numbers and complex numbers. | Theory and problems of Chapter 1 | Solve exercises and study theory. | 1,5 weeks |
| Chapter 2. Matrices, determinants, and systems of equations. | Theory and problems of Chapter 2 | Solve exercises and study theory. | 3,5 weeks |
| Chapter 3. Successions and numerical series. | Theory and problems of Chapter 3 | Solve exercises and study theory. | 2 weeks |

| | | | |
|---|---|---|---|
| Chapter 4. Integrals and Fourier series. | Theory and problems of Chapter 4 | Solve exercises and study theory. | 2 weeks |

**STATISTICS**

| Description | Face-to-face activities | Student Workload | Timing |
|---|---|---|---|
| Tema 1. Univariate data analysis | Theory and problems of Chapter 1 | Solve exercises and study theory. | 1 week |
| Tema 2. Probability calculation | Theory and problems of Chapter 2 | Solve exercises and study theory. | 1 week |
| Tema 3. Random variables | Theory and problems of Chapter 3 | Solve exercises and study theory. | 2 weeks |

## Evaluation

| Abbr. | Marking Activity | Ponderation | Group | Mendable |
|---|---|---|---|---|
| C1 | Sagemath Test | 10% | YES (<=2) | NO |
| P1 | 1st Partial Exam | 40% | NO | YES |
| C2 | R tutorial Test | 10% | YES (<=2) | NO |
| P2 | 2nd Partial Exam | 40% | NO | YES |
| | | | | |
| **Final Mark** = 0.1*C1 + 0.4*P1 + 0.1*C2 + 0.4*P2 | | | | |

The course is passed if the final mark is 5 or higher. The final mark is a weighted sum of both partial exams, the 1st test and the R tutorial test.

Each partial exam has a weight of 40% in the final mark, with a minimum mark of 1 required. Both partial exams

and the tests are compulsory.

## Bibliography

• Cristina Dalfó, Nacho López i Jordi Pujolàs. Quadern d'estadística i optimització. (2022)

**Optimization:**

• Magda Valls and ....[et al]. Curs Pràctic d'Àlgebra per a Informàtics, Col·lecció Eines. Edicions de la Universitat de Lleida, 2004.
• Isaac A. García and Susanna Maza. Curso de introducción al cálculo para grados en ingeniería. Edicions de la Universitat de Lleida, 2013
• Francesc Aguiló and ....[et al]. Temes Clau de Càlcul. Edicions de la UPC,Barcelona, 1991.

**Statistics:**
• Daniel Peña. Fundamentos de estadística. Alianza editorial, 2001.
• Murray R. Spiegel, et al. Probabilidad y estadística. McGrawHill. 3ª edición. 2010.