COURSE DATA

DATA SUBJECT

Code: 36589
Name: Numerical Methods
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1928 - Double Degree Program Physics-Mathematics	Facultat de Ciències Matemàtiques	2	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1928 - Double Degree Program Physics-Mathematics	Segundo Curso (Obligatorio)	COMPULSORY

COORDINATION

ARANDIGA LLAUDES FRANCESC

SUMMARY

The purpose of the Numerical Methods course is to provide knowledge of the basic methods for solving systems of linear equations and numerical integration, both deterministic and stochastic.

A large number of physical and technical problems, after appropriate mathematical modeling, lead to solving a linear system -often of large dimension- or to calculating eigenvalues and eigenvectors of certain matrices related to the problems at hand. The abundance of such problems in various scientific fields (physics, chemistry, economics, engineering, etc.) is very high, which makes their solution highly important.

Numerical linear algebra is a mathematical area with a significant impact on other scientific and technological fields. The development of numerical linear algebra is continuously driven by concrete problems that, in turn, benefit from the techniques developed. One example is the relationship between linear systems and finite difference methods used to solve differential equations.

This course also introduces students to basic integration rules and the statistical techniques of Monte Carlo methods.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

The basic concepts required to begin this course will have been covered in the subjects of Basic Statistics, Vector Calculus, Computational Tools, Mathematical Analysis I, and Linear Algebra and Geometry.

COMPETENCES / LEARNING OUTCOMES

DESCRIPTION OF CONTENTS

1. **LU Decomposition**
   Elementary transformations.
   Existence and uniqueness of LU decomposition.
   Partial pivoting.
   Symmetric and positive definite matrices.
2. **Linear systems and their numerical solution**
   Vector and matrix norms.
   Numerical solution of linear systems.
   Stability of solutions. Condition number.
3. **Iterative methods**
   Introduction. Need for iterative methods.
   Jacobi method.
   Gauss-Seidel method.
   Convergence analysis.
4. **Methods for eigenvalues and eigenvectors**
   Eigenvalues and eigenvectors.
   Gershgorin's theorems.
   Power method.
   Inverse power method.
5. **Basic numerical integration**
   Basic integration methods: simple rectangle rule, trapezoidal rule, and Simpson's rule.
   Composite rules.
6. **Statistical methods**
   Monte Carlo methods.
   Random numbers. Uniform random number generators.
   Sampling from distributions.
   Inverse transform method.
   Acceptance-rejection method.
   Monte Carlo integration.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	30,00
Other activities	7,50
Computer classroom practice	22,50
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	7,50
Preparation of lessons	57,50
Preparation for assessment activities	25,00
Resolution of case studies	0,00
Total hours	**90,00**

TEACHING METHODOLOGY

The course is structured around three main components: theory sessions, practical classes (in the classroom using computers), and tutorials and seminars.

Regarding the theory sessions, the instructor will cover the main topics of the syllabus, using the classroom computer when necessary to illustrate specific points. Students are expected to dedicate the necessary preparation time to these classes to ensure optimal learning. The practical classes will allow students to verify their level of understanding by tackling relatively complex problems and analyzing the results obtained. As before, students must prepare for these sessions to complete the experiments within the allotted time.

EVALUATION

The assessment of students' knowledge and skills will be conducted continuously throughout the course and will consist of the following evaluation components:

1. Theory and practicals: since the course objectives focus on strengthening computer-based calculation techniques, this evaluation will be carried out in two stages:
a. Continuous assessment of practical sessions and submission of reports, including code, results, and comments. Tests on practical content will also be conducted. (Up to 4 points, i.e., 40% of the final grade).
b. Final assessment, consisting of a theoretical exam scored up to 5 points, i.e., 50% of the final grade.

2. Seminars and tutorials: participation in these sessions will be evaluated with a maximum score of 1 point, i.e., 10% of the final grade.

To pass the course, it is necessary that the scores in subcomponents 1.a and 1.b exceed 40% of their maximum scores.

Grades obtained from the continuous assessment in section 2 will be considered valid for both exam periods of the academic year in which they were obtained.

REFERENCES

- F. Aràndiga, R. Donat y P. Mulet. Mètodes Numérics per a l'Àlgebra Lineal. Publicacions de la Universitat de València. 2000.
- F. Aràndiga y P. Mulet. Càlcul Numèric. Publicacions de la Universitat de València. 2008.
- R. L. Burden y J. D. Faires. Análisis Numérico. Thomson-Learning. México, 2002 Referència b4: G. Cowan. Statistical Data Analysis. Oxford. University Press 1998.

Additional Bibliography

- Golub, G. H. y C. F. van Loan: Matrix Computation, 3rd ed., Johns Hopkins University Press, Baltimore, MD, 1996.
- Biswa Nath Datta: Numerical Linear Algebra and Applications, Society for Industrial and Applied Mathematics, 2010.
- A. Aubanell, A. Benseny y A. Delshams. Eines Básiques de Càlcul Numèric. Manuals de la Universitat Autònoma de barcelona, 1991.
- S. Amat , F. Aràndiga, J.V. Arnau, R. Donat, P. Mulet i R. Peris. Aproximació Numèrica. Publicacions de la Universitat de València. 2002.