Advanced Mathematics

Academic Year: (2025 / 2026) **Review date: 07/04/2025 10:37:06**

Department assigned to the subject: Mathematics Department

Coordinating teacher: SANCHEZ VILLASEÑOR, EDUARDO JESUS

Type: Basic Core ECTS Credits : 6.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I
Calculus II
Linear Algebra

LEARNING OUTCOMES

K2: Know basic humanistic contents, oral and written expression, following ethical principles and completing a multidisciplinary training profile.
K6: Demonstrate basic programming skills in order to use and develop statistical packages
C1: Develop and master interpersonal skills on initiative, responsibility, conflict resolution and negotiation, which are essential in the professional environment.
S3: e able to dedicate themselves to autonomous long-life learning, that enables them to adapt to new situations
S7: Describe, synthesize and graphically represent the information contained in a data set

OBJECTIVES

The goal of this course is to acquaint the student with mathematical tools necessary for an adequate compression of some advanced techniques of statistical analysis:
- Complex numbers
- Series of functions
- Integral transforms
- Matrix calculus
- Singular value decomposition
- Introduction to numerical calculus

DESCRIPTION OF CONTENTS: PROGRAMME

T0. PRELIMINARIES
- Complex numbers: Graphical representation, arithmetic, complex exponential.
- Summation, products, indexed sums.

T1. NUMERICAL ISSUES: CALCULUS
- Errors, Floating-point arithmetic
- Computer: Newton's method; Trapezoidal Rule.

T2. MATRIX CALCULUS
- Exponential matrix
- Derivatives with scalars, vectors and matrices.
- Multidimensional integration. Integration with scalars, vectors and matrices.

T3. SINGULAR VALUES DESCOMPOSITION
- Singular value decomposition
- Moore-Penrose pseudoinverse.
- Principal component analysis

T4. NUMERICAL ISSUES: LINEAR ALGEBRA
- Computer: LU factorization; Power method for approximating eigenvalues.

T5. SERIES OF FUNCTIONS
- Numerical series, convergence criteria.
- Series of functions: powers, Taylor, Maclaurin.
- Series of functions: Fourier.

T6. INTEGRAL TRANSFORMS
- Improper integrals.
- Fourier transform. Characteristic function
- Laplace transform. Moment-generating function

LEARNING ACTIVITIES AND METHODOLOGY

The course will primarily be taught using the blackboard, with supplementary materials accessible on the course webpage. Two written tests will be scheduled to be completed during class hours throughout the semester. Additionally, there will be one computer homework assignment.

ASSESSMENT SYSTEM

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

A continuous assessment process will be implemented through periodic written tests conducted during teaching hours, accounting for 30% of the final grade. Additionally, one computer-based homework assignment will contribute 10% to the final grade. Failure to attend any test or lab session will result in a score of zero for that specific component; however, it will not affect the remaining assessments. The final examination will account for 60% of the final grade. Grades obtained through continuous assessment will be retained for students who must take the extraordinary examination.

BASIC BIBLIOGRAPHY

- D. Pestana, M. Rodríguez y F. Marcellán Curso Práctico de variable compleja y teoría de transformadas, Pearson, 2014

- B.N. Datta Numerical Linear Algebra and Applications, Brooks & Cole, 1995

- D. Zill Ecuaciones diferenciales con aplicaciones de modelado, Thomson, 1997

- James E. Gentle Matrix Algebra: Theory, Computation, and Applications in Statistics, Springer, 2007

- K. Sydsaeter and P. Hammond Essential Mathematics for economics Analysis, Pearson, 2012

- L.N. Trefethen & D. Bau Numerical Linear Algebra, SIAM, 1997

- Salas, Hille y Etgen Calculus (I y II), Reverté, 2002