UAB
Universitat Autònoma de Barcelona

Numerical Methods and Optimisation

2026/2027

Code: 104848
Credits: 6

Degree programme	Type	Course
Applied Statistics	FB	2

Contact lecturer

Name : Joan Torregrosa Arus

Email : joan.torregrosa@uab.cat

Group languages

You can consult this information at the end of the document.

Prerequisites

It is recommended to have passed the following courses: Àlgebra Lineal, Càlcul 1 and Càlcul 2.

Objectives

This course will provide students the basic numerical methods to solve real problems which arise from science and mainly from applied statistics.

The purpose of the course is that the students learn the mathematical foundations of the methods, their range of applicability and the type of errors that should be expected. The student should also be able to recognize the problems whose solution requires the use of a numerical method, and to apply a proper method to get an approximate solution in an efficient way.

The student shoud also be able not only to use some programming languages to implement and test simple algorithms, but to work with the functions provided by the correspondig software.

Learning outcomes

- KM04 (Recognise the mathematical bases of the methods, the conditions of applicability and the types of errors that can appear in the numerical (algorithmic) solution of different types of problems.) Recognise the mathematical bases of the methods, the conditions of applicability and the types of errors that can appear in the numerical (algorithmic) solution of different types of problems.
- SM02 (Implement algorithms using different programming languages (Máxima, R, Python, Julia), working with the programmed functions provided by the software packages used.) Implement algorithms using different programming languages (Máxima, R, Python, Julia), working with the programmed functions provided by the software packages used.
- SM03 (Solve, using numerical methods, optimisation problems, linear algebra and analysis in general that appear in science and, especially, in statistics.) Solve, using numerical methods, optimisation problems, linear algebra and analysis in general that appear in science and, especially, in statistics.

Contents

1. Errors

Floating point arithmetic. Propagation of errors.

Conditioning of a problem.

2. Numerical Linear Algebra

LU decomposition. Perturbation analysis.

QR decomposition. Applications.

Singular value decomposition. Applications.

3. Numerical Solution of Nonlinear Equations

One variable equations: Fixed point methods. Newton-Raphson's method.

Methods for systems of nonlinear equations.

4. Polynomial interpolation

Lagrange polynomial. Divided differences.

Error estimate.

5. Unconstrained Optimitzation

One dimensional minimization.

Line search methods, gradient, Newton.

6. Constrained Optimitzation

The penalty method.

Augmented Lagrangian method.

7. Numerical Integration

Trapezoidal and Simpson's rules. Romberg method.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Study	32	1.28	
Problems	14	0.56	
Exercises	35	1.4	
Computer work	21	0.84	
Theory	26	1.04	

Computer sessions	12	0.48

In the theoretical lectures the teacher will explain the mathematical foundations and basic properties of the numerical methods and will present several illustrative examples.

Different lists of exercises will be proposed so that the student can practice and learn the contents of each topic. In the problem lectures the teacher will work on the lists of exercises, will solve the doubts of the students and will discuss and provide indications for solving the exercises.

Each computer session will have a script associated. In the computer sessions the student will do the work proposed in the correspondig script under the supervison of the teacher. It is convenient that before the session the student reads carefully the script in order to know the goal of the computer session and the numerical methods to be used.

All the course material will be posted on the Virtual Campus.

For this course, the use of Artificial Intelligence (AI) technologies is permitted exclusively for support and clarification tasks related to solving exercises and practical assignments. Students must clearly identify which parts have been generated using this technology, specify the tools used, and include a critical reflection on how these have influenced both the process and the final outcome of the activity. Failure to be transparent about the use of AI in this assessed activity will be considered a breach of academic honesty and may result in a partial or total penalty to the activity grade, or more severe sanctions in serious cases.

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Final-term exam	40%	2.5	0.1	KM04, SM03
Mid-term exam	40%	2.5	0.1	KM04, SM03
Computer work	20%	2	0.08	SM02
Recovery Exam	80%	3	0.12	KM04, SM03

See the Catalan version.

Bibliography

See the Catalan version.

Software

See the Catalan version.

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TE) Theory	1	Catalan	first semester	afternoon
(PAUL) Classroom practices	1	Catalan	first semester	afternoon
(PLAB) Practical laboratories	1	Catalan	first semester	afternoon
(PLAB) Practical laboratories	2	Catalan	first semester	afternoon