UAB
Universitat Autònoma de Barcelona

Numerical Methods and Optimisation

Code: 104848
ECTS Credits: 6

2024/2025

Degree	Type	Year
2503852 Applied Statistics	FB	2

Contact

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Teaching groups languages

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

Prerequisites

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

Objectives and Contextualisation

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 (Maxima, R,...) to implement and test simple algorithms, but to work with the functions provided by the correspondig software.

Learning Outcomes

1. KM04 (Knowledge) 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.
2. SM02 (Skill) Implement algorithms using different programming languages (Máxima, R, Python, Julia), working with the programmed functions provided by the software packages used.
3. SM03 (Skill) Solve, using numerical methods, optimisation problems, linear algebra and analysis in general that appear in science and, especially, in statistics.
4. SM04 (Skill) Resolve problems associated with the extreme points of functions of one and several variables, and the calculation of moments.

Content

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.

Methods without derivatives.

6. Constrained Optimitzation

The penalty method.

Augmented Lagrangian method.

7. Numerical Integration

Trapezoidal and Simpson's rules. Monte Carlo method.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problems	14	0.56	
Theory	26	1.04	
Type: Supervised			
Computer sessions	12	0.48	
Type: Autonomous			
Computer work	21	0.84	
Exercises	35	1.4	
Study	32	1.28	

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 solve 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. The student must attend the computer sessions.

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

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

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Computer work	20%	2	0.08	SM02
Final-term exam	40%	2.5	0.1	KM04, SM03, SM04
Mid-term exam	40%	2.5	0.1	KM04, SM03, SM04
Recovery Exam	80%	3	0.12	KM04, SM03, SM04

See the Catalan version.

Bibliography

See the Catalan version.

Software

See the Catalan version.

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	first semester	afternoon
(PLAB) Practical laboratories	1	Catalan	first semester	afternoon

| (TE) Theory | 1 | Catalan | first semester | morning-mixed |