UAB
Universitat Autònoma de Barcelona

Modelling and Simulation

Code: 104410
ECTS Credits: 6

2025/2026

Degree	Type	Year
Computational Mathematics and Data Analytics	OB	3

Errata

- Contact:

Where the contact professor is listed, it should be replaced with:

Name: David Rojas Perez

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- Assesment:

In the sections where the three types of assessment are described, the following terminology should be corrected:

- Instead of "Exams", it should read "Final Exam".
- Instead "Oral Presentations", it should read "Midterm Exam".

Contact

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Teachers

Gabriel Vicent Jover Mañas

Teaching groups languages

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

Prerequisites

The contents of calculus, probability, and linear algebra given in the 1st year should be known. A fair command of programming in Python is also necessary. It is advised to have followed the subjects Ordinary Differential Equations (2nd year) and Partial Differential Equations (3rd year).

Objectives and Contextualisation

One of the aims of data analysis is to describe the real world and foresee its behavior.This requires a modeling task that involves different competencies such as problem analysis, simplification hypotheses, contrasting model results with empirical facts, progressive model refining, and simulation of modeled system components.

The main aim of this subject is that students achieve the ability to formulate models suitable for solving actual problems and to analyze them either formally or computationally, as best suits.

This subject has an important practical component, setting it as a bridge between mathematics and the real world and aiming to cross it in both directions.

Learning Outcomes

1. CM25 (Competence) Assess the difficulty of doing an analytical probability calculation in complex situations.
2. CM27 (Competence) Create reality simulation models to establish and verify hypotheses in the study of more complex problems or situations.
3. KM22 (Knowledge) Identify the basics of logistics and other fields in which operations research is applied in the technological and industrial field.
4. SM20 (Skill) Distinguish, in a problem, what is important for the construction of the mathematical model and its solution from what is not.
5. SM21 (Skill) Distinguish when analytical probability calculations can be performed and when stochastic simulation should be used.
6. SM22 (Skill) Select models of the scientific or technological reality related to a decision-making problem, expressing them in the mathematical language of optimisation problems with dynamic programming or stochastic queueing.
7. SM23 (Skill) Use computer applications for statistical analysis, numerical and symbolic calculation, graph visualisation, optimisation and others to experiment with and solve problems.

Content

- The Mathematical modeling cycle.
- Dimensional Analysis.
- Modeling with differential equations.
- Uncertainty analysis.
- Model validation and verification.
- Stochastic processes.
- Discrete Event Simulation.
- Introduction to Markov chains.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theoretical lessons	20	0.8	

Type: Supervised		
Project	30	1.2
Type: Autonomous		
Project development and personal study	96	3.84

This course will combine theory and Challenge-Based Learning (CBL) through a project that will be carried out in teams.

The project problem is different for each team and will have to be validated by the teacher. Optionally, one can choose a project from the Aprenentatge Servei (ApS) office.

The project must be developed by each team as autonomously as possible.

The development of the project must lead to a final report.

In addition to the written work, the results will be the subject of an oral presentation.

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
Exams	45%	2	0.08	CM27, KM22, SM20, SM21, SM23
Oral presentations	25%	2	0.08	CM25, SM20, SM21
Written report and deliveries	30%	0	0	CM25, CM27, KM22, SM20, SM21, SM22, SM23

The evaluation of this subject will be based on:

- Exams
- Written report and deliveries
- Oral presentations

To pass the subject, one must:

- To obtain a minimum of 4.0 out of 10 points in the exams.
- To obtain an overall average of 5.0 out of 10, which will be the final grade for the course.

In the case that any exam is under the minimum grade, the subject grade will be the grade of that exam.

For each of the exams, there will be a second call ("recovery" in the official terminology of the UAB). Attendance at this second call will automatically cancel the grade of the first. Within the same call, the exams of the different parts can be on the same day. This subject does not foresee the single assessment system.

Since most of the work is based on a project that is developed throughout the course, the evaluation is continuous, and its final result cannot be resitted.

Although much of the work will be done in teams, the evaluation is individual. If deemed necessary, individual interviews may also be carried out, as well as written exams on the project.

For the eventual assignment of an outstanding grade (Matrícula d'Honor), the grades of the second call will not be taken into account.

For this subject, the use of Artificial Intelligence (AI) technologies is allowed exclusively in support tasks, such as bibliographic or information search, text correction, or translations. The student will have to clearly identify which parts have been generated with this technology, specify the tools used, and include a critical reflection on how they have influenced the process and the final result of the activity.

The non-transparency of the use of AI will be considered a lack of academic honesty and leads to the automatic failure of the subject or major sanctions, in the same way as copying or plagiarism in the deliveries or cheating in an exam does.

Bibliography

- Edwards, D. & Hamson, M. (2001) *Guide to mathematical modelling*. 2nd ed. Houndmills; Palgrave.
- Dym, C. L. (2004) *Principles of mathematical modeling.* 2nd ed. Amsterdam; Elsevier Academic Press.
- Olinick, M. (2014) *Mathematical modeling in the social and life sciences*. Hoboken, New Jersey; John Wiley & Sons.
- Giordano, F. R. et al. (2014) *A first course in mathematical modeling*. 5th ed. International ed. Australia; Brooks/Cole, Cengage Learning.
- Coleman, H. W. & Steele, W. G. (2018) *Experimentation and uncertainty analysis for engineers*. 4Th ed. Hoboken, NJ, USA; Wiley.
- Law, A. M. (2015) *Simulation modeling and analysis*. 5th ed. International edition. New York; Mcgraw-Hill.
- Kroese, D. P. et al. (2011) *Handbook of Monte Carlo methods*. Hoboken, N.J; Wiley.

Software

During the course, the software will be specified, and instructions to install it will be given if necessary.

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PLAB) Practical laboratories	1	Catalan	second semester	morning-mixed
(SEM) Seminars	1	Catalan	second semester	morning-mixed
(TE) Theory	1	Catalan	second semester	morning-mixed