UAB
Universitat Autònoma de Barcelona

Operational Research

Code: 102150
ECTS Credits: 6

2025/2026

Degree	Type	Year
Business and Information Technology	OB	2

Contact

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Teachers

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Teaching groups languages

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Prerequisites

Basic knowledge of mathematics and quantitative techniques (equivalent to Mathematics II) would be advisable. Furthermore, a basic awareness of algorithmic techniques is equally convenient. Finally, the analysis of the setings in which the course focuses requires a basic understanding of Business Economics.

Objectives and Contextualisation

The basic aims of the Operations Research (OR) course are:

- To introduce students to the methodological approach developed by OR professionals to help effective decision-making using quantitative methods;
- Study the key basic tools and techniques to solve optimization problems, including its main theoretical results and algorithms;
- Apply the studied methodologies to real life projects and problems arising in business and organizations, also making use of both generic and specific software tools (Excel, LINGO, etc.).

At the end of the course, students should be able to model real-world problems arising in businesses and organizations in which OR and optimization methods can be useful. In particular, they should be competent to decide on a significant set of items to consider, choose the appropiate type of mathematical model and use computer packages to solve it and interpret the results obtained, including sensitive analysis. They should also be able to present appropriate recommendations, both to OR professionals and to business managers. Moreover, they should be able to critically evaluate the use of OR models in the situations studied, considering the complexity and uncertainty of decision making in today's world.

Learning Outcomes

1. CM10 (Competence) Refer to the operation of the most common mathematical programming algorithms for the resolution of optimization problems.
2. KM12 (Knowledge) Describe the analytical tools required, both qualitative and quantitative, for problem-solving and decision-making at the different functional levels of the company.
3. KM19 (Knowledge) Define the mathematical and algorithmic principles applicable to solving business and technological problems.
4. SM05 (Skill) Use mathematical and algorithmic tools to solve problems in the business-economic sphere with deterministic components.
5. SM06 (Skill) Apply methods to convert data into relevant information for business control and decision making and to share these decisions within and outside the organisation.

Content

The course is organized around five units. The first one (unit 0) will be developed across the entire length of the course while the following four will be introduced in a more linear way.

Unit 0. Operational Research methodology
We will discuss the role of models in the decision-making process, together with the broad lines of the methodological process used in OR to help in such process. It will also involve the conceptual analysis of a project or problem, the use of various design tools to model it; as well as the process of definition, validation and planning the implementation of the recommended solution. Preparation and presentation of results, both in oral and written form, is also an important part of this process.

Unit 1. Multiple constraints on decision making: linear programming

The topic aims to the detailed study of linear programming, probably the most popular and widely used mathematical programming model. We will first study the basic features of linear problems and their solutions. Graphic resolution of two variable models will lead to the study of general algorithmic methods to compute optimal solutions (simplex method), and to the use of software. Sensitivity analysis is also considered, together with the review of several standard applications of linear programming.

Unit 2. Between the complexity for solving and the accuracy of the solution: Integer programming

The topic motivates the use of integer and binary programming models, as well as the difficulties inherent to different solving strategies. Basic branch and bound methods are presented and discussed.

Unit 3. Capturing significant non-linear features: Nonlinear programming

The unit presents some economic situations requiring relatively simple nonlinear models. We will review the theoretical conditionsfor finding the optimal solution (based on the Lagrange function and the Karush-Kuhn-Tucker conditions), and introduce the basic numerical methods for solving nonlinear problems in an algorithmic way.

Unit 4. Network models: a dissimilar decision-making tool

This unit presents some of the key classical problems that can be modeled through the use of graphs (networks), as well as the main algorithms for solving them.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
A. Theoretical lectures	29.5	1.18	KM12, KM19, KM12
B. Classroom problems	8	0.32	SM05, SM06, SM05
C. Laboratory classes	10	0.4	KM12, KM19, SM05, SM06, KM12
D. Oral presentations	2	0.08	CM10, SM06, CM10
Type: Supervised			
E. Tutorials	15	0.6	SM05, SM06, SM05
Type: Autonomous			
F. Independent study	31	1.24	CM10, KM12, KM19, SM05, SM06, CM10
G. Modelling and solving case studies	25	1	KM12, SM05, SM06, KM12
H. Drafting of written and oral reports	25	1	SM05, SM06, SM05

The teaching methodology focuses on problem-based learning, and includes a range of problems connected with the reality of business management. In particular, a number of different classical meta-models will be used to boost the IO for its formal development (the diet problem, the problem of the traveling salesman, transportation, assignment and transshipment problems, etc.).

This approach requires a special involvement of the students in the development of the lectures of the course. Indeed, the students will be allowed to decide, up to a point, when and which of the main theoretical results of the field will be studied during the course. Therefore, the order of the units may not be strictly followed; and unit 0 will be in fact compiled as such towards the end of the semester.

The course will use generic software, including Microsoft © Excel Solver, but also more specific software. The objective is twofold: to serve as a help tool in understanding different mathematical techniques for solving IO models; and to allow the analysis of problems conceptually and numerically more complex without the difficulties of a manual resolution. The aim is to highlight both the modeling and the interpretation of all information provided by the software. It is therefore recommended for students to regularly bring their laptops to the classroom.

During the course, both teamwork and the collaborative exchange of information and tools for modeling and solving problems will be encouraged. However, the final learning process must be individual, to complement and enrich the work initiated in the course's directed sessions. The supervised activity, around regular tutorials and sporadic consultations carried out during the course, is also an indispensable tool in acquiring the suitable knowledge and skills the subject should provide.

The use of Artificial Intelligence (AI) technologies is allowed exclusively in the activities related to the laboratory practices of the subject, to highlight both the potential and possible problems of interpretation of the results obtained with an AI tool. The student should 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 its result. Lack of transparency in the use of AI in these assessable activities will be considered a lack of academic honesty and may result in a partial or total penalty in the grade of the activity, or greater penalties in cases of seriousness. (Model 2 - restricted use)

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
1. Oral contributions during the lectures	5%	0	0	CM10, KM12, KM19, SM05, SM06
3. Small format tests and problems	12.5%	1.5	0.06	CM10, KM12, SM05
3. Written/Oral submission of solved problems and laboratory case studies	37.5%	0	0	SM05, SM06
4. Final exam	45%	3	0.12	CM10, KM12, KM19, SM05, SM06

The assessment of the course will be formative, thus carried out throughout the semester. It is based on the following learning evidences:

- Oral contributions of the students to the lectures, prepared both individually and in small groups, to stimulate the active participation of the students in their own learning process.
- Reports related to problems or projects worked out during the course, and in particular in the laboratory classes, to enhance equally the acquisition of specific and transversal competences. Both technical and non-technical (i.e. addressed to the involved business organization) reports will be requested.
- Small format tests and problems solved within the classroom, aiming at the reinforcement of the actual understanding of the methodologies and techniques described in the course.
- A final exam carried out in the last week of the semester, to favor the individual consolidation of the whole content of the course

The students' final grade will be obtained from the weighted sum of the assessments of the various evidences, considering specific weights for each of the four components:

N = 5% (contributions) + 37.5% (reports) + 12.5% (small format tests) + 45% (final exam)

subject to the two following constraints: (1) each one of the components of the assessment must be a strictly positive value, and (2) the score obtained in the final exam is at least 4.5 (out of 10).

Students having not passed the subject, i.e. with a grade less than 5.0 or not having met the above conditions to be graded, will be eligible for the retake process described below if one of the following situations apply:
(a) They met conditions (1) and (2) above, and the total grade obtained (N) falls between 3.5 and 5 (3.5 <= N <5).
(b) The mark of the final exam is less than 4.5, but the rest of the student's marks are higher enough such that if the average were calculated, a mark of 5 or higher would be obtained.

Note:

1. A student having not participated in any of the assessment activities will be considered "Not evaluable".

2. This subject does NOT offer the option for comprehensive evaluation.

Calendar of evaluation activities

The dates of the evaluation activities (exercises, assignments ...) will be announced well in advance during the semester.

The dates of the final exam is scheduled in the assessment calendar of the Faculty. To this end, it must be taken into account that:

- *"The dates of evaluation activities cannot be modified, unless there is an exceptional and duly justified reason why an evaluation activity cannot be carried out. In this case, the degree coordinator will contact both the teaching staff and the affected student, and a new date will be scheduled within the same academic period to make up for the missed evaluation activity."* ***Section 1 of Article 115. Calendar of evaluation activities (Academic Regulations UAB)***.
- Students who. in accordance with the previous paragraph. need to change an evaluation activity date must process the request by filling out an Application for exams' reschedule available at https://eformularis.uab.cat/group/deganat_feie/application-for-exams-reschedule

Grade revision process

After all grading activities have ended students will be informed of the date and way in which the course grades will be published. Students will be also be informed of the procedure,place, date and time of grade revision following University regulations.

Retake Process

"To be eligible to participate in the retake process, it is required for students to have been previously been evaluated for at least two thirds of the total evaluation activities of the subject." Section 3 of Article 112 ter. The recovery (UAB Academic Regulations). Additionally, it is required that the student achieves an average grade of the subject between 3.5 and 4.9.

The date of the retake exam is posted in the calendar of evaluation activities of the Faculty. Students taking this exam and passing will get a grade of 5 for the subject. The students having not passed the retake exam will be graded using his/her final exam grade, and hence, will fail the course.

Irregularities in evaluation activities

Despite other disciplinary measures deemed appropriate, and in accordance with current academic regulations, *"whenever a student makes any irregularity that could lead to a significant variation in the grade of an evaluation activity, it will be graded with a 0, regardless of the disciplinary process that can be instructed. In case of occurrence of various irregularities in the evaluation of the same subject, the final grade of this subject will be 0"*. ***Section 10 of Article 116. Results of the evaluation. (UAB Academic Regulations).***

Bibliography

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Taylor, Bernard, III. *Introduction to Management Science, EBook, Global Edition*, Pearson Education, Limited, 2019. *ProQuest Ebook Central*, https://ebookcentral.proquest.com/lib/uab/detail.action?docID=5601327.

Vanderbei, Robert J. (2020). *Linear Programming.* Springer. https://link-springer-com.are.uab.cat/book/10.1007%2F978-3-030-39415-8.

Winston, Wayne W. (2003). *Operations Research. Applications and Algorithms* (4th. ed.). Duxbury Press.

Software

The course will use computer tools with implemented optimization algorithms, both generic, such as Microsoft © Excel Solver, and also more specific, such as LINGO.

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
(PAUL) Classroom practices	201	Catalan	second semester	morning-mixed
(PLAB) Practical laboratories	201	Catalan	second semester	morning-mixed
(PLAB) Practical laboratories	202	Catalan	second semester	morning-mixed
(PLAB) Practical laboratories	203	Catalan	second semester	morning-mixed
(TE) Theory	20	Catalan	second semester	morning-mixed