

Course Unit	Operational Research	Field of study	Mathematics
Bachelor in	Civil Engineering	School	School of Technology and Management
Academic Year	2022/2023	Year of study	2
Type	Semestral	Semester	2
Level	1-2	ECTS credits	6.0
Code	9089-322-2204-00-22		
Workload (hours)	162	Contact hours	T 30 TP - PL 30 TC - S - E - OT - O -

T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s) Carla Alexandra Soares Gerales, Maria Clara Rodrigues Bento Vaz Fernandes

### Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. Formulate and solve problems that can be described as problems of Linear Programming (LP);
2. Understand and apply the simplex algorithm and its specific cases to LP problems; understand and applying the duality characteristic to a primal of the simplex;
3. Interpret, economically, the primal / dual relationship;
4. Analyse the impact, on the optimal solution, of discrete changes in the parameters of the model; carry out a sensibility analysis to the model parameters;
5. Acknowledge and apply the Dantzig algorithm to Transport problems and their particular cases;
6. Acknowledge and apply the Hungarian and the Bottleneck Assignment Problem algorithms to assignment problems;
7. Decompose a project in activities and implement the distinct techniques of planning and time control, cost and other resources associated with the project. ;

### Prerequisites

Before the course unit the learner is expected to be able to:

The student should have some basic statistic, geometric and algebraic knowledge.

### Course contents

Introduction to Operations Research (OR). Introduction to Linear Programming (LP). Solving linear programming problems. Duality theory. Post-optimality and Sensitivity Analysis. The Transportation and Assignment problems. Network analysis.

### Course contents (extended version)

1. Introduction to Operations Research (OR). The origins of Operational Research. Methodology.
  - Application domains.
2. Linear Programming (LP). Formulation of a mathematical model and its graphical representation.
3. Resolution of PL problems. The graphical solution. The Simplex method. The Primal Simplex algorithm
  - Geometric interpretation of the Simplex; The artificial - variable technique (the two-phase method).
  - Economic interpretation of Simplex. The degenerate problems.
4. Duality theory. The Primal/Dual relationships. Economic interpretation. The Dual Simplex method.
5. Post-optimization and Sensibility Analysis.
  - Alteration of the objective function coefficients (ci) and right-hand side terms (bj).
  - Introduction of new variables and new restrictions. The allowable range to stay optimal (ci and bj).
6. The Transportation problem. Formulation of transportation problems.
  - The NW Corner and the Minimum Cost methods for obtain the initial BF solution.
  - The Dantzig algorithm. Particular cases.
7. The Assignment problem. Formulation of an Assignment problem.
  - The Hungarian Method and the "Bottleneck". Particular cases.
8. Network analysis. Representation of a project through a network of activities.
  - The CPM technique and its extensions.

### Recommended reading

1. Hillier, F. S. , Lieberman, G. J. , Introduction to Operations Research, McGraw-Hill, 2021
2. Mourão, M. , Pinto, L. , Simões, O. , Valente, J. , Pato, M. , Investigação Operacional - Exercícios e Aplicações, Escolar Editora, 2019
3. Investigação Operacional, Valadares Tavares, L. , Hall Themido, I, Carvalho Oliveira, R. , Nunes, McGraw-Hill, 1996

### Teaching and learning methods

The contents of this course will be present and discuss during presential sessions (PS) and not presential sessions (NPS). During PS problems will be solve adopting a question clarification methodology. NPS will, particularly, focus on application problems taking into account the specificity of students needs; These sessions will also have space for individual and group work.

### Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary)
  - Final Written Exam - 40%
  - Intermediate Written Test - 40%
  - Presentations - 10% (Participation.)
  - Portfolio - 10% (Files saved in virtual.ipb.)
2. Alternative 2 - (Regular, Student Worker) (Final, Supplementary, Special)
  - Final Written Exam - 100%
3. Alternative 3 (English classes) - (Regular, Student Worker) (Final, Supplementary)
  - Intermediate Written Test - 50% (The midterm exam will be held during the classes.)
  - Intermediate Written Test - 50% (The Final exam will be held at the final exam's day.)
4. Alternative 4 (English classes) - (Regular, Student Worker) (Final, Supplementary, Special)
  - Final Written Exam - 100%

### Language of instruction

Portuguese

## Electronic validation

Carla Alexandra Soares Geraides, Maria Clara Rodrigues Bento Vaz Fernandes	António Jorge da Silva Trindade Duarte	António Miguel Verdelho Paula	José Carlos Rufino Amaro
08-03-2023	17-03-2023	18-03-2023	25-03-2023