INSTITUTO POLITÉCNICO DE BRAGANÇA

Course Unit	Operational Research			Field of study	Mathematics		
Bachelor in	Management Informatics			School	School of Technology and Management		
Academic Year	2022/2023	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9186-709-2204-00-22		

Workload (hours)	162	Contact hours	T	TP	PL	TC	S	E	OT	O
			30	-	30	-	-	-	-	-

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 Geraldes, 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; Analyse the impact on the optimal solution, of discrete changes in the parameters of the model; make a sensibility analysis;
4. Formulate and solve problems of Programming Integer and Binary Programming; Solve BIP problems (the Branch-and-bound technique).
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. Acknowledge and apply some Networks Optimization models.

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 Operational Research: The origins of Operational Research; Methodology and application domains. Linear Programming: Graphical solution method; Simplex method; Integer Programming: Mathematical formulation; Some formulation examples of binary integer problems (BIP); Solving BIP problems (the Branch-and-bound technique). The transportation and Assignment problems. Decision Analysis: Decisions in environments with uncertainty and risk; Decision criteria; Decision Trees.

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 bi).
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 maximum flow problem.
   - The shortest-path problem.
   - The minimum cost flow problem.
   - Maximum Flow Algorithms and Dijktra Algorithm.
9. Decision Analysis: Decisions in environments with uncertainty and risk.
   - Decision criteria.
   - Decision Trees.

Recommended reading

1. Introduction to Operations Research Hillier, F. S. and Lieberman, G. J. MacGraw-Hill, 2015
2. Investigação Operacioal, Mourão, M. , Pinto, L. , Simões, O. , Valente, J. , Pato, M. , Escolar Editora 2019
3. Investigação Operacional, Valadares Tavares, L. , Hall Themido, I, Carvalho Oliveira, R. , Nunes Correia, F. , MacGraw-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.)

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Assessment methods

4. Alternative 4 (English classes) - (Regular, Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%

Language of instruction

1. Portuguese
2. English

Electronic validation

Carla Alexandra Soares Geraldes, Maria Clara Rodrigues Bento Vaz Fernandes	António Jorge da Silva Trindade Duarte	José Carlos Rufino Amaro	Nuno Adriano Baptista Ribeiro
08-03-2023	17-03-2023	17-03-2023	27-03-2023

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