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Course Unit	Operational Research		Field of study	Mathematics
Bachelor in	Civil Engineering		School	School of Technology and Management
Academic Year	2023/2024	Year of study	2	Level	1-2	ECTS credits	6.0
Type	Semestral	Semester	2	Code	9089-322-2204-00-23

| 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 Geraldes, José Mário Escudeiro de Aguiar |

Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Formulate linear programming problems
2. Know and apply the simplex algorithm
3. Know and apply the duality theory
4. Perform postoptimality and sensitivity analysis
5. Know and apply the Dantzig algorithm to transport problems
6. Know and apply the Hungarian and the bottleneck assignment problem algorithms to assignment problems
7. Apply CPM and PERT methods to project planning

Prerequisites

Before the course unit the learner is expected to be able to:
1. Perform elementary operations of matrix algebra
2. Solve systems of linear equations

Course contents

Introduction to Operational Research. Linear programming models. Duality theory. Postoptimality and sensitivity analysis. The transportation and assignment problems. Project management.

Course contents (extended version)

1. Introduction to Operational Research
    - The origins of Operational Research
    - Methodology and application domains
2. Linear programming models
    - Mathematical formulation of linear programming models
    - Graphical solution method
    - Simplex method
    - Economic interpretation of simplex
3. Duality theory
    - The essence of duality theory
    - Primal-dual relationships
    - Economic interpretation of duality
    - The dual simplex method
4. Postoptimality and sensitivity analysis
    - Changes in the objective function coefficients (cj)
    - Changes in the right-hand side (bi)
    - Introduction of new variables
    - Introduction of new constraints
    - Allowable range for the objective function coefficients
    - Allowable range for the right-hand sides
5. The transportation and assignment problems
    - The transportation problem
    - The Dantzig algorithm
    - The assignment problem
    - The Hungarian method
    - Bottleneck assigment problem
6. Project management
    - Critical Path Method (CPM)
    - Critical path determination
    - Programme Evaluation and Review Technique (PERT)

Recommended reading

1. Geraldes, C. A. S. (2023). Operations Research - Lectures Notes, ESTiG-IPB.
2. Hillier, F. S. , Lieberman, G. J. (2021). Introduction to Operations Research (11th Edition). McGraw-Hill.
3. Valente, J. , Pinto, L. S. , Pato, M. V. , Mourão, M. C. , Simões, O. A. (2019). Investigação Operacional, Exercícios e aplicações (2ª Edição). Escolar Editora.
4. Pina Marques, M. (2010). Textos de Apoio de Investigação Operacional.
5. Guerreiro, J. , Magalhães, A. , Ramalhete, M. (1995). Programação Linear, Vol. I e II (4ª edição). McGraw-Hill.

Teaching and learning methods

Contents will be covered with student attendance, in theoretical-practical classes, as well as the analysis and solution of exercises. Non-contact hours should be spent reviewing the lectured contents and solving practical exercises from the worksheets. Tutorial sessions might be held in non-contact hours, if necessary, individually or in groups.

Assessment methods

1. Alternative 1 (Portuguese classes) - (Regular, Student Worker) (Final, Supplementary, Special)
    - Final Written Exam - 100%
2. Alternative 2 (Portuguese classes) - (Regular, Student Worker) (Final, Supplementary)

Assessment methods

    - 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.)
3. OR-1 (Mobility students attending english classes) - (Regular, Student Worker) (Final)
    - Practical Work - 40% (Held in classes for students who are attending in the current academic year)
    - Presentations - 10% (Presentation and discussion of the practical assignments.)
    - Intermediate Written Test - 50% (Held on the regular exam day.)
4. OR-2 (Mobility students attending english classes) - (Regular) (Supplementary, Special)
    - Final Written Exam - 100%
5. OR-3 (Mobility students attending english classes) - (Student Worker) (Final, Supplementary, Special)
    - Final Written Exam - 100%

Language of instruction

1. Portuguese
2. English

Electronic validation

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04-03-2024	07-03-2024	09-03-2024