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|------------------|---------------------------------------|---------------|----------------|-------------------------------------|------|
| Course Unit      | Operational Research II               |               | Field of study | Quantitative Methods                |      |
| Bachelor in      | Industrial Management and Engineering |               | School         | School of Technology and Management |      |
| Academic Year    | 2022/2023                             | Year of study | 3              | Level                               | 1-3  |
| Type             | Semestral                             | Semester      | 1              | ECTS credits                        | 6.0  |
|                  |                                       | Code          |                | 9104-754-3103-00-22                 |      |
| Workload (hours) | 162                                   | Contact hours | T -            | TP 60                               | PL - |
|                  |                                       |               | 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) António Jorge da Silva Trindade Duarte

#### Learning outcomes and competences

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

1. Identify and select the appropriate operational research techniques to solve existing problems in organizations
2. Critically analyze complex problems
3. Develop simulations models, using a software package, to solve Industrial Management problems
4. Interpret simulation results and draw conclusions from the simulation projects

#### Prerequisites

Before the course unit the learner is expected to be able to:  
The student should know the basic concepts of Operational Research.

#### Course contents

Formulation and solving techniques for Integer Programming problems. Markov processes. Queuing systems. Simulation.

#### Course contents (extended version)

1. Integer Linear Programming
  - The use of binary variables in Integer Programming.
  - Some formulation examples in Integer Programming.
  - General procedures used to solve Integer Programming problems.
  - The Branch-and-Bound algorithm.
  - The Cutting Planes algorithm.
2. Markov Processes
  - Definition and basic concepts
  - Transition matrix of a Markov chain
  - Analysis of both ergodic and absorbing chains
  - Generalizations
3. Queuing systems
  - Characterisation of queuing processes
  - The M/M/1 queuing system
  - Queuing systems with more than one server
  - Finite source models and systems with limited capacity
  - Priority queuing models
4. Simulation
  - Simulation in OR
  - Modelling of systems (manufacturing or services) using simulation
  - Fundamental concepts (entities, queues, etc.)
  - Development of models
  - SIMIO simulation software
  - Validity and credibility of the simulation model
  - Applications and analysis of simulation outputs

#### Recommended reading

1. Notas de apoio (fornecidas pelo docente)
2. Hillier, F. S. , Lieberman, G. J. , Introduction to Operations Research, 11th ed. McGraw-Hill, 2021 (ISBN: 9781259872990)
3. Mourão, M.C , Pato, M.V., Pinto, L.S, Simões, O.A., Valente, J., Investigação Operacional - Exercícios e Aplicações, 2.ª ed., Escolar Editora, 2019 (ISBN: 9789725925560)

#### Teaching and learning methods

The theoretical contents should be presented in theoretical-practical lectures, accompanied by the exercises solving. In non-presencial hours the topics should be consolidated through the exercises solving supported by computer tools. Some individual or group tutorial lectures could be scheduled if it would be necessary.

#### Assessment methods

1. Distributed evaluation - (Regular, Student Worker) (Final)
  - Final Written Exam - 40% (Only for students attending the classes.)
  - Practical Work - 50% (Only for students attending the classes. To be partially held during classes.)
  - Portfolio - 10%
2. Final evaluation - (Regular, Student Worker) (Supplementary, Special)
  - Final Written Exam - 100%

#### Language of instruction

Portuguese

## Electronic validation

|  |   |                            |
|--|---|----------------------------|
| António Jorge da Silva Trindade Duarte | Maria Clara Rodrigues Bento Vaz Fernandes | Paulo Alexandre Vara Alves |
| 11-10-2022                             | 15-10-2022                                | 24-10-2022                 |