Universidad Zaragoza

Academic Year/course: 2022/23

30125 - Extension of Operational Research

Syllabus Information

Academic Year: 2022/23
Subject: 30125 - Extension of Operational Research
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
Degree: 425 - Bachelor's Degree in Industrial Organisational Engineering
ECTS: 6.0
Year: 3
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The subject and its expected results meet the following approaches and objectives:

the decisions in Industrial Organization Engineer are involved with many different areas within a production process. The concept of optimization is essential for such decisions. In this context, operational research is an essential tool because it provides quantitative methods that support any technical decision within the production process.

It is intended that the student is able to identify, analyze, formulate and solve actual decision problems related to the organization and management of production systems. It will be essential that students acquire the ability to determine the best strategy for action in order to improve the functioning of a system and be able to make decisions from a problem solving or a simulating complex system.

For this purpose, the course has an applied purpose, where is essential the resolution of practical cases.

These approaches and objectives are in line with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/), in such a way that the acquisition of the course learning outcomes provides training and competence to contribute to their achievement to some degree:

- ODS 8. Decent work and economic growth.
- ODS 12. Responsible consumption and production.

1.2. Context and importance of this course in the degree

The course is mandatory for the Management Engineering profile. It is part of the first half of the 3rd year of the curriculum for the Degree in Management Engineering, which means that the student has acquired training in learning outcomes in the subjects of Mathematics I, Mathematics II, Statistics and Operational Research. Expansion of Operational Research course provides skills that will be useful tools in key areas such as production or logistics.

Almost all professional profiles of a management engineer involving decision-making processes, and require a certain skill in understanding basic mathematical models.

Therefore, basic training in the "science of decisions" is necessary. Operational Research has had an impressive impact on improving the efficiency of numerous and diverse organizations around the world. One could cite their contributions to production problems, the efficient use of materials and reliability of them, basic research and new product development. As in other sciences, Operational Research becomes a vital tool for engineers because it allows them to understand phenomena subject to variations and predict or control them effectively. In addition, simulation of complex systems can address real problems with prior information to avoid unnecessary costs and damage to the productive system.

1.3. Recommendations to take this course

It is valuable that the student possesses basic knowledge of algebra, calculus and has passed the courses of Statistics and Operational Research. It is also highly valuable to be familiar with the use of statistical software.

2. Learning goals

2.1. Competences

Being passed the course, students will be more competent to ...

- Ability to solve problems and make decisions with initiative, creativity and critical thinking.
- Ability to communicate and transmit knowledge, skills and abilities in Spanish language.
- Ability to work in a multidisciplinary group and in a multilingual environment.
- Ability to learn continuously and develop independent learning strategies.
- Basic knowledge of the use and programming of computers, operating systems, databases and software with applications in engineering.
- Ability to solve mathematical problems that may arise in engineering. Ability to apply knowledge about: statistics and optimization.
- Knowledge and skills to apply quantitative methods of decision in organizations.

2.2. Learning goals

The student, for passing this subject, should demonstrate the following results ...

- Differentiate between stochastic and deterministic models.
- Identify and develop more complex models that involved integer variables and/or nonlinear functions.
- Identify and develop operational research models in real systems whose behavior depends on chance, in order to predict the performance of them and also to help in the decision making process, either at the stage of design or in the comparison of alternative policies.
- Handle the basic mathematical principles necessary for the resolution of these models.
- Use computer software to solve the proposed models.
- Apply simulation models in the analysis of complex systems

2.3. Importance of learning goals

Operational research is a mathematical tool to address decision making in the company, it is based on the scientific method and uses quantitative analysis. Operational research applied to problems relating to the optimization of activities within an organization. It has been applied extensively in such diverse areas as transportation, production or public services, to name a few.
The formulation of the problem, the construction of a mathematical model that summarizes the essence of the real problem, and the validity of this model are fundamental in optimizing resources. Justify the chosen model and solving technique used as an optimization problem, it is what validates the result itself and allows for improvement in the system.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate that he/she has achieved the intended learning outcomes through the following evaluation activities:

- Exams: During the course two written tests will be conducted. Will focus on theoretical and / or practical aspects of the subject. Its weight in the rating is 60%. Learning outcomes with those related are 1, 2, 3, 4 and 6.
- Participatory controls: Throughout the course two controls participatory be made. Its weight in the rating is 10%. Learning results which are related are the 1, 2, 3, 4, and 6.

In written tests and participatory controls be evaluated:

- understanding of mathematical concepts used to solve problems
- using strategies and efficient procedures in its resolution
- clear and detailed explanations
- the absence of errors in the mathematical development and solutions
- correct use of terminology and notation
- the correct domain and use of mathematical software commands needed to solve problems
- the detail of the code used in solving problems
- Applied work: individual type work on simulation and analysis of queuing theory is performed. Its weight in the rating is 30%. Learning results which are related are the 1, 2, 3, 4, 5 and 6.

In the works will be assessed:

- the correct domain and use of mathematical software commands needed to solve problems
- the correct resolution of the problem and mathematical methods and strategies employed
- the detail of the code used in solving problems

- the correct interpretation of the results
- the ability to select the most appropriate method
- explanations and / or clear and detailed questions arguments made
- the outcome and quality of work
- quality and coordination in the exhibition of the same
- the mathematical language used
- the quality of bibliographical sources
- ability to work in collaboration with other students
- the attitude shown during development work, as well as the degree of participation in it

Overall assessment: Students who have not passed the subject with the system of continuous rating, have to pass an exam equivalent to previous ones, whose weight in the final exam is 70 %. They also must submit work individually been awarded to him throughout the course, being its weight 30% of the final grade. The evaluation criteria will be those set out in the preceding paragraphs.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The proposed methodology seeks to promote the continued work of the student and focuses on the practical aspects of operational research: the approach and solving practical problems.
In order to achieve this goal, all classes are held in the computer room. The theoretical explanations of the concepts of the subject will be reinforced by examples or case studies analyzed by the computer.

The approach, methodology and assessment of this guide are intended to be the same for any teaching scenarios. They will be adapted to the social-health situation at any particular time, as well as to the instructions given by the authorities concerned.

4.2. Learning tasks

The program is offered to students to help them achieve the expected results includes the following activities

The course is organized with 4 hours of class a week for the 15 weeks of the semester. All times are taught in the computer room, where theoretical concepts are reinforced with practical work using mathematical software.

Personal work: 60 hours

4.3. Syllabus

The course will address the following topics:

- Integer Programming: binary, integer, and mixed-integer programming. Branch and bound techniques. Auxiliary variables: Selection of restrictions. Functions with m possible values. Selecting continuous variables. Problems with fixed cost.
- Nonlinear programming: Local and global optimum. Karush-Kuhn-Tucker conditions (CKKT). Conditions of qualification. convex set, convex function, convex programming. Numerical Methods: SQP algorithm.
- Dynamic programming: The problem of a stagecoach. Bellman principle of optimality. Optimization using phases or sequences. Allocation problems. The knapsack problem. Resource allocation. Continuous dynamic programming.
- Inventory theory: Continuous demand-uniform Review. Periodic Review: production planning by dynamic programming. Stochastic demand: Model of a period with no/yes fixed cost. s-S policy. The model with several costs periods without preparation. Continuous review model with fixed delivery times.
- Queueing Theory: Pattern arrivals. Pattern Servers. Queue discipline. System capacity. Number of service channels. Number of stages of service. Poisson arrival process. Processes of birth and death in the steady-state. Queuing models: M / M / 1 system, queues servers in parallel M / M / C, queues with parallel servers and capacity limit M / M / c / K, the Erlang formula (M / M / C / C), unlimited queue server, queues with limit at the source, with time-dependent. Approach to Problems G / G / c: M / G / 1.
- Simulation with Arena: Entities, resources, queues, basic and advanced processes.

4.4. Course planning and calendar

The contents will be developed for 15 weeks with the following weights:

- Optimization problems 2-3 credit
- Inventory theory 2-3 credit
- Queueing Theory and Simulation models 1-2 credits

The course takes 15 weeks and takes place in the computer room, theoretical concepts will be reinforced with practical

sessions solving exercises and practical cases using specific software. Two main tests throughout the course will be made. In addition, the continued work in the classroom will also be assessed by performing 2 participatory controls, involving the resolution of practical exercises.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=30125