## 1. Key Information

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|---|---|---|
| **Module Code:** 13627 | **Module Title:** Operations Research | |
| **Credit Points:** 6 | **Module Status:** Compulsory | **Module Block:** Business Technologies |
| **Course Title:** BSc in Engineering and Management | | **Module Theme:** Support Technologies |

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|---|---|---|---|
| **2. Lecturer:** | Francisco Fraile Gil | **Tutorial Hours:** | Fridays 16.00h – 19.30h |

## 3. Required Reading:

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|---|---|
| *Operations Research Problems Statements and Solutions* | *Raul Poler, Josefa Mula & Manuel Díaz-Madroñero* |
| *Introduction to operations Research* | *Frederick S Hillier* |
| *Handbook of Operations Research: Models and Applications v. 2* | *Joseph J. Moder, Salah E. Elmaghraby* |
| *Operations research: applications and algorithms* | *Wayne L. Winston* |
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## 4. General overview of the module

At this course, students will learn the fundamental methods used in Operations Research; subjects to cover include linear, integer and non-linear programming, decision theory, games theory, graph theory, and simulation. While subjacent theory is discussed, focus is mainly placed in modelling and applications of these ideas in diverse environments. Students will learn to model real world problems and they will develop the ability to build, analyse and reason logically with them. Emphasis is placed in modelling complex real world problems and analyse the results, rather than in solving the problems by hand. Thus, students will learn to choose the best mathematical techniques to solve a specific problem and be familiarized with software tools to solve them. The goal is that students can control commercial programs to model and solve complex problems. Primarily, the practical work will be developed with Python and Jupyter Notebooks (eg linear, integer and non-linear programming, graph theory). Additionally, the students will be introduced to other modelling and simulation programs such as MLB (mathematical modelling) or Anylogic (simulation).

## 5. Recommended prior knowledge

| *Code* | *Module* |
|---|---|
| *13602* | *Algebra* |

## 6. Module objectives – Learning outcomes

| **Basic and General Competences** |
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| 03 – Define, solve and expose systematically complex technical problems |
| 06 – Capacity to take decisions in certainty and uncertainty business environments |
| CB2 – Students can apply their knowledge to their job or vocation in a professional manner and posses competencies that are shown by elaboration and defense of arguments and problem resolution within their area of study |
| CB4 – Students can disseminate information, ideas, problems and solutions both to specialized and non-specialized audiences |
| **Specific Competences** |
| 12 – Manage business information using technology and appropriate systems |

## 7. Teaching and learning units

| Unit | Schedule |
|---|---|
| 1. INTRODUCTION TO OPERATIONS RESEARCH AND MATHEMATICAL MODELING | *Session 1* |
| 2. MATHEMATICAL PROGRAMMING: CONTINOUS LINEAR PROGRAMMING | Sessions 2, 3, 4, 5, 6, 7, 8, 9, 10 |
| 3. MATHEMATICAL PROGRAMMING: INTEGER PROGRAMMING, COMBINATORIAL OPTIMIZATION AND GRAPH THEORY | Sessions 11, 12, 13, 14, 15, 16, 17 |
| 4. MATHEMATICAL PROGRAMMING: NON-LINEAR PROGRAMMING | Sessions 18, 19, 20, 21, 22 |
| 5. DECISION THEORY AND GAME THEORY | Sessions 23, 24, 25, 26 |
| 6. SIMULATION | Sessions 27, 28, 29, 30 |

## 8. Teaching and learning methods

| Unit | Theory (Classroom) | Practical (Classroom) | Practical (Laboratory) | Practical (Classroom) | Practical (ICT) | Self-guided study | TOTAL HOURS |
|---|---|---|---|---|---|---|---|
| **01** | 1 | 1 | -- | -- | -- | 6 | 5 |
| **02** | 8 | 8 | 2 | -- | 2 | 24 | 48 |
| **03** | 6 | 4 | -- | -- | 4 | 21 | 35 |
| **04** | 2 | 4 | 2 | -- | -- | 15 | 23 |
| **05** | 4 | 4 | -- | -- | -- | 22 | 30 |
| **06** | 3 | 3 | 2 | -- | -- | 16 | 24 |
| **TOTAL HOURS** | **24** | **24** | **6** | **--** | **6** | **105** | **165** |

## 9. Assessment

| Overview | Nº of activities | Weighting (%) |
|---|---|---|
| Academic work (continuous assessment) | **5** | **20%** |
| Objective multiple choice exam (continuous assessment) | **5** | **20%** |
| Written open answer exam (summative assessment) | 3 | 60% |

*Student evaluation will consist of both continuous and summative assessments:*

1. *Academic work: The submission of practical work either carried out individually or in groups and participation in the different activities both inside the classroom, such as the analysis, summation and discussion of required readings, and outside including company visits, will account for this mark. This part of the assessment carries a weighting of 30% towards the final mark and is part of the continuous assessment.*
2. *Objective (multiple choice) exam: These tests can combine both theoretical and practical content. This part of the assessment carries a weighting of 10% towards the final mark and is part of the continuous assessment.*
3. *Written open answer exam: These tests can also combine both theoretical and practical content and carries a weighting of 60% towards the final mark.*

*Continuous assessment is attendance based and non-recoverable. Therefore, the mark obtained for this part of the assessment will serve for both the first summative assessment and any subsequent repeat if required. The repeat will only be available at the end of the semester.*

*In order to pass the module an average of more than 5 in summative assessment must be obtained. There are two partial tests, one covering teaching units 1 and 2, and one covering teaching units 3, 4. Provided that the grade of any partial tests is higher than 5, students will qualify for a reduced final exam not covering the teaching units already evaluated in the partial exam(s) that have been passed. The summative assessment will be calculated by the average of the three tests. Students that do not qualify for the reduced exam will have to complete a full final exam covering all teaching units. The final mark achieved must be 5 or above to pass the module.*

*Attendance is compulsory to ensure that you extract the most value from the module and meet the learning requirements. Therefore, session absence accounting for more than 15% of the prescribed hours will result in the inability to be awarded a mark for continuous assessment. Consequently, the maximum mark that can be achieved will be that obtained solely from the summative assessments. Completion of at least 4 practical works is also mandatory to qualify for continuous assessment.*

*Students enrolling in the module for the second time will receive specific instructions from their lecturer on what is required for them to pass the continuous assessment element. The final mark will be obtained by combining the summative assessment (80%) and the continuous assessment (20%), having to gain a final mark equal to or greater than 5 to pass the module.*