240ST012 - Modelling of Transport Systems and Logistics

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research
Academic year: 2019
Degree: MASTER'S DEGREE IN SUPPLY CHAIN, TRANSPORT AND MOBILITY MANAGEMENT (Syllabus 2014).
(Teaching unit Compulsory)
MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: English

Teaching staff
Coordinator:
- ESTEVE CODINA SANCHO
Others:
Primer quadrimestre:
JAIME BARCELÓ BUGEDA - 10
ESTEVE CODINA SANCHO - 10

Opening hours
Timetable: To be defined at the beginning of the course

Prior skills
Prior knowledge of algebra and basic knowledge of Operational Research.
Using programming languages ??oriented computing Technical / scientific (MATLAB and / or Python) or equivalent.

Degree competences to which the subject contributes
Specific:
CETM2. Understanding and quantifying capacity fundamentals transport systems and mobility determine the safety, quality and sustainability of transport infrastructure and optimizing the operation of these systems.
CESC4. Know and apply the techniques of modeling, simulation and optimization to solve the problems involved the design and management of supply chains.
CETM3. Knowledge for planning, management and operation of transportation systems and mobility, ability to analyze service levels to users, operating costs and environmental and social such as mass transit, and private vehicle traffic impacts, air transport, sea transport, intermodal transport and urban mobility.

Teaching methodology
The teaching method will combine classic exposition sessions of contents (theory) and laboratory sessions / problems to reinforce / complement the theory sessions. The teaching method requires specific training materials by monitoring the subject and conducting lab sessions. The theoretical sessions will be alternating slides and developments in the blackboard. Throughout the course one or more case studies will be presented and developed to illustrate the application in practice of the concepts in the course. Throughout the course three practical exercises or exams will be given to ensure proper monitoring and control of students. A specific plan for students with poor or inconstant performance will be developed.
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Learning objectives of the subject

General Objectives: The objectives of the course are addressed to the acquisition by students of the foundations for the analysis of transport systems and logistics in terms of mathematical models of flows in networks from the Operational Research point of view. This is a course that aims to equip students with algorithmic and modeling tools that address the analysis of different systems that occupy a central position in the Studies, such as Supply Chains and Planning and Operations in Transportation Systems. The issues addressed in the course (vehicle routing problems and network flow on shortest paths, traffic shaping, etc...) play a central role for understanding the different variables that describe Logistic and Transportation Systems.

Specific Objectives

Apply the methodology of building models of Transport Systems and Logistics; application of the scientific method under a systemic and Operational Research’s approach.

Knowing how to use algebraic languages ??seen in the course to formulate and solve the various issues covered in the syllabus of the course.

Learn to model transport problems as min-cost problem (minimum cost, maximum flow ...) and as capacitated or uncapacitated network flow problem.

Apply the algorithms to the problems and know how to to solve them, using the tools explained during the course.

Know the formulation of various routing problems: Travelling Salesman, Pick up and Delivery. Apply the heuristics developed in the course to solve them.

Understand the role of dual variables and know how to perform and interpret the sensitivity analysis of the model results. Formulate and solve problems of event sequencing.

Know how to apply the concept of equilibrium expressed by the principle of Wardrop. Learn to apply the Frank and Wolfe algorithm and the heuristics described in the course to solve the problem of traffic assignment user equilibrium.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours medium group:</th>
<th>30h</th>
<th>24.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>12.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>80h</td>
<td>64.00%</td>
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### Content

#### The concept of model: introduction to modelling techniques

<table>
<thead>
<tr>
<th>Description:</th>
<th>Learning time: 34h 20m</th>
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Practical classes: 2h  
Self study: 28h 20m |

#### Network flow models

<table>
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<tr>
<th>Description:</th>
<th>Learning time: 41h 40m</th>
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</table>
| Linear models of network flows: flows of minimum cost, maximum flow, roads and trees of minimum cost. Or potential dual variables. Optimality conditions. Multicommodity flow models. Capacitated flow problems. | Theory classes: 10h  
Practical classes: 5h  
Self study: 26h 40m |

#### Vehicle routing problems

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<tr>
<th>Description:</th>
<th>Learning time: 41h 40m</th>
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</table>
| Vehicle routing models: the traveling salesman problem, routing problems, pick up and delivery problems. Problems with time windows. | Theory classes: 10h  
Practical classes: 5h  
Self study: 26h 40m |

#### Introduction to equilibrium problems in transport

<table>
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<tr>
<th>Description:</th>
<th>Learning time: 25h</th>
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| Introduction to equilibrium models in transportation. Top of Wardrop network traffic, the traffic assignment problem. Heuristic solutions. Frank and Wolfe algorithm. | Theory classes: 6h  
Practical classes: 3h  
Self study: 16h |

### Qualification system

50% Mark Theory + 50% Practical Lab Exercises  
Theory Mark = max (Final Exam Mark, 0.5Ex1 + 0.5Ex2)
Regulations for carrying out activities

A sheet of paper with formulas + pocket calculator

Bibliography

Basic:


Complementary:


Others resources:

- Hyperlink
  - Plataforma ATENEA
  - teaching Platform

- Computer material
  - Sistema AMPL Estudiant
    - System for solving and coding optimization models used in exercises

- GUIDEN
  - Software GUIDEN for learning models/algorithms for network flow problems