Course guide
240ST012 - 240ST012 - Modelling of Transport Systems and Logistics

Last modified: 16/05/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research.

Degree: MASTER'S DEGREE IN SUPPLY CHAIN, TRANSPORT AND MOBILITY MANAGEMENT (Syllabus 2014). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer:
- ESTEVE CODINA SANCHO

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

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 examsn will be given to ensure proper monitoring and control of students. A specific plan for students with poor or inconstant performance will be developed.

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

Type	Hours	Percentage
Self study	80,0	64.00
Hours medium group	30,0	24.00
Hours small group	15,0	12.00

Total learning time: 125 h

CONTENTS

The concept of model: introduction to modelling tecniques

Description:
Modeling road networks as graphs street routing Vehicle versus routing problems. Introduction to algebraic modeling languages??. Formulation as optimization problems. Decision variables. Objective function. Constraints.

Full-or-part-time: 34h 20m
Theory classes: 4h
Practical classes: 2h
Self study : 28h 20m

Network flow models

Description:
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.

Full-or-part-time: 41h 40m
Theory classes: 10h
Practical classes: 5h
Self study : 26h 40m

Vehicle routing problems

Description:
Vehicle routing models: the traveling salesman problem,
routing problems, pick up and delivery problems. Problems with time windows.

Full-or-part-time: 41h 40m
Theory classes: 10h
Practical classes: 5h
Self study : 26h 40m

Introduction to equilibrium problems in transport

Description:
Introduction to equilibrium models in transportation. Top of Wardrop network traffic, the traffic assignment problem. Heuristic solutions. Frank and Wolfe algorithm.

Full-or-part-time: 25h
Theory classes: 6h
Practical classes: 3h
Self study : 16h

GRADING SYSTEM

50% Mark Theory +50% Practical Lab Exercises
Theory Mark= max (Final Exam Mark, 0.5Ex1 + 0.5Ex2)

EXAMINATION RULES.

A sheet of paper with formulas + pocket calculator

BIBLIOGRAPHY

Basic:
- Hillier, Frederick S ; Lieberman, H. Introduction to Operations Research. 9th ed. Boston: McGraw Hill, 2010. ISBN 9780071267670.
- Ahuja, R.K. ; Magnanti,T.L. K; Orlin, J. Network flows : theory, algorithms, and applications. Englewood Cliffs: Prentice Hall, 1993. ISBN 013617549X.
- Sheffi, Yosef. Urban transportation networks : equilibrium analysis with mathematical programming methods. Englewood Cliffs: Prentice-Hall, 1985. ISBN 0139397299.
- Ball, M.O. Handbooks in Operations Research and Management Science, 8: Network Routingg [on line]. New York: Elsevier, 1995 [Consultation: 20/04/2023]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/handbook/handbooks-in-operations-research-and-management-science/vol/7/suppl/C. ISBN 9780444821416.
- Toth P. ; Vigo, D. The vehicle routing problem. Caps 1, 5, 7, 9. Philadelphia: SIAM, 2002. ISBN 0898714982.

Complementary:
- Bell, M.G.H. ; Iida, Y. Transportation Network Analysis. Chichester: John Wiley & Sons, 1997. ISBN 047196493X.
- Daganzo, Carlos. Logistics Systems Analysis [on line]. 4th ed. Berlin: Springer, 2005 [Consultation: 28/04/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/3-540-27516-9. ISBN 3540239146.

RESOURCES

Computer material:
- GUIDEN. Software GUIDEN for learning models/algorithms for network flow problems
- Sistema AMPL Estudiant. System for solving and coding optimization models used in exercises

Hyperlink:
- Plataforma ATENEA. teaching Platform