POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Optimization in transport [S2Trans1E-TrZ>OwT]

Course

Field of study
Transport

Year/Semester
1/1

Area of study (specialization)
Sustainable Transport

Profile of study
general academic

Level of study
second-cycle

Course offered in
english

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr hab. inż. Piotr Sawicki prof. PP
piotr.sawicki@put.poznan.pl

Lecturers

Prerequisites

Knowledge: the student has a structured, theoretically founded knowledge of technology, transport systems and various means of transport. Skills: the student is able to properly use information and communication techniques, applicable at various stages of the implementation of transport projects. Social competencies: the student understands that in technology, knowledge and skills very quickly become obsolete.

Course objective

Learning the techniques of multiple criteria making managerial decisions in the field of transport and logistics in the selection and effective use of technical and human resources, as well as with regard to distributed resources management (supply chains).

Course-related learning outcomes

Knowledge:
Student has advanced and in-depth knowledge of transport engineering, theoretical foundations, tools and means used to solve simple engineering problems
Student has advanced detailed knowledge of selected issues in the field of transport engineering

Skills:
Student is able to use analytical, simulation and experimental methods to formulate and solve engineering tasks and simple research problems
Student is able - when formulating and solving engineering tasks - to integrate knowledge from various areas of transport (and, if necessary, also knowledge from other scientific disciplines) and apply a system approach, also taking into account non-technical aspects

Social competences:
Student rozumie znaczenie wykorzystywania najnowszej wiedzy z zakresu inżynierii transportu w rozwiązywaniu problemów badawczych i praktycznych

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
In the lecture part: the workshop based on a team solution to a given multiple criteria decision problem. Written test summarizing the lectures, in the form of a multiple-choice test. In the laboratory part: activity during classes and ongoing preparation for classes. Implementation of laboratory tasks individually and in groups. Periodic written checking of preparation for classes.

Programme content

Lecture and laboratory classes are closely related. On the basis of the content presented during the lectures, the tasks (in most cases problematic, based on case studies) are performed during the laboratory classes. All the topics are devided into 5 modules: {M0, M1, …, M4}.
M0: Introduction
1. General introduction (decision problem, classification of decision problems, optimum vs. Pareto-optimum, non-dominanted solutions, generation of efficient solutions, selection of the compromise solution/s); key concepts related to the building a mathematical model - single vs. multiple criteria. Overview of the main thematic areas and discussion of the detailed program, i.e. M0: introduction to multiple criteria optimisation, M1: resource selection and allocation, M2: operations planning, M3: supply chain design, M4: summary. Formulating an exemplary multiple criteria decision problem in which an intuitive solution is sought, and the effectiveness of the solution is checked in the form of a mathematical model.
2. Key steps in solving multiple criteria optimisation problem in transport, i.e. problem formulation, building a mathematical model, generation of solutions (e.g. Epsilon-constraints methods), searching results and selection the compromise solution (e.g. scalarisation, Light Beam Search method, etc.), interpretation of result and sesibility analysis.
M1: Resource selection and allocation
3. Portfolio desing problem. Principle of solving a portfolio problem using single and multiple criteria mathematical models: problem identification, construction of a mathematical model, solving the problem, sensitivity analysis, comparison of results. Case study.
4. The fleet size and fleet composition problem. Principle of solving a fleet size/composition problems using single and multiple criteria mathematical models: problem identification, construction of a mathematical model, solving the problem, sensitivity analysis, comparison of results. Case study.
5. The crew assignment/scheduling problems (a developed resource allocation problem). Principle of solving a crew assignment/scheduling problems using single and multiple criteria mathematical models: problem identification, construction of a mathematical model, solving the problem, sensitivity analysis, comparison of results. Case study.
M2: Operations
6. The knapsack problem. Principle of solving a knapsack problem using single and multiple criteria mathematical models: problem identification, construction of a mathematical model, solving the decision problem, sensitivity analysis, comparison of results (single vs. multiple criteria). Case study.
7. The MIX pallet problem. Principle of solving a MIX pallet problem using single and multiple criteria mathematical models: problem identification, construction of a mathematical model, solving the decision problem, sensitivity analysis, comparison of results (single vs. multiple criteria). Case study.
M3: Supply chain design
8. Introduction to supply chain design. Classification of supply chains design models nPo-pPr-sC (n-tiers, p-products, s-optimization criteria).
9. Supply chain design problem - transport planning issue using 1Po-1Pr-CT model. Principle of solving a

decision problem using single and multiple criteria mathematical models: problem identification, construction of a mathematical model, solving the decision problem, sensitivity analysis, comparison of results (single vs. multiple criteria). Case study.
10. Supply chain design problem - transport and storage (1-tier and multiple tier) issue; 1Po-1Pr-CS+CT and 2Po-1Pr-CT+CS models. Principle of solving a decision problem using single and multiple criteria mathematical models: problem identification, construction of a mathematical model, solving the decision problem, sensitivity analysis, comparison of results (single vs. multiple criteria). Case study.
11. Supply chain design problem - production, transport and storage issues; 2Po-1Pr-CP+CS+CT model. Principle of solving a decision problem using single and multiple criteria mathematical models: problem identification, construction of a mathematical model, solving the decision problem, sensitivity analysis, comparison of results (single vs. multiple criteria). Case study.
M4: Summary
12. Workshop on solving selected multiple criteria optimisation decision problems. Summary of modules M1-M3 in team working. Worshop schemme: problem identification, construction of a mathematical model, solving the problem, sensitivity analysis, recommendation of the final result.
13. Final test (exam).

Teaching methods

1. Problem lecture with a multimedia presentation.
2. Workshop methods.
3. Case study.
4. Laboratories - computational experiments.

Bibliography

Basic
1. Trzaskalik T., Michnik J. (Eds.), Multiple Objective and Goal Programming. Springer-Verlag Berlin Heildeberg, 2002.
2. Steuer R.E., Multiple Criteria Optimization: Theory, Computation, and Application. Wiley series in probability and mathematical statistics, Wiley, 1986.
3. Jaszkiewicz A., Słowiński R., The ‘Light Beam Search’ approach – an overview of methodology applications. European Journal of Operational Research, 1999, 113 (2), 300-314.
4. Mavrotas G., Effective implementation of the ε-constraint method in Multi-Objective Mathematical Programming problems. Applied Mathematics and Computation. 2009, 213 (2): 455–465.
5. Sawicki P.: Multiple criteria optimisation in transport. Politechnika Poznańska, Wydział Inżynierii Lądowej i Transportu, Poznań 2021. E-book available on the website: http://piotr.sawicki.pracownik.put.poznan.pl/dydaktyka
Additional
1. Harmon M.: Step-by-Step Optimization with Excel Solver, www.ExcelMasterSeries.com, 2011.
2. Sawicki P.: Wielokryterialna optymalizacja procesów w transporcie, Wydawnictwo Instytutu Technologii Eksploatacji, Radom, 2013 (in Polish).
3. Sawicki P.: Optymalizacja w transporcie. Politechnika Poznańska, Wydział Inżynierii Lądowej i Transportu, Poznań 2009. E-book available on the website: http://piotr.sawicki.pracownik.put.poznan.pl/dydaktyka/_-metody-optymalizacji-w/

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00