STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
Optimization methods in transportation and logistics	**1010611361010616002**

Field of study	Profile of study (general academic, practical)	Year /Semester
Transport	**general academic**	**3 / 6**
Elective path/specialty	**Subject offered in:**	**Course (compulsory, elective)**
Logistics of Transport	**Polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
First-cycle studies	**full-time**

No. of hours	No. of credits
Lecture: **2** Classes: **-** Laboratory: **2** Project/seminars: **-**	**3**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
other	**university-wide**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**3 100%**
Technical sciences	**3 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	A student has an ordered, theoretically founded general knowledge in the field of technology, transport systems and various means of transport [T1A_W03]
2	**Skills**	A student is able to properly use information and communication techniques, which exist at various stages of transport projects [T1A_U02]
3	**Social competencies**	A student understands that skills in technology quickly become out-dated [K1_K05]

Assumptions and objectives of the course:

The objective of the course is to learn the techniques of making managerial decisions in the field of transport and logistics, both in the selection and effective application of technical and personal resources, It is also related to the problems related to resource management in supply chains.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. A student has a fundamental knowledge about directions of development referred to technical achievements and other related scientific disciplines, in transport engineering particularly - [T1A_W05]
2. A student knows the basic techniques, methods and tools applied into the decision making process in the field of transport, mainly of an engineering nature - [T1A_W07]
3. A student has a basic knowledge of management and running a business; he/she knows the general principles of creating and developing individual entrepreneurship - [T1A_W10]

Skills:

1. A student is able to apply properly selected methods, including analytical, simulation or experimental methods, while formulating and solving decision problems in the field of transport - [T1A_U04]
2. A student can evaluate the computational complexity of algorithms applied to solve transport problems - [T1A_U08]
3. A student has the ability to formulate decision problems in the field of transport engineering and is able to use at least one of the popular tools to solve it - [T1A_U11]

Social competencies:

1. A student can think and act in an entrepreneurial way, including finding commercial applications for his/her results, keeping in mind not only economy but also social benefits of the business - [T1A_K03]
2. A student correctly identifies and resolves dilemmas related to the transport engineer profession - [T1A_K05]

Assessment methods of study outcomes

A lecture part: Workshop consisting in a team working on a selected decision problem. A result of a written multiple-choice test is achieved at the end of semester. A laboratory part: periodic checking of preparation for classes in the form of short tests is applied to; the final evaluation is an arithmetic average of partial grades.

Course description

1. Introduction ? module 0 (M0)

Content: Key concepts regarding the decision-making process and building a mathematical model; presentation of the main thematic areas and discussion on a detailed program, i.e. module 0 (M0): introduction, module 1 (M1): selection and use of resources, module 2 (M2): supply chain design. Formulating an example decision problem in which an intuitive solution is looking for, finally the effectiveness of its solution is proved with an application of mathematical model (formal record of the decision problem) and solutions using the optimization engine (Solver for MS Excel).

2. Portfolio selection problem ? an application of linear programming, module 1 (M1)

Principles of building a product portfolio using linear programming techniques: problem identification, building a mathematical model, solving the problem with the use of two alternative techniques (graphic method and simplex method), sensitivity analysis of the problem using generated reports: results report, sensitivity report and limits report (Solver option).

3. Fleet composition problem - application of integer programming (M1)

Types of vehicles in a fleet and number of vehicles in each type (fleet size) based on a defined set of transport tasks are considered. The model of the fleet composition problem is formulated in the form of an integer programming problem, solving using the branch & bound technique (available in the Solver for MS Excel). Analysis and interpretation of the solution is performed as well.

4. Knapsack problem - application of binary and integer programming (M1).

Formulation of the problem of loading / packing products into collective packaging, expressed in the form of a classic knapsack problem is discussed. Construction of a mathematical model with the use of binary and integer programming, depending on the complexity of the problem and the loading specific. A decision problem (case study) using Solver for MS Excel is obtained.

5. Crew scheduling - application of a binary programming (M1).

Problem formulation as a developed version of resource allocation is discussed. Analysis of the problem of employee allocation to the tasks within a defined time frame is analysed and compared. A decision problem (a case study) is analysed; as a consequence a mathematical model (applied binary programming) is formulated and solved with an application of Solver for MS Excel. A result is discussed from practical point of view.

6. Workshop on module 1 (M1): the selection and effective use of resources

A workshop is performed at the end of M1. It is composed of analysis of a selected decision problems (team working on solving various problems) and searching for alternative solutions. During a workshop mathematical models are constructed, an appropriated solving method is applied, and interpretation of a practical aspect of solution is performed.

7. Introduction to the supply chain design ? module 2 (M2)

Key requirements regarding the construction of optimal transport and storage solutions are analysed. Classification of models describing the functioning of supply chains nPo-pPr-Ki, referred to: nPo tier numbers (1- and multiple level models), number of products in supply chain pPr (1- and multiple product models) and Ki optimization criteria (models based on: transport costs - KT, storage costs - KM and production costs - KP).

8. Supply chain design ? model 1Po-1Pr-KT (M2)

Modelling, optimization and practical application of a supply chain type 1Po-1Pr-KT is discussed, i.e. 1-tier (n = 1), 1-product (p = 1), and based on the transport cost function (KT) model. Case study is analysed, solving a balanced and unbalanced problem. A Solver for MS Excel is applied to solve the problem.

9. Supply chain design ? model 1Po-1Pr-KT+KM (M2)

Modelling, optimization and practical application of a supply chain type 1Po-1Pr-KT+KM, i.e. 1-tier (n = 1), 1-product (p = 1), and based on the cost of transport and storage (KT+KM) model. A Solver for MS Excel is applied to solve a considered model. A Comparison of the result achieved by 1Po-1Pr-KT and 1Po-1Pr-KT+KM models are performed.

10. Supply chain design ? model 2Po-1Pr-KT+KM (M2)

Modelling, optimization and practical application of a supply chain type 2Po-1Pr-KT+KM, i.e 2-tier (n = 2), 1-product (p = 1), and based on the costs of transport and storage (KT + KM) is discussed. A Solver for MS Excel is applied to solve the problem.

11. Supply chain design ? model: 2Po-2Pr-KT+KM (M2)

Modelling, optimization and practical application of a supply chain type 2Po-2Pr-KT+KM, i.e. 2-tier (n = 2), 2-products flow applied (p = 2), and based on the costs of transport and storage (KT + KM). A Solver for MS Excel is applied to solve the problem.

12. Summary of module M1 and M2

A final test

Basic bibliography:

1. Sawicki P. Optymalizacja w transporcie. Politechnika Poznańska, Wydział Inżynierii Transportu, Poznań 2009. E-skrypt dostępny pod adresem: http://piotr.sawicki.pracownik.put.poznan.pl/dydaktyka/_-metody-optymalizacji-w/

Additional bibliography:

1. Harmon M., Step-by-Step Optimization with Excel Solver, www.ExcelMasterSeries.com, 2011
2. Ignasiak E., Badania operacyjne, PWE, Warszawa 2001
3. Kukuła K. (red.), Badania operacyjne w przykładach i zadaniach, Wydawnictwo Naukowe PWN, Warszawa 2011
4. Sawicki P. Wielokryterialna optymalizacja procesów w transporcie, Wydawnictwo Instytutu Technologii Eksploatacji, Radom 2013
5. Szapiro T. (red.), Decyzje menedżerskie z Excelem, PWE, Warszawa 2000
6. Christopher M., Logistyka i zarządzanie łańcuchem dostaw, Polskie Centrum Doradztwa Logistycznego, Warszawa 2000

Result of average student's workload

Activity	Time (working hours)
1. Preparation for classes	12
2. Participation in classes (according to plan)	56
3. Knowledge consolidation (results reporting)	4
4. Participation in the exam	4

Student's workload

Source of workload	hours	ECTS
Total workload	76	3
Contact hours	60	2
Practical activities	44	1