STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
Operations Research		**1010604241010620104**

Field of study	Profile of study (general academic, practical)	Year /Semester
Transport	**(brak)**	**2 / 4**
Elective path/specialty	**Subject offered in:**	**Course (compulsory, elective)**
-	**Polish**	**obligatory**

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

No. of hours				No. of credits
Lecture: **18**	Classes: **12**	Laboratory: **-**	Project/seminars: **-**	**3**

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

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

Responsible for subject / lecturer:

Adam Kadziński
email: adam.kadzinski@put.poznan.pl
tel. +48 61 665 2267
Faculty of Working Machines and Transportation
ul. Piotrowo 3, 60-965 Poznań

Responsible for subject / lecturer:

Bogusław Kasprzak
email: bkkasprzak@gmail.com
tel. +48 61 665 2267
Faculty of Working Machines and Transportation
ul. Piotrowo 3, 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Student has basic knowledge relating to mathematical analysis, probability calculus and mathematical statistics.
2	**Skills**	Student has fluent skills in computer office software.
3	**Social competencies**	Student can manage his/her own time dedicated to performance of indicated tasks. Student realizes that reduction of costs of functioning of mass service systems and resource systems can be achieved through better adaptation to streams of reports and demands generated in reality.

Assumptions and objectives of the course:

Learning methods of problem solving and acquisition of practical problem-solving skills relating to mass service and resource management theory and linear and non-linear programming.

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

Knowledge:

1. Student knows definitions/names for key terms connected with in-operation research relating to mass service theory, resource theory, linear and non-linear programming. - [K1A_W08]
2. Student knows elementary analytical models and simulation models relating to mass service theory. - [K1A_W08]
3. Student knows selected deterministic models and selected stochastic models relating to the resource theory. - [K1A_W08]
4. Student knows methods of construction of linear and nonlinear decision-making models. - [K1A_W08]
5. Student knows selected searching methods for optimum decision-making model solutions. - [K1A_W08]

Skills:

1. Student can properly use basic terms connected with in-operation research relating to mass service theory, resource theory, linear and non-linear programming. - [K1A_U02]
2. Student can apply selected elementary analytical models and selected simulation models relating to mass service theory. - [K1A_U15, K1A_U18]
3. Student can apply selected deterministic and selected stochastic models relating to the resource theory. - [K1A_U17, K1A_U18]
4. Student can apply methods to design selected decision-making models. - [K1A_U18]
5. Student can find optimum solutions for selected decision-making models. - [K1A_U18]

Social competencies:

1. Student improves his/her systemic thinking skills. - [K1A_K07]
2. Student improves his/her teamwork skills. - [K1A_K05]
3. Student improves his/her skills relating to rational decision making in team management. - [K1A_K05]

Assessment methods of study outcomes

Lecture: a written examination.

Practical classes: credit based on reports prepared and a written test.

Course description

Introduction to the topic of the course. The curriculum, hours, literature and method of crediting.

Basic terms connected with mass service systems. Methods of research on mass service systems. Generating quasi-random sampling figures. Descriptive method of modeling (research) of the mass service system. Analytical modeling of open systems of mass service such as M/M/1/oo, M/M/n/0, M/M/n/oo, M/M/n/r. Little's formulas. The notion and opportunities for use of a cyclical bistage model of mass service system. Basic problems of resource stock control. Deterministic models of resource stock control. Stochastic models of resource stock control. Resource stock replenishment policies. Research on processes of stocking and sales of resources in transport systems.

Linear programming: standard and canonical form, conditions for solutions, algebraic and geometric interpretation. Simplex method - simplex condition and method algorithm, base and free variables, searching for a preliminary base solution, proceeding to an optimum solution, linear programming dual task. Nonlinear programming - indirect methods: conditions for existence of stationary points, Hessian of objective function, problems with limitations - Lagrange method of undetermined multipliers and Kuhn-Tucker conditions. Nonlinear programming - direct methods: search for minimum in a direction, examples of gradient and non-gradient methods. Methods with minimization for numerous variables: non-gradient methods, first order gradient methods, second order gradient methods, variable metric methods, methods to allow for limitations. Random methods: systematic search method, Monte Carlo method, Brooks? random gradient method.

Practice in application of problems relating to mass service theory and resource management, linear and non-linear programming.

Basic bibliography:

1. Badania operacyjne. Praca zbiorowa pod redakcją W. Sikory. Polskie Wyd. Ekonomiczne, Warszawa, 2008.
2. Glinka M., Elementy badań operacyjnych w transporcie. Wyd. Politechniki Radomskiej, Radom, 2007.
3. Kadziński A., Badania operacyjne. Elementy teorii masowej obsługi i gospodarki zasobami. E-skrypt Politechniki Poznańskiej, Poznań, 2012, niepublikowany, przekazywany na pierwszym wykładzie.
4. Krawczyk S., Badania operacyjne dla menedżerów. Wyd. Akademii Ekonomicznej we Wrocławiu, Wrocław, 1996.
5. Krzyżaniak S., Podstawy zarządzania zapasami w przykładach. Biblioteka Logistyka, Poznań, 2002.
6. Runka J.H., Programowanie matematyczne. Część I i II. Programowanie liniowe. Wyd. Akademii Ekonomicznej w Poznaniu, Poznań, 1997.

Additional bibliography:

1. Anholcer M., Gaspars H., Owczarkowski A., Przykłady i zadania z badań operacyjnych i ekonometrii. Wydawnictwo Akademii Ekonomicznej w Poznaniu, Materiały dydaktyczne nr 140, Poznań, 2003.
2. Filipowicz B., Modele stochastyczne w badaniach operacyjnych. WNT, Warszawa, 1996.
3. Findeisen W., Szymanowski J., Wierzbicki A., Teoria i metody obliczeniowe optymalizacji. PWN, Warszawa, 1980.
4. Jędrzejczyk Z., Skrzypek J., Kukuła K., Walkosz A., Badania operacyjne w przykładach i zadaniach. PWN, Warszawa, 1999.
5. Kadziński A., Badania operacyjne. Ćwiczenia laboratoryjne. Skrypt Politechniki Poznańskiej nr 1801, WPP 1994, www.wbc.poznan.pl/dlibra.
6. Marcinkowski J., Rozkłady prawdopodobieństwa przydatne w rozwiązywaniu problemów transportu. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 1997.
7. Sarjusz-Wolski Z., Sterowanie zapasami w przedsiębiorstwie. PWE, Warszawa, 2002.
8. Siudak M., Badania operacyjne, zeszyt 1 i 2. Wydawnictwa Politechniki Warszawskiej, Warszawa, 1989.

Result of average student's workload

Activity	Time (working hours)

1. Preparation to the lecture	5
2. Participation in the lecture	18
3. Consolidation of the lecture content	16
4. Consultation about the lecture	2
5. Preparation to the exam	16
6. Participation in the exam	2
7. Preparation to the classes	5
8. Participation in the classes	8
9. Consolidation of the classes content	8
10. Consultation about the classes	1

Student's workload

Source of workload	hours	ECTS
Total workload	85	3
Contact hours	35	1
Practical activities	0	0