Subject (course) name: **Operations research**		
Field of study: **Computer Science** Specialization: **-**		Subject code:
		Title graduate: **Mgr (M.Sc)**
Type of course: **obligatory**	Course level: **Second-cycle studies**	Year: **I** Semester: **II** Semester: **summer**
Form of classes: **Lectures, Classes, Labs, Seminar, Project**	Number of hours per week: **2L, 0C, 1Lab, 0S, 0P**	Credit points: **4 ECTS**

GUIDE TO SUBJECT

SUBJECT OBJECTIVES

C1. Solving of linear and nonlinear exercises (Simplex method and Lagrange method).

C2. Acquaintance with Matlab (The MathWorks, Inc.) programming language (The Language of Technical Computing).

C3. Learning syntax of scripts in Matlab programming language.

C4. Acquaintance with functions in Optimization toolbox.

C5. Acquaintance with functions in Global Optimization toolbox.

SUBJECT REQUIREMENTS

1. Basic knowledge of programming concept involving conditional expressions and loops.
2. Basic computer skills.
3. Knowledge of English.

LEARNING OUTCOMES

EK 1 – Student understands fundamentals of analytical optimization methods: Simplex method, Lagrange Method Kuhn-Tucker Method.

EK 2 – Student is able to perform analysis of sampled optimization problem

EK 3 – Student is able to write Matlab scripts to construct and solve optimization problem

EK 4 – Student knows selected applications of multivariable optimization methods and global optimization methods

SUBJECT CONTENT

Form of classes - Lectures

Contents	Number of hours
W 1 – Introduction to decision analysis and operations research. Decision making process. Probabilistic modelling and simulation.	**2**
W 2 – Introduction to mathematical programming. Linear programming. Solving linear-programming exercises using graph method. Simplex method, standard and canonical form, implementation of the algorithm. Sensitivity analysis.	**4**
W 3 – Nonlinear Programming. Unconstrained nonlinear optimization. Constrained nonlinear optimization.	**4**
W 4 – Equation solving. Least squares method, model fitting.	**2**
W 5 – Network optimization. Shortest path problem in graph. Logistical and transportation planning methods.	**2**
W 6 – Dynamic programming. Bellman's principle of optimality. A dynamic decision problem.	**2**
W 7 – System dynamics. Logistics and supply chain management.	**2**
W 8 – Choice under uncertainty and risk.	**2**
W 9 – Discrete stochastic processes. The Bellman equation in a stochastic problem. Markov decision processes. Stochastic control.	**2**
W 10 – Multiobjective optimization. The goal attainment method. Minimizing the maximum objective.	**2**
W 11 – Computer applications in optimization. Systems optimization: models and computation. Advanced algorithms. Engineering risk analysis of investment. Systems supporting decision making process.	**4**
Test	**2**
Total:	**30**

Form of classes – laboratory

Contents	Number of hours
L 1 – Using optimization methods in mathematical modelling (least squares method, approximation of chronological processes, model fitting)	**2**
L 2 – Solving nonlinear optimization exercises using *MatLab software (Optimization Toolbox)*	**3**
L 3 – Nonlinear equations solving	**2**
L 4 – Solving network optimization exercises - shortest path problem in graph	**2**
L 5 – Dynamic programming models	**2**
L 6 – Solving multiobjective optimization exercises	**3**
Practical test	**1**
Total:	**15**

STUDY METHODS

1. Lectures using multimedia presentation, accompanied by discussion.
2. Laboratory experiments – work in groups on computers with dedicated software

EDUCATIONAL TOOLS

1. Audiovisual equipment, blackboard, lecture slides in PDF version
2. Computers with Matlab/Simulink software including Optimization and Global Optimization Toolboxes.

METHODS OF GRADING (F – Forming, P – Summary)

F1. Laboratory – preparation to lab experiments – individual oral answer (50% of the laboratory grade)
F2. Laboratory - individual reports (pdf files, scripts) with results of lab experiments (50% of the laboratory grade)
P1. Lectures – written final test

STUDENT WORKLOAD

Form of activity		Averaged workload (hours)		
		[h]	∑ [h]	ECTS
Participation in class activities	lectures laboratory	30 10	45	2.5
Studying literature		10	40	1.5
Preparation to laboratory and preparation of lab reports		15		
Preparation to the exam		15		
	Total		**100**	**4**

A. BASIC READING

1. Blumenfeld D., Operations Research. Calculations Handbook, CRC Press, 2009
2. The Mathworks Inc.: *Optimization Toolbox. User's Guide,*http://www.mathworks.com
3. The Mathworks Inc.: *Global Optimization Toolbox. User's Guide,*http://www.mathworks.com

B. FURTHER READING

1. Eiselt H.A., Sandblom C.-L., Operations Research. A Model-Based Approach, Springer-Verlag Berlin Heidelberg 2010
2. Hillier F.S., Lieberman G.J., Introduction to Operations Research, McGraw-Hill Companies, Inc, 2001

Learning outcomes	**In relation to the learning outcomes specified for the field of study**	**Subject objectives**	**Study methods**	**Methods of assessment**
EK1	K_W14 K_U08	C1	lectures, laboratory	**F1, F2, P1**
EK2	K_W10 K_W17 K_U08 K_K02	C2, C5	lectures, laboratory	**F1, F2, P1**
EK3	K_W09 K_U16 K_U22	C3, C5	lectures, laboratory	**F1, F2, P1**
EK4	K_W08 K_U10	C4	lectures	**P1**

II. EVALUATION

Grade	Outcome
EK1	**Student understands fundamentals of analytical optimization methods: Simplex method, Lagrange Method Kuhn-Tucker Method**
2 (F)	Student does not know basics of analytical optimization method
3 (E)	Student has partial formal knowledge of basics of analytical optimization method
4 (C)	Student has knowledge of analytical optimization method basics but without full understanding
5 (A)	Student knows and fully understands basics of analytical optimization method
EK2	**Student is able to perform analysis of sampled optimization problem**
2 (F)	Student does not know how to construct optimization model
3 (E)	Student knows about objective function and constraints but is not able to apply it to analysis
4 (C)	Student is able to perform analysis of optimization model but does not understand details
5 (A)	Student performs analysis of optimization model understanding construction of constraints
EK3	**Student is able to write Matlab scripts to construct and solve optimization problem**

2 (F)	Student is not able to design and implement even a simple scripts
3 (E)	Student is able to design only simple scripts
4 (C)	Student is able to design scripts but do not know all useful methods
5 (A)	Student designs and implements optimization problem using suitable software tools if needed
EK4	**Student knows selected applications of multivariable optimization methods and global optimization methods**
2 (F)	Student does not know (with some details) any application of multivariable optimization methods and global optimization methods
3 (E)	Student is able to enumerate presented applications and describe at least one of them
4 (C)	Student knows applications of multivariable optimization methods and global optimization methods and his/her knowledge is mostly correct
5 (A)	Student knows all presented applications of multivariable optimization methods and global optimization methods, can describe them in details and is able to perform advanced scripts

III. OTHER USEFUL INFORMATION

1. All information for students on the schedule are available on the notice board and on the website: www.el.pcz.pl
2. Information on the consultation shall be provided to students during the first lecture and will be placed on the website www.el.pcz.pl
3. Terms and conditions of credit courses will be provided to students during the first lecture