

FACULTY OF ELECTRICAL  
ENGINEERING**SUBJECT CARD**

Name in Polish: **Matematyczne metody optymalizacji**  
 Name in English: **Mathematical optimisation**  
 Main field of study (if applicable): **Control Engineering and Robotics**  
 Specialization (if applicable): **Automation of Machines, Vehicles and Apparatus**  
 Level and form of studies: **2nd level, full-time**  
 Kind of subject: **obligatory**  
 Subject code: **ARR041309**  
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	90		60		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	3		2		
including number of ECTS points for practical (P) classes :			2		
including number of ECTS points for direct teacher-student contact (BK) classes:	2.10		1.40		

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. A basic knowledge of the properties of functions, calculus of functions of several variables, linear algebra.

**SUBJECT OBJECTIVES**

- C1. Transfer of the basic knowledge and skills necessary for the proper formulation of optimization problems.  
 C2. Introduction to the basic methods of solving optimization problems.  
 C3. Training the skills in practical use of common software for solving optimization problems.

**SUBJECT EDUCATIONAL EFFECTS***relating to knowledge:*

- PEK\_W01 knows the rules of mathematical formulation of the optimization problems.  
 PEK\_W02 knows basic mathematical theorems on extreme functions of several variables, including the presence of constraints.  
 PEK\_W03 knows the basic methods and algorithms for solving linear and nonlinear optimization tasks.

*relating to skills:*

- PEK\_U01 able to formulate a mathematical model of the optimization problem.  
 PEK\_U02 able to select and use available software to solve optimization problems and correctly interpret the results.

*relating to social competences:*

- PEK\_K01 able to think and act in a creative and enterprising way.

## PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Introduction. Basic concepts. The objective function, constraints, parameters.	2
Lec 2	Optimisation problem formulation. Examples of problems.	2
Lec 3	Mathematical preliminaries. Vectors and Matrices. Elements of differential calculus. Convex sets and functions.	2
Lec 4	Unconstrained problems. Optimality conditions for unconstrained problems	2
Lec 5	Unconstrained minimization techniques. The steepest descent method. The Newton methods.	2
Lec 6	Conjugate gradient. Levenberg-Marquardt method. Non-gradient methods.	2
Lec 7	One-dimensional search methods. Golden section search.	2
Lec 8	Nonlinear constrained optimisation. Equality and inequality constraints. Kuhn-Tucker conditions.	2
Lec 9	Lagrangian function. Lagrangian duality.	2
Lec 10	Penalty methods.	2
Lec 11	Linear programming.	2
Lec 12	The simplex method. SLP method.	2
Lec 13	Integer programming.	2
Lec 14	Genetic algorithms. Basic concepts.	2
Lec 15	Genetic algorithms. Example of use.	2
Total hours:		<b>30</b>

Form of classes - laboratory		Number of hours:
Lab 1	H&S regulations. Laboratory working rules. Rules for working in a group. Rules for final crediting.	1
Lab 2	Constructing a mathematical model of an optimization problem. Analytical determination of the extremum of a function.	2
Lab 3	The study of numerical methods for unconstrained problems.	2
Lab 4	The study of numerical methods for unconstrained problems.	2
Lab 5	The study of numerical methods for unconstrained problems.	2
Lab 6	The study of numerical methods for unconstrained problems.	2
Lab 7	Applying the Optimization Toolbox of Matlab.	2
Lab 8	Applying the Optimization Toolbox of Matlab.	2
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Lecture with multimedia presentations.  
 N2. Computer laboratory suitable for group working.

## EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation <i>F - forming (during semester) P - concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEK_W01 PEK_W02 PEK_W03	Written exam.
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02 PEK_K01	Grading the correctness of optimization problem solutions.
P(L)	P=F1	

## PRIMARY AND SECONDARY LITERATURE

### PRIMARY LITERATURE:

- [1] Podstawy optymalizacji, A. Stachurski, A. P. Wierzbicki, WPW 1999.  
 [2] Metody rozwiązywania zadań optymalizacji, J. Seidler, A. Badach, W. Molisz, WNT 1980.

### SECONDARY LITERATURE:

- [1] Teoria i metody obliczeniowe optymalizacji, W. Findensein, J. Szymanowski, A. Wierzbicki, PWN 1977.  
 [2] Podstawy optymalizacji, F. Milkiewicz, Politechnika Gdańska 1995.  
 [3] Practical Optimization Methods, M. Asghar Bhatti, Springer-Verlag 2000

**SUBJECT SUPERVISOR**

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT  
**ARR041309 - Mathematical optimisation**  
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics**  
AND SPECIALIZATION **Automation of Machines, Vehicles and Apparatus**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)	Subject objectives	Programme content	Teaching tool number
PEK_W01	K2AiR_W01	C.1	Lec1 Lec2	N.1
PEK_W02	K2AiR_W01	C.1 C.2	Lec3 Lec4 Lec8 Lec9 Lec11	N.1
PEK_W03	K2AiR_W01	C.2	Lec5 Lec6 Lec7 Lec10 Lec12 Lec13 Lec14 Lec15	N.1 N.2
PEK_U01	K2AiR_U01	C.1	Lab2	N.1 N.2
PEK_U02	K2AiR_U01	C.3	Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_K01	K2AiR_K06	C.1 C.2 C.3	Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2