(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: OPTIMIZATION METHODS	**2. Course code** S I-AiIP/38a
3. Validity of course description: 2017/2018	
4. Level of studies: 1st cycle of higher education	
5. Mode of studies: intramural studies	
6. Field of study: AUTOMATICS AND INDUSTRIAL INFORMATICS	(RG)
7. Profile of studies: practical profile	
8. Programme:	
9. Semester: 6	
10. Faculty teaching the course: Faculty of Mining and Geology, Department of Electrical Engineering and Control in Mining	
11. Course instructor: Andrzej Nowrot, Ph.D.	
12. Course classification: specialty items	
13. Course status: elective	
14. Language of instruction: English	
15. Pre-requisite qualifications: mathematics, including mathematical analysis and algebra. It is assumed that the student has a background in, among others, differential and integral calculus, investigating the functions, matrix algebra and programming microcontrollers.	
16. Course objectives: The objective of this course is to teach students to solve and verify solutions of optimization tasks arising in technical problems. Student will know the different optimization algorithms taking into account the computing power. The differences between the PC's and microcontrollers' capacity (clock speed and memory size) in terms of used algorithm will be discussed.	

17. Description of learning outcomes:

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1.	Knows the basic ways of formulating optimization problems	Written test	Lecture, laboratory	K_W01++
2.	Knows the searching methodology of the numerical solutions to the problems of optimal control taking into account the computing capabilities of microcontrollers	Written test	Lecture, laboratory	K_W05+
3.	Is able to propose and implement a numerical algorithm for microcontroller, solving the optimization problem taking into account the limitations resulting from the memory size and computing power of microcontroller	Written test, laboratory report	Laboratory	K_U01++
4.	Is able to find the optimum solution for simple unconditional and conditional optimization problems	Written test, laboratory report	Laboratory	K_U01++
5.	Student is able to propose and implement a numerical algorithm for microcontroller that find solutions for practical optimization problems allowing the minimization of time to reach an optimal solution	Written test, laboratory report	Laboratory	K_U01+ K_U05++

18. Teaching modes and hours

Lecture 15 h, Laboratory 15 h

19. Syllabus description:

Lectures:

Finding and verifying solutions of optimization tasks arising from technical problems. Optimization algorithms taking into account the computing power - the differences between the PC's and microcontrollers' capacity (clock speed and memory size). Examples of optimization problems, static and dynamic optimization. Unconditional optimization, local and global extremum, example of theorem of the existence of solutions for the optimization problem, functionals and their differentiation, examples of differentiation of functionals. Implementation of the selected parameter

optimization during control in industrial facility using the microcontroller. Conditional extremum, types of restrictions, convex problems, necessary condition for the convex restrictions, functional gradient, regular points of restrictions.
Local theory of conditional optimization, the introduction of Lagrange multipliers, Lagrange functionals, necessary conditions of local optimality. Saddle point theorem, duality in convex problems. Convex programming, convex programming with linear constraints, square programming. Solving tasks by Simplex algorithm.
Problems of control optimization, optimal control, one-step problems, Hamiltonian. The implementation of the optimization process, using the microcontroller computational power. Problems of optimal control of continuous time problems with a specific, free and movable end, the necessary conditions for optimum control.

Laboratory:
Use of different families of microcontrollers (e.g. ARM) in solving optimization problems. Optimization of industrial processes based on input signals (e.g. from sensors). Optimization methods without restrictions, one-dimensional problems. Gradient optimization algorithms without restrictions. Linear programming, simplex algorithm. Gradientless optimization methods. Direct methods of dynamic optimization. Synthesis of optimal control. The use of complex numerical algorithms in supporting and accelerating the optimization process.

20. Examination: No

21. Primary sources:

1. Battiti Roberto; Mauro Brunato, Franco Mascia; Reactive Search and Intelligent Optimization. Springer Verlag 2008
2. Duda Z., Ordys A., Swierniak A.: Laboratorium metod optymalizacji dynamicznej, Wydawnictwo Politechniki Śląskiej, Gliwice, 1993
3. Parkinson A., Balling R., Hedengren J.; Optimization Methods for Engineering Design. Provo, UT: Brigham Young University 2013

22. Secondary sources:

1. Bradley S., Hax A., Magnanti T.; Applied mathematical programming. Addison Wesley 1977
2. Kincaid D., Cheney W.: Analiza numeryczna. WNT Warszawa 2006

23. Total workload required to achieve learning outcomes

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	15/15
2	Classes	0/0
3	Laboratory	15/35
4	Project	0/0
5	BA/ MA Seminar	0/0
6	Other	0/0
	Total number of hours	30/50

24. Total hours: 80

25. Number of ECTS credits: 3

26. Number of ECTS credits allocated for contact hours: 1

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 2

28. Comments:

Approved:

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(date, Instructor's signature) (*date, the Director of the Faculty Unit signature)*