(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: NUMERICAL METHODS 2	**2. Course code** S I-AiIP/38b
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: numerical methods 1, mathematics, including mathematical analysis and algebra. It is assumed that the student has a background in, among others, differential and integral calculus, analysing functions, matrix algebra and programming microcontrollers, physics and electronics	
16. Course objectives: The objective of this course is to teach students to apply numerical methods in microcontrollers. Students will learn, among others, integration, differentiation and solving differential equations using resources (computing power and memory) of microcontrollers used in industrial equipment	

17. Description of learning outcomes:

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1.	Is able to write a program for the single-chip microcontroller performing complex numerical calculations in order to control given technological process	Written test, laboratory report	Lecture, laboratory	K_U01++
2.	Is able to develop and write a program for the microcontroller performing the process of integration, differentiation or solving a differential equation treating input signals at the ports of the microcontroller as a variables	Written test, laboratory report	Lecture, laboratory	K_U01++ K_U04++
3.	Is able to take into account limitations in numerical methods arising from using the equipment in explosive atmospheres	Written test, laboratory report	Laboratory	K_U02+
4.	Is able to implement selected numerical algorithms in the digital signal processor	Written test, laboratory report	Laboratory	K_U01+ K_U02++
5.	Knows the differences between the calculation capacity of PC's and microcontrollers	Written test,	Laboratory	K_W05+

18. Teaching modes and hours

Lecture 15 h, Laboratory 15 h

19. Syllabus description:

Lectures:

The computational power and memory size of microcontrollers in terms of different numerical algorithms. Applying numerical methods with the use of microcontrollers. Numerical integration, numerical differentiation. Solving selected differential equations in a microcontroller. Numerical filtering and approximation methods of measurement signals in real time. Numerical extrapolation. Examples of devices in which microcontrollers perform complex numerical calculations. Theory of errors, error sources, the absolute and relative error, the upper limit of absolute and relative error, significant figure, the number of accurate digits, the rounding rules, arithmetic operations errors. Linking the sampling frequency of ADC

and DAC converters with numerical algorithm in use. Interpolation, formulation of the interpolation problem, the optimal selection of interpolation nodes. Systems of linear equations: accurate methods - Cramer equations, Gaussian elimination method implemented in microcontrollers. Nonlinear equations: location of equation root, secant method, tangent method. Numerical methods in ARM processors. Restrictions for numerical algorithms resulting from the requirements of ATEX.

Laboratory:

General rules for implementing numerical algorithms in microcontrollers. Filtering of the measurement data in real time. The numerical approximation in microcontrollers. Saving the calculations results on the SD card of microcontroller circuit. Interpolation - polynomial interpolation (Lagrange polynomial and Newton polynomial), spline functions, trigonometric interpolation. Solving systems of linear equations. Solving differential equations in microcontrollers during the industrial process control with and without taking into account the requirements for ATEX equipment.

20. Examination: No

21. Primary sources:

1. Steven .C.Chapra, Raymond P.Canale ; Numerical Methods for Engineers; McGraw-Hill Education; New York 2015
2. Jeffrey R. Chasnov; Introduction to Numerical Methods; Hong Kong University of Science and Technology 2012
3. R.W. Hamming; Numerical Methods for Scientists and Engineers; Dover publications Inc., New York 1973
4. Kincaid D., Cheney W.: Analiza numeryczna. WNT Warszawa 2006

22. Secondary sources:

1. Jankowscy J. i M.: Przegląd metod i algorytmów numerycznych. WNT Warszawa 1981
2. Ralston A.: Wstęp do analizy numerycznej. PWN 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)*