COURSE DESCRIPTION CARD - SYLLABUS

Course name
Algebra and Fundamentals of Optimization Methods for ICT [S1MiKC1E>AiPMO]

Course

Field of study
Microelectronics and Digital Communication

Year/Semester
1/1

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
English

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

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Prerequisites

Student has knowledge of mathematics, in accordance with the secondary school education program.

Course objective

Providing students basic knowledge of algebra and optimization methods. Knowledge of algebra includes complex numbers and operations on these numbers, matrix operations and vector operations. Knowledge of optimization methods includes the basics of nonlinear optimization, with a presentation of the most important aspects of gradient-based optimization widely used in the technique. An important objective of the course is to teach students the ability to solve selected technical problems (also from the ICT area), by using the methods of algebra and optimization algorithms learned. The presented objective also includes the ability of students to interpret the obtained solutions for the considered problems.

Course-related learning outcomes

Knowledge:

1. Student has knowledge of complex numbers, matrices of numbers, vectors of numbers, and their practical applications [K1_W01].
2. Student has knowledge of the most important, from the point of view of technical applications, mathematical operations on complex numbers, matrices of numbers and vectors of numbers [K1_W01].
3. Student has basic knowledge of optimization methods, in particular gradient-based optimization methods. Has knowledge of the mathematical description of selected optimization methods [K1_W01].

Skills:
1. Student is able to perform mathematical operations on complex numbers, matrices of numbers and vectors. Student is able to interpret the obtained solution. Student is able to indicate technical applications of the mathematical operations [K1_U03].
2. Student is able to provide a mathematical description for a simple technical problem. Student is able to solve this problem using a selected optimization algorithm and interpret the obtained solution. In addition, student understands the significance of individual calculation steps used in examplary optimization algorithms [K1_U03].
3. Student is able to define input parameters for the optimization methods learned and propose an algorithm for ending calculations in these methods [K1_U03].

Social competences:
Student is open and understands the need for continuous education in order to improve their qualifications. They are able to think logically and to formulate constructive conclusions [K1_K01].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Lecture
Written exam. The exam consists of several to a dozen or so questions relating to the theory and practical side (calculations) of the presented methods. The exact nature of the exam questions will be presented to students during one of the last lectures. Passing threshold: 50% of total points.
2. Exercises
Colloquium at the end of the semester. The colloquium consists of several questions testing skills in the scope of the learned elements of algebra and optimization methods. Passing threshold: 50% of total points.
For passing the lecture and exercises, the following percentage thresholds apply to individual grades: 2.0 (< 50%), 3.0 (50%-59%), 3.5 (60%-69%), 4.0 (70%-79%), 4.5 (80%-89%), 5.0 (90% and more). The students' answers (independently for each question/task) are scored by awarding a portion of the points allocated for the question/task that corresponds to the degree (in percentage terms) to which the answer given is correct.

Programme content

Complex numbers, matrices of numbers, vectors of numbers, selected mathematical operations. Basic optimization methods, including gradient-based optimization.

Course topics

1. Lecture
The concept of a complex number, selected methods of presenting complex numbers, mathematical operations on complex numbers. Examples of applications in ICT.
The concept of a matrix of numbers, determinant and a vector of numbers. Operations on matrices and operations on vectors. Matrix eigenvalues and eigenvectors. Examples of applications in ICT.
The extremum of a function of one and many variables. Selected methods of optimizing a function. Issues of nonlinear programming (introduction, direct search methods, selected gradient-based optimization methods). Examples of applications in ICT.
2. Exercises
Operations on complex numbers.
Selected operations on matrices and vectors. Determinant. Matrix eigenvalues and eigenvectors.
Solving nonlinear programming problems.
Optimization with and without constraints.
The presented examples of ICT applications will refer to contemporary techniques/algorithms used in

this field.

Teaching methods

1. Lecture
Classes with distinct elements of traditional lecture and problem-based lecture (discussion with students of a specific problem), depending on the content of the presented material. Presentation of elements of algebra and optimization methods along with examples of their use. Selected lecture content is presented on a multimedia projector or a board. The discussion of issues is accompanied by information about their practical application.
2. Exercises
Solving problems given by the teacher. Interpretation of the obtained solution and formulation of conclusions. Discussion of the possibilities of practical application of the methods/calculations that are the subject of the exercises.

Bibliography

Basic:
1. M. Grzesiak, Liczby zespolone i algebra liniowa, Wydawnictwo PP Poznań 1999.
2. T.Jurlewicz, Z. Skoczylas, Algebra liniowa 1,2 Wydawnictwo GiS 2015.
3. W. Leksiński, I. Nabiałek, W. Żakowski, Matematyka. Definicje, twierdzenia, przykłady, zadania, seria EIT, WNT Warszawa 1992 (i późniejsze).
4. A. Stachurski, Wprowadzenie do optymalizacji, OWPW, 2009.
5. I. N. Bronsztejn (i inni), Nowoczesne kompendium matematyki, PWN, Warszawa 2007.

Additional:
1. J. Rutkowski, Algebra liniowa w zadaniach, PWN, Warszawa , 2008.
2. S. S. Rao, Engineering Optimization. Theory and Practice, Wiley, 2009.
3. A. Nowak, Optymalizacja. Teoria i zadania, Gliwice 2007.

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00