Optimization methods - course description

General information

Course name	Optimization methods
Course ID	11.9-WE-AutD-OptimMeth-Er
Faculty	Faculty of Computer Science, Electrical Engineering and Automatics
Field of study	Automatic Control and Robotics / Computer Control Systems
Education profile	academic
Level of studies	Erasmus programme
Beginning semester	winter term 2017/2018

Course information

Semester	1
ECTS credits to win	6
Course type	obligatory
Teaching language	english
Author of syllabus	• prof. dr hab. inż. Andrzej Obuchowicz

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Exam
Laboratory	30	2	-	-	Credit with grade

Aim of the course

- to familiarize students with the basic techniques of linear and nonlinear programming
- to develop students' skills in the specification of optimization tasks in engineering design tasks and to solve them using numerical packages

Prerequisites

Mathematical analysis, Linear algebra with analytical geometry, Numerical methods

Scope

Linear programming tasks (ZPL). Classic, standard, and canonical ZPL characters. The geometric method, base solutions, and simplex algorithm. Quotient programming. Transport and allocation problems.

Nonlinear programming (ZPN) tasks - conditions for optimality. Convex sets and functions. Necessary and sufficient conditions for the existence of an extreme function without restrictions. Lagrange multipliers method. Extrema of functions in the presence of equality and inequality constraints. Karush-Kuhn-Tucker conditions (KKT). The regularity of restrictions. Conditions for the existence of a saddle point. Square programming.

Computational methods for solving ZPN. Methods of searching the minimum towards Fibonacci methods, the golden ratio, Kiefer, Powell, and Davidon. Simple search methods: Hooke-Jeeves and Nelder-Mead methods. Continuous and discrete gradient algorithm. Newton's method. Gauss-Newton and Levenberg-Marquardt methods. Basic methods of improvement directions: Gauss-Seidel methods, fastest decrease, Fletcher-Reeves conjugate gradients, variable Davidon-Fletcher-Powell metrics. Searching for the minimum under restrictive conditions: methods of internal, external and mixed punishment, gradient projection method, sequential square programming method, methods of acceptable directions.

Basics of discrete and mixed optimization. Integer programming. Problems of shortest routes and maximum flow. Elements of dynamic programming.

Global Optimization. Stochastic optimization. Adaptive random search. Metaheuristic methods: simulated annealing algorithm, evolutionary algorithms, particle swarm optimization.

Multi-criteria optimization and adaptation in non-stationary environments. Paretooptymlaność. Types of non-stationary environments, classification of adaptive problems.

Practical issues. Simplification and elimination of restrictions. Elimination of discontinuities. Scaling the task. Numeric zooming of the gradient. Use of library procedures. Review of selected libraries of optimization procedures. Discussion of the methods implemented in popular numerical and symbolic processing systems.

Teaching methods

wykład: wykład konwencjonalny

laboratorium: ćwiczenia laboratoryjne

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Students are able to formulate optimization tasks based on a textual description of a technical problem, technological or logistics.		• exam	• Lecture

Outcome description	Outcome symbols	Methods of verification	The class form
Students are able to determine optimal solutions for linear, convex programming tasks and selected classes discrete optimization tasks.		• exam	• Lecture
Students are able to explain the operation of iterative optimization algorithms		• exam	• Lecture
Students are able to indicate an effective method of optimization for a specific problem.		• test, lab exercises reports	• Laboratory
Students are able to use numerical environments (Matlab, Maple) to determine the optimal solutions for complex problems.		• test, lab exercises reports	• Laboratory

Assignment conditions

Wykład - warunkiem zaliczenia jest uzyskanie pozytywnej oceny z egzaminu przeprowadzonego w formie pisemnej lub ustnej

Laboratorium - warunkiem zaliczenia jest uzyskanie pozytywnych ocen ze wszystkich ćwiczeń laboratoryjnych, przewidzianych do realizacji w ramach programu laboratorium

Składowe oceny końcowej = wykład: 50% + laboratorium: 50%

Recommended reading

1. Kukuła K.(red.): Badania operacyjne w przykładach i zadaniach, PWN, Warszawa, 2006
2. Bertsekas D.: Nonlinear programming, Athena Scientific, 2004
3. Ignasiak E.(red.): Badania operacyjne, PWN, Warszawa, 2001
4. Kusiak J., Danielewska-Tułecka A., Oprocha P.: Optymalizacja. Wybrane metody z przykładami zastosowań, PWN, 2009

Further reading

1. Bertsekas D.: Convex Analysis and Optimization, Athena Scientific, 2003
2. Spall J.: Introduction to Stochastic Search and Optimization: Estimation, Simulation and Control, Wiley InterScience, 2003

Notes

Modified by dr hab. inż. Wojciech Paszke, prof. UZ (last modification: 28-04-2020 20:09)