COURSE DESCRIPTION CARD - SYLLABUS

Course name
Optimization computation methods [N2AiR1-ISA>MOO]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/1

Area of study (specialization)
Intelligent Control Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
0

Other
0

Tutorials
20

Projects/seminars
0

Number of credit points

5,00

Coordinators

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Lecturers

Prerequisites

[K2_W02 (P7S_WG)][K3_W02 (P7S_WG)] [K2_U01 (P7S_UU)] [K2_K05 (P7S_KO)]

Course objective

The aim of this course is to present both theory and optimization methods to the students, giving emphasis of applicability of optimization methods to control problems. Theoretical basis is illustrated by means of examples, including optimal control problems.

Course-related learning outcomes

Knowledge
[K2_W1]
[K2_W8]
Skills
[K2_U10]
[K2_U27]
Social competences
[K2_K1]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Lecture: written exam. Tutorials: verification of the ability of students to solve optimization problems analytically and by using available software; monitoring progres of studens, exercises accompanied by self-study handouts via eKursy; using software enabling to solve presented problems at home.

Programme content

Linear programming. Duality. Nonlinear programming with equality or inequality constraints. Variational calculus. Minimum principle. Penalty function approach.

Course topics

Linear programming. Graphical method. Matrix and table simplex methods. Duality in linear programming problems. Linear programming in discrete sets. Sensitivity analysis of the simplex method. Solving nonlinear problems as sequential linear programming problems. Nonlinear programming without constraints, with equality or inequality constraints. Convex optimization. Dual Lagrange problem. Iterative methods for single- and multiple-variable problems. Interior point methods for linear and quadratic problems. Variational calculus. Minimum principle of Pontryagin. Bellmann's optimality principle. Linear matrix inequalities. Multicriteria optimization. Penalty function approach.
2021 update: examples, using selected optimization methods to optimal control, including tuning of controllers.

Teaching methods

LECTURE
pdf slides (figures, photos), with additional information written on the blackboard; lectures accompanied by self-studying handouts via eKursy; theory presented with reference to current knowledge of students and to practical problems; new subjects preceded by recalling subjects connected or known from other lectures
TUTORIALS
Sample problems solved on the blackboard; commented solutions of the solved problems by the tutor and discussing solutions; numerical experiments.

Bibliography

Basic
[1] Horla D., Metody obliczeniowe optymalizacji w zadaniach, wyd. 2, Wydawnictwo Politechniki Poznańskiej, Poznań, 2016.
[2] Optymalizacja układów sterowania - zadania, Rumatowski K., Królikowski A., Kasiński A., Wydawnictwa Naukowo-Techniczne, Warszawa, 1974
[3] Stadnicki J., Teoria i praktyka rozwiązywania zadań optymalizacji z przykładami zastosowań technicznych, Wydawnictwa Naukowo-Techniczne, Warszawa, 2006
Additional
[1] Athans M., Falb P.L., Optimal Control. An Introduction to the Theory and Its Applications, McGraw Hill, 1966
[2] Baldick R., Applied Optimization. Formulation and Algorithms for Engineering Systems, Cambridge University Press, 2006
[3] Bazaraa M.S., Sherali H.D., Shetty C.M., Nonlinear Programming. Theory and Algorithms, wyd. 3, Wiley-Interscience, 2006
[4] Chong E.K.P., Żak S.H., An Introduction to Optimization, wyd. 2, John Wiley & Sons, 2001.
[5] Gelfand I.M., Fomin S.W., Rachunek wariacyjny, wyd. 4, Państwowe Wydawnictwo Naukowe, Warszawa, 1979
[6] Horla D., Computational Burden Analysis for Integer Knapsack Problems Solved with Dynamic Programming, 14th International Conference on Informatics in Control, Automation and Robotics ICINCO, Madrid, Spain , 2017, s. 215-220
[7] Horla D., Performance evaluation of ilterative methods to unconstrained single variable minimization problems, Studia z Automatyki i Informatyki, 2013, T. 38, s. 7-34
[8] Ignaczak M., Horla D., Performance evaluation of basic optimization methods for polynomial binary problems, Studia z Automatyki i Informatyki, 2016, vol. 41, s. 7-34

[9] Robinett R.D., Wilson D.G., Eisler G.R., Hurtado J.E., Applied Dynamic Programming for Optimization of Dynamical Systems, SIAM, 2005.
[10] Szukalski M., Horla D., Performance evaluation of iterative minimization methods for nonlinear programming problems with constraints, Studia z Automatyki i Informatyki, 2015, vol. 40, s. 7-36
[11] Vanderbei R.J., Linear Programming: Foundations and Extensions, wyd. 2, Springer, 2001

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	40	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	85	3,00