COURSE DESCRIPTION CARD - SYLLABUS

Course name
Optimization computation methods

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 studies

Course offered in
Polish

Form of study
full-time

Requirements

Number of hours

Lecture
30

Laboratory classes

Other (e.g. online)

Tutorials
30

Projects/seminars

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
dr hab. inż. Dariusz Horla, prof. PP

Responsible for the course/lecturer:
mgr inż. Piotr Kozierski

Prerequisites

Zna i rozumie w pogłębionym stopniu wybrane działy matematyki [K2_W02 (P7S_WG)]
Ma zaawansowaną i pogłębioną wiedzę w zakresie metod analizy i projektowania systemów sterowania [K3_W02 (P7S_WG)] Potrafi krytycznie korzystać z informacji literaturowych, baz danych i innych źródeł; Posiada umiejętności samokształcenia w celu podnoszenia i aktualizacji kompetencji zawodowych. Potrafi samodzielnie planować własne uczenie się przez całe życie i ukierunkowywać innych w tym zakresie [K2_U01 (P7S_UU)] Jest gotów do myślenia i działania w sposób przedsiębiorczy [K2_K05 (P7S_KO)]

Course objective

The aim of this lecture 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_W03 (P7S_WG)], [K2_W02 (P7S_WG)], [K2_W01 (P7S_WG)]

Skills

[K2_U07 (P7S_UW)], [K2_U01 (P7S_UU)], [K2_U10 (P7S_UU)]

Social competences

[K2_K01 (P7S_KK)], [K2_K05 (P7S_KO)]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: written exam.

Laboratory exercises: 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 Moodle; using software enabling to solve presented problems at home.

Programme content

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.

2020 update: examples, using selected optimization methods to optimal control, including tuning of controllers.

Teaching methods

a) lecture

- pdf slides (figures, photos), with additional information written on the blackboard,

- lectures accompanied by self-studying handouts via Moodle,

- 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.

b) laboratory exercises

- 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, 2nd ed, 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, 3rd ed, Wiley-Interscience, 2006

4. Chong E.K.P., Żak S.H., An Introduction to Optimization, 2nd ed, John Wiley & Sons, 2001.

5. Gelfand I.M., Fomin S.W., Rachunek wariacyjny, 4th ed, 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, pp. 215-220

7. Horla D., Performance evaluation of ilterative methods to unconstrained single variable minimization problems, Studia z Automatyki i Informatyki, 2013, vol. 38, pp. 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, pp. 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, pp. 7-36

11. Vanderbei R.J., Linear Programming: Foundations and Extensions, 2nd ed, Springer, 2001

Breakdown of average student's workload

	Hours	ECTS
Total workload	135	4,0
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam) [1]	105	3

[1] delete or add other activities as appropriate