SYLLABUS

Name: ***Advanced Optimization Methods (MakAu>SM1-AOM-19)***
Name in Polish:
Name in English: ***Advanced Optimization Methods***

Information on course:

Course offered by department: Faculty of Automatic Control, Electronics and Computer Science
Course for department: Silesian University of Technology

Default type of course examination report:

ZAL

Language:

English

Course homepage:

https://platforma2.polsl.pl/rau1/course/view.php?id=242

Short description:

The objective of the lectures is to give the knowledge in the fields of advanced optimization methods and algorithms, both for mathematical programming and optimal control problems. The expected outcomes are development of skills necessary to implement and solve complex optimization problems.

Description:

ECTS: 4
Total workload: 100 hours (60 contact hours, 40 students' own work hours) Forms of contact hours:
Lecture 30h
Laboratory 30h

Students' own work: preparation for classes, elaboration results from classes, writing reports, preparation for final test

Lecture:
duality in linear programming
integer and binary integer programming,
mixed integer problems,
branch and bound method,
computational complexity and NP-completeness,
non-linear constraints and unconstrained optimization,
evolutionary algorithms,
multi-criteria optimization, pareto-optimality
discrete and continuous dynamical optimization problems,
optimal control,
maximum principle,
examples of optimization problems

Laboratory:
1. Integer and binary integer linear programming
2. Decision trees
3. Genetic algorithms
4. Direct methods of unconstrained dynamic optimization
5. Constrained dynamic optimization (penalty methods)
6. Linear Quadratic problem
7. Optimal control
8. Optimization in graph problems

teaching methods, including distance learning:
the lecture is given in traditional way using multimedia materials;
form and criteria for semester completion, including retake tests, as well as conditions for admission to the examination:
the lecture part of the course is evaluated by four written tests;
course organisation and rules of participation in the course, with an indication whether a student's attendance is obligatory;
the lecture part of the course is divided into 15 lectures lasting two hours each, attendance at lectures is not obligatory.

Bibliography:

Primary sources:
Matlab Optimization Toolbox 2025.
Świerniak A., A. Gałuszka, Optimization Methods and Decision Making. Lecture Notes. Wyd. Politechniki Śląskiej, Gliwice 2003.
Ogonowski Z., J. Smieja, Optimization Methods and Decision Making. (Handbook for students) Art&Kolor, Gliwice, 2001. (available for download at http://www.platforma.polsl.pl/rau1/)
Figwer J., J. Mościński, Z. Ogonowski. (red. Z.Ogonowski) Laboratorium metod optymalizacji statycznej. Skrypty Uczelniane Politechniki Śląskiej, Nr. 1852, Gliwice.
Duda Z., A. Ordys, A. Świerniak. Laboratorium metod optymalizacji dynamicznej. Skrypty Uczelniane Politechniki Śląskiej, Nr. 1171, Gliwice.
Lisowski J. Metody Optymalizacji. WYdawnictwo Morskie w Gdyni, 2022.

Secondary sources:
Cormen, Thomas H.; Leiserson, Charles E.; Rivest, Ronald L.; Stein, Clifford (2009). Introduction to Algorithms (3rd ed.). MIT Press. ISBN 0-262-03384-4
Brian D. O. Anderson, John B. Moore: Linear Optimal Control, Prentice-Hall, Inc., 1971
Luenberger D.: Optimization by vector space methods, John Wiley, 1969 (Polish translation-Teoria optymalizacji, PWN, 1974)
Luenberger D.: Introduction to linear and nonlinear programming, Adison-Wesley, 1973

Helmke U., J. Moore: Optimization and dynamical systems, Springer, 1994
Bryson A., Y.C. Ho: Applied optimal control, Blaisdell, 1969

Learning outcomes:

Knowledge: Student knows and understands advanced knowledge of methods of optimization, inference and decision making, as well as their application to the diagnosis and life-cycle management of machines, devices, and automation and robotic systems. K2A_W01

Student is capable of effectively applying methods of optimization, inference, and artificial intelligence to the analysis and design of control algorithms in automation and robotics. K2A_W04

Skills: Student can to compare design solutions of automation elements and systems with respect to given utility and optimization criteria, such as cost, operating speed, positioning accuracy, quality of operation, reliability, and serviceability. K2A_U01

Student is able to to apply selected advanced optimization and decision-making methods to the analysis and design of complex optimization algorithms in automation and robotics. K2A_U11

Student is able to compare the quality of solutions of advenced optimization algorithms with respect to given utility and optimization criteria, such as cost, time efficiency, available resources. K2A_U15

Assessment methods and assessment criteria:

The final grade is assigned basing on an average of two components: the first components is the grade obtained by student during written test, second component is the grade obtained by student during laboratory. Written test grade is an average of three grades of problems to be solved by student within one hour. Solution of each problem is awarded from zero (0) to five (5) points. Second component is an average of all grades obtained for four laboratory classes.

Additional rules:
- student's absence from the course: there is one additional term lasting 3 hours (for those who do not obtained positive grade for one of laboratories, or could not be present at one of laboratories),
- differences in study programmes for students changing their field of study, changing university or resuming studies at the Silesian University of Technology: based on individual assessment made by lecturer.

The syllabus is valid from winter semester / academic year 2025/2026 and its content is not subject to change during the semester.

Course credits in various terms:

<without a specific program>

Type of credits	Number	First term	Last term
European Credit Transfer System (ECTS)	4	2020/2021-L	