Syllabus

1. Data about the program of study

1.1 Institution	Technical University of Cluj-Napoca
1.2 Faculty	Automation and Computer Science
1.3 Departament	Automation
1.4 Field of study	Systems Engineering
1.5 Cycle of study	Bachelor of Science
1.6 Program of study/Qualification	Automation and Applied Informatics (English)
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Optimization***				Discipline code	**55.10**
2.2 Course responsible/lecturer	*Prof.dr.ing. Zsofia Lendek, zsofia.lendek@aut.utcluj.ro*					
2.3 Teachers in charge of applications	*Prof.dr.ing. Zsofia Lendek, zsofia.lendek@aut.utcluj.ro*					
2.4 Year of study	4	2.5 Semester	2	2.6 Assessment *(E/C/V)*		E
2.7 Type of subject	*DF – fundamental, DS – specialty, DC – complementary*					DS
	DOB – compulsory, DOP – elective, DFA – optional					DOP

3. Estimated total time

3.1 Number of hours per week	4	of which:	Course	2	Seminar	0	Laboratory	2	Project	0
3.2 Number of hours per semester	56	of which:	course	28	Seminar	0	Laboratory	28	Project	0

3.3 Individual study	
(a) Manual, lecture material and notes, bibliography	20
(b) Supplementary study in the library, online and in the field	10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	33
(d) Tutoring	3
(e) Exams and tests	3
(f) Other activities:	20

3.4 Total hours of individual study (sum of (3.3(a)…3.3(f)))	69
3.5 Total hours per semester (3.2+3.4)	125
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	Numerical calculus, analysis, linear algebra, differential equations, Matlab
4.2 Competence	Numerical calculus, analysis, linear algebra, differential equations, Matlab

5. Requirements (where appropriate)

5.1. For the course	Attending at least 7 lectures is compulsory.
5.2. For the applications	Presence and successfully completing the lab/project applications are compulsory

6. Specific competences

Professional competences	C1 Use of knowledge in mathematics, physics, measurement techniques, technical drawing, mechanical engineering, chemical engineering, electrical engineering, and electronics in systems engineering. C1.2 Explaining engineering problems to be solved and justifying solutions in systems engineering through the application of techniques, concepts, and principles from mathematics, physics, chemistry, technical drawing, electrical engineering, and electronics. C1.3 Solving common problems in the field of systems engineering by identifying appropriate techniques, principles, and methods, and by applying mathematics, with an emphasis on numerical computation methods. C3 Use of the fundamentals of automatic control, modeling, simulation, identification, and process analysis methods, as well as computer-aided design (CAD) techniques. C3.2 Explaining and interpreting automation problems for various types of processes by applying the fundamentals of automatic control, methods of modeling, identification, simulation, and process analysis, as well as computer-aided design (CAD) techniques.
Cross competences	

7. Expected learning outcomes

Knowledge	The student applies the fundamentals of automatic control and methods of process modeling, simulation, identification, and analysis to solve optimization problems specific to dynamic and industrial systems. They employ both conventional and artificial intelligence–based computer-aided design techniques to optimize the performance of automated and intelligent systems. Furthermore, the student develops and implements automatic control algorithms and control structures using modern programming environments, microcontrollers, embedded systems, and advanced information technologies. They are capable of formulating and solving optimization problems in applications involving automatic control, robotics, and intelligent control systems.
Skills	Applies evaluation criteria and methods to identify, model, experiment with, analyze, and qualitatively and quantitatively assess phenomena and processes specific to the field, including the use of digital technologies. Designs solutions to medium-complexity engineering problems while considering performance, safety, sustainability, and economic constraints. Applies modern project management techniques, economic methods, and decision-making approaches, including in multidisciplinary contexts. Applies engineering techniques, principles of physics, and appropriate mathematical methods to solve systems engineering problems, with an emphasis on numerical computation methods. Selects and applies field-specific scientific methods and techniques in the development and implementation of systems engineering projects and analyzes the advantages and disadvantages of the proposed methods. Interprets and explains automation problems using systems theory, modeling and simulation, analytical methods, and computer-aided design techniques. Specifies requirements, develops simulation scenarios, proposes control solutions, and analyzes the performance of automated systems. Models, simulates, and experimentally analyzes processes using mathematical foundations. Designs and implements control systems based on both conventional algorithms and artificial intelligence techniques. Develops software solutions that integrate algorithm design, data management, and workflow automation for engineering applications.

Responsibilities and autonomy	Practices logical reasoning, evaluation, and self-assessment in decision-making processes. Communicates the results of engineering activities effectively to both technical and non-technical audiences. Demonstrates a commitment to lifelong learning and the continuous updating of professional knowledge. Works effectively in multidisciplinary teams and contributes constructively to the development of engineering solutions. Carries out project management processes and clearly presents results both verbally and in writing. Takes responsibility for the quality, safety, and ethical implications of the solutions developed. Uses engineering tools and platforms responsibly, following best practices for configuration, testing, and deployment. Plans, executes, and independently manages engineering tasks, from problem formulation to solution delivery, demonstrating initiative in adopting new methods and technologies.

8. Course objectives

General objective	Mathematical formulation of an optimization problem Optimization methods Global optimization
Specific objectives	Solving single variable optimization problems Implementing optimization methods Solving multivariable optimization problems Applying optimization methods Using genetic algorithms for particular applications

9. Contents

9.1 Lecture	No.hours	Teaching methods	Notes
Introduction. Starting an optimization problem.	2	Exposition Questions Discussions with students Proofs	Possibly online on Teams platform
Unconstrained optimization. Sufficient conditions. Constrained optimization.	2		
Optimization of single variable functions.	2		
Newton and gradient methods.	2		
Conjugate gradient and quasi-Newton methods.	2		
Algorithms for minimization without derivatives.	2		
Linear programming. Formulation.	2		
The simplex method.	2		
Quadratic programming.	2		
Active set methods.	2		
Genetic algorithms for numerical optimization	2		
Genetic algorithms for numerical optimization	2		
Applications.	2		

Bibliography:

1. Optimal, predictive, and adaptive control, Edoardo Mosca, Englewood Cliffs, New Jersey, 195
2. Modern control design: with MATLAB and SIMULINK, Ashish Tewari, Wiley, 2002
3. Tehnici de optimizare, vol. 2, T. Colosi, P.Bikfalvi, D.Isoc, Cluj-Napoca : Institutul Politehnic Cluj-Napoca, 1989
4. Optimal control with engineering applications, Geering, H, Springer, 2007
5. Optimization, P. Raica, UTPress, 2010

Lecture notes available online at lendek.net/teaching

9.2 Aplications (seminar/laboratory/project/practical work)	No.hours	Teaching methods	Notes
Numerical methods in optimization.	2	Tutorials and application	Attendance mandatory. Matlab will be used. Possibly online on Teams platform
Unconstrained optimization. Applications	2		
Optimization of single variable functions.	2		
Optimization of single variable functions.	2		
Newton and gradient methods. Applications.	2		
Newton and gradient methods. Applications.	2		
Nelder-Mead and Rosenbrock methods. Applications.	2		
Nelder-Mead and Rosenbrock methods. Applications.	2		
Simplex method. Applications.	2		
Simplex method. Applications.	2		

Active set method. Applications.	2		
Active set method. Applications.	2		
Genetic algorithms. Applications.	2		
Genetic algorithms. Applications.	2		

Bibliography:

1. Optimal, predictive, and adaptive control, Edoardo Mosca, Englewood Cliffs, New Jersey, 195
2. Modern control design: with MATLAB and SIMULINK, Ashish Tewari, Wiley, 2002
3. Tehnici de optimizare, vol. 2, T. Colosi, P.Bikfalvi, D.Isoc, Cluj-Napoca : Institutul Politehnic Cluj-Napoca, 1989
4. Optimal control with engineering applications, Geering, H, Springer, 2007
5. Optimization, P. Raica, UTPress, 2010

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10. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The alignment of the course content with the expectations of the epistemic community, professional associations, and representative employers in the field associated with the study program is achieved by orienting the course toward modern optimization methods used both in academic research and in current industrial applications.
The methods studied within the course contribute to building a solid foundation in the field of optimization. Students acquire the ability to formulate optimization problems mathematically, analyze their properties, select appropriate solution methods, and interpret the results obtained.
Through the project component, students become familiar with current research results and emerging directions in the field, while also having the opportunity to engage in research activities related to optimization.
The knowledge and competencies acquired can be applied both in the academic environment, through research activities in optimization, and in the industrial sector, in applications such as optimal design and the improvement of industrial process performance.

11. Evaluation

Activity type	11.1 Assessment criteria	1.2 Assessment methods	11.3 Weight in the final grade
11.4 Course	Level of understanding of the material	Exam	0.4
11.5 seminar/laboratory/project/ practical work	Implementation, analysis, report, discussion	Partial exam	0.6
11.6 Minimum performance standard: Attendance of at least 7 lectures, all lab exercises completed, and final grade >=5			

Date of filling in:		Title Firstname NAME	Signature
10.07.2026	Course	Prof.dr.ing. Zsofia Lendek	
	Aplications	Prof.dr.ing. Zsofia Lendek	

Date of approval by the Department Board	Head of Departament Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty Council	Dean Prof.dr.ing. Vlad MUREȘAN