SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Automation
1.4 Field of study	System's Engineering
1.5 Cycle of study	Master
1.6 Program of study / Qualification	Cyber Physical Systems
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Evolutive Systems***			Subject code	**2.00**
2.2 Course responsible / lecturer	Prof.phd.eng. Honoriu VĂLEAN – Honoriu.Valean@aut.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Lect.phd.eng. Claudiu DOMUȚA – Claudiu.Domuta@aut.utcluj.ro				
2.4 Year of study	1	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary				DA
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)				DI

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	2	Seminars		Laboratory	1	Project	
3.2 Number of hours per semester	42	of which:	Course	28	Seminars		Laboratory	14	Project	
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										28
(b) Supplementary study in the library, online and in the field										10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										17
(d) Tutoring										
(e) Exams and tests										3
(f) Other activities:										28

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	58
3.5 Total hours per semester (3.2+3.4)	100
3.6 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	N/A
4.2 Competence	N/A

5. Requirements (where appropriate)

5.1. For the course	N/A
5.2. For the applications	Mandatory attendance

6. Specific competence

6.1 Professional competences	• Interacts professionally in research and professional environments • Communicates scientific findings • Disseminates results to the scientific community • Demonstrates disciplinary expertise • Conduct scientific research • Manage research data • Manage personal professional development • Thinks abstractly • Operates scientific and laboratory research equipment • Publishes academic research papers • Performs data analysis • Writes scientific and academic papers and technical documentation • Synthesizes information • Uses software libraries
6.2 Cross competences	• Show initiative • Think analytically • Apply scientific, technological, and engineering knowledge • Work in teams

7. Expected Learning Outcomes

Knowledge	The student will know • advanced concepts, principles, and methodologies in systems engineering, automation, and cyber-physical systems • principles of design, operation, and evaluation for complex control systems, industrial networks, and related hardware and software components • modeling and simulation methods for control systems, including how to develop and analyze dynamic models of industrial and cyber-physical systems • advanced applications of AI, machine learning, and AR/VR technologies in industrial contexts, including their integration into control systems, automation, and human-machine interaction • interdisciplinary concepts from mathematics, signal processing, automation, control theory, and computer science applicable to the design and optimization of complex systems
Skills	The student will be able to • conduct scientific and interdisciplinary research, analyze data, and communicate results effectively to professional and academic audiences • design, develop, simulate, and implement hardware, software, and control applications for industrial and cyber-physical systems • analyze technical data, evaluate alternatives, and apply problem-solving strategies to complex engineering challenges • use modeling, simulation, AI, machine learning, and AR/VR tools to develop intelligent, autonomous, and automated solutions • integrate multidisciplinary knowledge to design, optimize, implement, and evaluate innovative solutions for complex control systems and industrial networks
Responsibilities and autonomy	• The student will be responsible for carrying out professional or research projects in compliance with quality, safety, and security standard • The student will be responsible for ensuring ethical conduct, academic integrity, and proper management of research and experimental data

8. Discipline objective (as results from the *key competences gained*)

8.1 General objective	The use of multidisciplinary knowledge in the field of systems engineering, computers and information technology in order to analyze, design, optimize, implement and test evolutionary mechanisms in the field of cyber-physical systems.
8.2 Specific objectives	To design and implement solutions based on evolutionary algorithms

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
What is an evlutionary algorithm, from simple to complex. Simulated Annealing	2 hours	Interactive presentation with examples on the projector. In case of force majeure, online on Teams	
Genetic Algorithms and Genetic Programming	2 hours		
Nature inspired algorithms with applications. Ant algorythm. Differential evolution	2 hours		
Artifficila bee colony algorythm. Firefly algorythm	2 hours		
Particle swarm algorythm. Cockoo search	2 hours		
Bat algorythm. Harmony search. Flower algorythm	2 hours		
Gray wolf optimisations.Gravitational search algorytrhm	2 hours		
Hybrid algoryrthms	2 hours		
Evolutionary algorithms in optimization problems	2 hours		
Multimodal optimization	2 hours		
Multiobjective optization	2 hours		
GA in NN and Fuzzy systems	2 hours		
GA in planning problems	2 hours		
GA in transport problems	2 hours		

Bibliography:

1. X. Yu, M. Gen. Introduction to evolutionary algorythms. Springer, e-ISBN 978-1-84996-129-5
2. S.V. Sivanandam, S.V. Deepa. Introduction to genetic algorythms. Springer, ISBN 978-3-540-73189-4
3. D.E. Goldberg. Genetic Algorythms in search, optimization and machine learning. Addison-Wesley, ISBN 0-201-15767-5
4. M.Gen, R. Cheng. Genetic algorythms and engineering optimization. John Wiley & Sons.
5. K. Miettinen , P. Neittaanmaki , M. M. Makela , J. Pkriaux . Evolutionary algorithms in engineering and computer science. John Wiley & Sons. ISBN 0-471-99902-4
6. R. Poli, W.B. Langdon, N.F. McPhee, J.R. Koza. A field guide to genetic programming. https://www.researchgate.net/publication/216301261
7. J. Koza. Genetic programming IV. Kluwer academic publishers, ISBN: 1-4020-7446-8

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
GA implementation in Python	2 hours	Practical applications on computer	
SI implementation in Python	2 hours		
AIS implementation in Python	2 hours		
GA in optimization problems	2 hours		
GA in transport problems	2 hours		
GA for controller synthesis	2 hours		
Laboratory assessment	2 hours		

Bibliography

8. X. Yu, M. Gen. Introduction to evolutionary algorythms. Springer, e-ISBN 978-1-84996-129-5
9. S.V. Sivanandam, S.V. Deepa. Introduction to genetic algorythms. Springer, ISBN 978-3-540-73189-4
10. D.E. Goldberg. Genetic Algorythms in search, optimization and machine learning. Addison-Wesley, ISBN 0-201-15767-5
11. M.Gen, R. Cheng. Genetic algorythms and engineering optimization. John Wiley & Sons.
12. K. Miettinen , P. Neittaanmaki , M. M. Makela , J. Pkriaux . Evolutionary algorithms in engineering and computer science. John Wiley & Sons. ISBN 0-471-99902-4
13. R. Poli, W.B. Langdon, N.F. McPhee, J.R. Koza. A field guide to genetic programming. https://www.researchgate.net/publication/216301261
14. J. Koza. Genetic programming IV. Kluwer academic publishers, ISBN: 1-4020-7446-8

**Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.*

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

The content of the discipline, along with the acquired skills and abilities, meet the expectations of professional organizations, companies, as well as national and international quality assurance bodies (ARACIS). It also ensures the adoption of ethical standards appropriate to engineering practice.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Assessment of knowledge using a test based on the knowledge acquired following participation in the course	Presentation of a physical or online project on Teams in case of force majeure	50%
Seminar			
Laboratory	Assessment of the practical skills and knowledge acquired during thw laboratory.	Practical or online Teams assessment (in case of force majeure).	50%
Project			
Exam grade >= 5 and lab assessment grade >= 5			

Date of filling in: 01.09.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Prof.phd.eng. Honoriu VĂLEAN	
	Applications	Lect.phd.eng. Claudiu DOMUȚA	

Date of approval in the department of Automation _____	Head of department, Prof.dr.eng. Honoriu VĂLEAN
Date of approval in the Faculty of Automation and Computer Science Council _____	Dean, Prof.dr.eng. Vlad MUREȘAN