SYLLABUS

1. Program Information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Department of Automation
1.4 Field of study	Automation, Applied Informatics and Intelligent Systems
1.5 Cycle of studies	Bachelor
1.6 Study Programme/Qualification	Intelligent Automation Systems (dual, in English language)
1.7 Form of education	IF – full-time education
1.8 Course code	27.00

2. Course information

2.1 Course title	**Introduction to Systems Theory and Control Systems**					
2.2 Course lecturer	*Conf.dr.ing. Alexandru Codrean –alexandru.codrean@aut.utcluj.ro*					
2.3 Seminar / Laboratory / Project Lecturer	*Conf.dr.ing. Alexandru Codrean –alexandru.codrean@aut.utcluj.ro*					
2.4 Year of study	2	2.5 Semester	4	2.6 Type of assessment		E
2.7 Course status	Formative category *(DF, DS, DC)*					DS
	Optionality *(DOB, DOP, DFac)*					DOB

3.Total estimated time

3.1 Number of hours per week	4	of which:	HEI	Lecture	2	Seminar	0	Laboratory	2	Project	0
			CO		0		0		0		0
3.2 Number of hours per semester	56	of which:	HEI	Lecture	28	Seminar	0	Laboratory	28	Project	0
			CO		0		0		0		0

3.3 Distribution of time allocation (hours per semester) for:	HEI	CO
(a) Study based on textbook, course support, bibliography, and notes	8	0
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	2	0
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	5	0
(d) Tutoring	1	0
(e) Examinations	3	0
(f) Other activities:	0	0
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	19	0
3.5 Total hours per semester (3.2+3.4)	75	0
3.6 Number of credits per semester	3	0

(HEI = Higher Education Institution, CO = Company)

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	• Process Modelling, Statistics and Numerical Calculus, • Linear Algebra, Mathematical Analysis, Special Mathematics • Electrotechnics, Chemistry, Physics
4.2 Competency Prerequisites	• Mathematical modelling, Differential and difference equations, Laplace, Z and Fourier Transforms, Linear Algebra, Numerical calculus

5. Conditions (where applicable)

5.1. Course Organization Conditions	-
5.2. Seminar / Laboratory / Project organization conditions	• Attendance at the laboratory is mandatory.

6. Specific Competencies Acquired

Professional Competencies	• PC02 Analyse test data • PC05 Conduct quality control analysis • PC08 Design automation components • PC12 Gather technical information • PC26 Use information technology tools • PC27 Execute analytical mathematical calculations • PC30 Design control systems • PC32 Perform data analysis
Transversal Competencies	• TC01 Apply knowledge of science, technology and engineering • TC02 Think analitically • TC05 Interpret mathematical information

7. Learning outcomes

Knowledge:	• The student can describe modelling approaches for different types of physical plants. • The student can identify and describe fundamental concepts from systems theory and control theory, related to analysis and design methods for feedback control systems. • The student can describe ways of implementing different control solutions in simulations and experiments, interpret and evaluate the performance of the results.
Skills:	• The student can apply different modelling approaches in describing the dynamics of physical plants, both in the time domain and frequency domain. • The student can perform systems analysis for feedback control systems, in terms of stability, steady state, reference tracking. • The student is able to design control systems, both in continous time and discrete time, and test them through implementations in simulations or experiments.
Responsibility and autonomy:	• The student can conduct projects of process automation: identify and argue for the best control solution, implement and test the solution, write documentation and provide instructions, and finally suggest possible improvements in the long term.

8. Course Objectives

8.1 General objective of the course	• The main goal of the discipline is to provide the understanding of the fundamental principles and methods from systems theory for modelling, analize and design of feedback control systems.
8.2 Specific objectives	Specific objectives refer to knowledge and abilities related to: • Mathematical modelling of physical systems (differential and difference equations, input-output models, state space models; • Analysis of linear systems (stability, steady state, control performances) in the time domain and the frequency domain • Design of output feedback controllers (PID) and state feedback controllers; • Discretization methods for plants and controllers, analysis (stability, steady state, control performances) in discrete time.

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
1. Introduction to systems theory and control principles. Modelling dynamics systems. Linearization.	2	Theoretical presentations, discussions and interpretations, proofs. Aplications and examples for each lecture.	
2. Continous time and discrete time signals. Representing signals in the s and z domains. Laplace and Z transforms.	2		
3. Input-output models. Transfer functions and transfer matrixes. Systems response.	2		
4. State space models. Conversions between input-output models and state space models.	2		
5. Types of connections between systems. Block diagrams. Operating regimes.	2		
6. Analysis of linear systems. First order and second order systems. Time delays. Steady state error.	2		
7. Stability of linear systems.	2		
8. Root locus method	2		
9. Frequency response. Bode diagrams.	2		
10. Frequency response. Bode diagrams.	2		
11. Output feedback. PID control	2		
12. Observability and controlability. State feedback and state estimation.	2		
13. System discretization. Stability of discrete systems.	2		
14. Discrete control systems	2		

Bibliography
1. G. F. Franklin, J. D. Powell, A. Emami-Naeini, Feedback Control of Dynamic Systems, Pearson, 2019.
2. R. Dorf, R. Bishop, Modern Control Systems, Pearson, 2021.
3. K. Ogata, Modern Control Engineering, Pearson, 2020.
4. T.-L. Dragomir, Elemente de teoria sistemelor, Vol. 1, Politehnica Timisoara, 2004.
5. W. S. Levine, The Control Handbook, Vol. 1, CRC Press, 2017.

9.2 Seminar / laboratory / project	Hours HEI	Hours CO	Teaching methods	Obs.
1. Introduction to Matlab and Simulink. Simulation examples. Linear approximation of dynamic systems.	4	0	Aplications and solved exercises, discussions and interpretation. Numerical calculus using Matlab/Simulink software, simulations and experiments.	
2. Input-output and state space models. Systems response and simulations for different types of physical systems (electrical, mechanical, hydraulic, chemical).	4	0		
3. Block diagrams and systems connections. Response of 1st order and 2nd order systems. Steady state error in control systems.	4	0		
4. Stability of linear systems. Root locus. Examples and applications.	4	0		
5. Construction and interpretation of Bode diagrams. Application to electric circuits and filters.	4	0		
6. Design of PID controllers. Application to DC motors.	4	0		
7. Design of discrete control systems. Application to DC motors.	4	0		

Bibliography
1. A. Codrean, P. Raica, Systems Theory Exercises Handbook, U.T. PRESS, 2024.
2. G. F. Franklin, J. D. Powell, A. Emami-Naeini, Feedback Control of Dynamic Systems, Pearson, 2019.
3. R. Dorf, R. Bishop, Modern Control Systems, Pearson, 2021.

4. K. Ogata, Modern Control Engineering, Pearson, 2020.
5. T.-L. Dragomir, Teoria sistemelor – Aplicatii 2, Politehnica Timisoara, 2007.

10. Correlation of course content with the expectations of the epistemic community representatives, professional associations, and major employers in the field related to the program

The course content combines theoretical concepts with applications, and it tends towards formulating and solving specific problems from a wide range of engineering branches (electrical, mechanical, chemical, biomedical, etc.). Most engineering fields benefit greatly from applying concepts, analysis and design methods, from Systems theory and Control theory. The course level is introductory, with the goal of motivating and training students for future studies in related and interconnected domains, but also for developing practical applications.

11. Evaluation

Activity Type	Evaluation criteria	Evaluation methods	Weight in final grade
11.1 Lecture	Ability of solving exercises related to the modeling and analysis of linear systems. Ability of solving exercises related to the design of control systems.	Partial exam -written Final exam - written	40% 60%
11.2 Seminar/ Laboratory/Project	Answering simple questions from the laboratory thematic	Lab tests (optional)	20%(optional)
11.3 Minimum Performance Standard			
40% Partial exam + 60% Final Exam + 20% Lab grade > 5			

Date of completion: 10.09.2025	Lecturers	Title First Name LAST NAME	Signature
	Course	Conf.dr.ing. Alexandru Codrean	
	Applications		
		Conf.dr.ing. Alexandru Codrean	

Date of approval by the Department of Automation Council 24.11.2025	Director of the Department of Automation Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty of Automation and Computer Science Council 28.11.2025	Dean Prof.dr.ing. Vlad MUREȘAN