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
1.8 Codul disciplinei	31.00

2. Data about the subject

2.1 Subject name		Syste	em T	heor	y II	
2.2 Course responsible/lec	turer		Assist. Prof. Mirela Dobra – mirela.trusca@aut.utcluj.ro			
2.3 Teachers in charge of a	applic	ations	s Assist. Prof. Mirela Dobra – <u>mirela.trusca@aut.utcluj.ro</u>			
2.4 Year of study	3	2.5 Semest	er	1	2.6 Assessment (E/C/V)	E
DF – fundo		– fundamental, DD – in the field, DS – specialty, DC – complementary				DD
2.7 Type of subject	DI – c	DI – compulsory, DO – elective, Dfac – optional			ve, Dfac – optional	DI

3. Estimated total time

3.1 Number of hours per week	5	of which:	Course	2	Seminar	1	Laboratory	2	Project	0
3.2 Number of hours per semester	70	of which:	course	28	Seminar	14	Laboratory	28	Project	0
3.3 Individual study										
(a) Manual, lecture material and notes, bibliography								25		
(b) Supplementary study in the library, online and in the field							10			
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays							12			
(d) Tutoring								28		
(e) Exams and tests							5			
(f) Other activities:						-				
3.4 Total hours of individual study (sum of (3.3(a)3.3(f))) 80										
3.5 Total hours per semester (3.2+3	3.4)				150					
3.6 Number of credit points					6					

4. Pre-requisites (where appropriate)

4.1 Curriculum	Mathematical analysis I (Differential calculus); Special mathematics (Complex analysis and transforms); Linear algebra and analytical geometry; System
	Theory I.
4.2 Competence	Physics, Electrotechnics, Analog and digital circuits; Process modelling.

5. Requirements (where appropriate)

5.1. For the course	N/A
5.2. For the applications	Applications are compulsory

6. Specific competences

6.1 Professional competences	C3.1 Identification of basic concepts of system theory, control engineering, of fundamental principles of modelling and simulation, as well as of process analysis methods in order to explain the basic problems of the field. C3.2 Explaining and interpreting some process automation problems through the application of automatic control fundamentals, of modelling, identification and simulation methods as well as of the computer aided design techniques. C3.3 Solving some types of control problems through: use of modelling
	methods and principles, development simulation scenarios, application of

	methods for the identification and analysis of processes (including technological processes) and systems
6.2 Cross competences	N/A

7. Course objectives

7.1 General objective	- Frequency response analysis;
	- Discrete time control structures modelling;
	- State space approach in LTI system control algorithms.
7.2 Specific objectives	- Analyze Bode and Nyquist diagrams
	- Simulate, test and validate the modes of continuous and discrete time LTI
	system
	- Analyze the frequency response of dynamic LTI systems using
	Matlab/Simulink
	- Test the behavior of dynamic LTI control systems using digital equipment

8. Contents

8.1 Lecture	No.hours	Teaching methods	Notes
Frequency Response			
Nyquist diagram, encirclements and number of closed loop	2		
poles, Nyquist contour, Nyquist stability criteria.			
Frequency Response:			
Bode response, Bode theorem, the relation between magnitude	2		
and phase, cross over frequency, bandwidth, and frequency	2		
domain characteristics of second order systems.			
Frequency Response: stability characteristics,			
poles and zeros on imaginary axis, controller design based on	2		
Nyquist diagram, relation between Bode and Nyquist plot.			
Stability analysis via Frequency response: Basic definitions,			
stability margins, gain and phase margin, bandwidth, cross over	2		
frequencies, relation between time and frequency response.			
Dead Time Systems; Nonminimum phase systems: Stability	2		
analysis via Frequency response	Z		
Sampled-data control systems: Sample and hold, sampling	2	Comprehensive	
modeling, data reconstruction, Shannon theorem, aliasing.	Z	slides	
Discrete time system representation: Z-transform, difference	2	Blackboard	
equation, state transition matrix, system characteristics.	Z	annotations	
Digital implementation of analog controllers: Forward		Oriented discussions	
difference, backward difference, bilinear Tustin, Tustin with pre-	2	on the subject	
warping.			
State Space Analysis			
Linear system theory: State transition matrix derivation	2		
methods: Dynamical modes, Cayley-Hamilton, Sylvester	2		
methods, similarity transformations.			
Canonical Forms:			
Controller Canonical Form, Observer Canonical Forma,	2		
Controllability Canonical Form, Observability Canonical Form			
Controllability and Observability: Observability, observability	2		
matrix, eigenvector test, controllability, duality	2		
State feedback: State feedback properties, tracking objective,	2		
pole placement methods.	۷		
State Observer: State observer general idea, full state observer,	2		
Luenberger Observer.	۷		
Multivariable Systems	2		
Bibliography			
1. R. C. Dorf, R. Bishop, "Modern Control Systems", Addison-Wesl	ey <i>,</i> 2004;		
2. K. Ogata, "Modern Control Engineering", Prentice Hall, 1990.			

2. K. Ogata, "Modern Control Engineering", Prentice Hall, 1990.

3. Discrete-time control systems (2nd edn) by Katsuhico Ogata, Prentice-Hall, Upper Saddle River, NJ, 1995, 745 pages.

4. Digital Control Systems by Benjamin Kuo, 1980

5. Benjamin Kuo, Matlab Tools for Control System Analysis and Design, 1995

6. SKOGESTAD Sigurd, POSTLETHWAITE Ian, Multivariable feedback control : analysis and design, 1997.

7. Golub, G. H., C.F. Van Loan, - Matrix computations, John Hopkins Univ. Press, Baltimore, 1984

8. M.Hanganut, "Teoria sistemelor", Vol 2., UTCN 1996

9. Ionescu, V. – Teoria Sistemelor , Editura Didactică și Pedagogică	, Bucureşti,	1985.	
8.2 laboratory	No.hours	Teaching methods	Notes
Plot and analyze Nyquist diagrams in Matlab	2		
Plot and analyze Bode diagrams in Matlab	2		
Plot and analyze Bode diagrams in Matlab for dead time and	2		
nonminimum phase systems	2		
Stability analysis via frequency response using Matlab	2		
Analog filters in Simscape /Simulink	2		
Matlab/Simulink representation of discrete-time systems	2	Caluing weakland	
Response of discrete time systems in Matlab	2	Solving problems	
Discrete time control systems: Root Locus analysis in Matlab	2		
Discrete time control systems for DC motors in Matlab	2		
DC motor: state space analysis in Matlab	2		
Canonical Forms in Simulink	2		
Controllability and Observability tests: script in Matlab	2		
DC motor: state space analysis			
State Observer for DC Motors	2		
8.2 seminar	No.hours	Teaching methods	Notes
Drawing and analyzing Nyquist diagrams.	2		
Drawing and analyzing Bode diagrams.	2		
Stability analysis using frequency response	2		
Discrete time control systems: Root Locus analysis	2	Solving problems	
Discrete time control systems for DC motors	2		
DC motor: state space analysis	2		
Ackerman algorithm for DC motor case	2		
Bibliography			
1. R. C. Dorf, R. Bishop, "Modern Control Systems", Addison-Wesh	ey, 2004;		
2. K. Ogata , "Modern Control Engineering", Prentice Hall, 1990.			

3. Benjamin Kuo, Matlab Tools for Control System Analysis and Design, 1995

4. SKOGESTAD Sigurd, POSTLETHWAITE Ian, Multivariable feedback control : analysis and design, 1997.

5. Golub, G. H., C.F. Van Loan, - Matrix computations, John Hopkins Univ. Press, Baltimore, 1984

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7. Ionescu, V. – Teoria Sistemelor, Editura Didactică și Pedagogică, București, 1985.

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

Practical applications by examples

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Solution correctness	Written examination; Face-to- face evaluation; on-line evaluation; Course assignments	80%
Seminar	N/A	N/A	0%
Laboratory	Solving problems using Matlab	Colloquium; Face-to-face evaluation; on-line evaluation;	20%

Project	N/A	N/A	0%
Minimum standard of performance: Final grade equal or above 5			

Date of filling in: _20.03.2023_		Title Firstname NAME	Signature
	Course	Assist. Prof Mirela Dobra	
	Aplications	Assist. Prof Mirela Dobra	

Date of approval by the Department Board Automation Department Head of Departament Prof.dr.ing. Honoriu VĂLEAN

Date of approval by the Faculty Council Computer Science and Automation Faculty Dean Prof.dr.ing. Liviu Cristian MICLEA