SYLLABUS

1. Data about the program of study

1.1	Institution	The Technical University of Cluj-Napoca
1.2	Faculty	Faculty of Electrical Engineering
1.3	Department	Electrical Machines and Drives
1.4	Field of study	Electrical Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/Qualification	Electrical System
1.7	Form of education	Full time
1.8	Subject code	29.00

2. Data about the subject

2.1	Subject name			Systems Theory and Automation			
2.2	Course responsible/lecturer			Prof. dr. eng. Calin Gh. RUSU *calin.rusu@emd.utcluj.ro*			
2.3	Teachers in charge of seminars			Sl.dr.eng. Szöke Enikö, *eniko.szoke@emd.utcluj.ro* *Sl.dr. eng SALCU Sorin Ionut, sorin.salcu@emd.utcluj.ro*			
2.4 Year of study	II	2.5 Semester	2	2.6 Assessment			exam
2.7 Subject category	Formative category						DD
	Optionality						DI

3. Estimated total time

3.1 Number of hours per week	5	of which	3.2 Course	2	3.3 Seminar	1	3.3 Laboratory	2	3.3 Project	-
3.4 Total hours in the curriculum	70	of which	3.5 Course	28	3.6 Seminar	14	3.6 Laboratory	28	3.6 Project	-

3.7 Individual study:	
(a) Manual, lecture material and notes, bibliography	21
(b) Supplementary study in the library, online and in the field	7
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	14
(d) Tutoring	6
(e) Exams and tests	6
(f) Other activities	1
3.8 Total hours of individual study (summ (3.7(a)...3.7(f)))	55
3.9 Total hours per semester (3.4+3.8)	125
3.10 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1	Curriculum	Electrical Circuit Theory, Electronics, Mechanics, Mathematical Analysis, Special Mathematics, Programming in C, C++ and Matlab
4.2	Competence	Real and complex variable functions, Laplace transform, Matrix operations, Kirchhoff's theorems, Operational amplifiers, C and C++ programming

5. Requirements (where appropriate)

5.1	For the course	Course classroom with blackboard and multimedia projector/On-line TEAMS, ZOOM, Skype
5.2	For the applications Seminar /Laboratory/Project	Lab Classroom with 10 desktop computer network, 10 labs breadboard kits, Matlab/Simulink academic licence/On-line TEAMS, Teaching by Doing (Do It Yourself – DIY)

6. Specific competences

Professional competences	C6.1. Fundamental principles for an automatic control system - open loop and closed loop systems C6.2. Modelling Systems. Transfer Functions (input-output - I/O). State-Equations model (input-state-output - I/S/O) C6.3. Time response and analysis in time domain for LTI-SISO systems, Steady State Errors, Stability C6.4. Frequency Response Technique and analysis for LTI-SISO systems in frequency domain, Bode Diagrams, Nyquist Stability C6.5. Root Locus Techniques, Design control system with Root Locus, Nichols-Zigler tunning method, PID controllers C6.6. Design compensators using Frequency response techniques for LTI-SISO systems
Cross competences	CT 1. Identification of the objectives to be achieved, of the available resources, the conditions for their completion, the working stages, the working times, the accomplishment terms and the related risks. CT 2. Identifying the roles and responsibilities in a multidisciplinary team and applying relationship techniques and efficient work within the team. CT 3. Efficient use of information sources and communication resources and assisted professional training (Internet portals, applications.

7. Discipline objectives (as results from the *key competences gained*)

7.1	General objective	➢ Understanding the concept of system and the concept of state of a system. ➢ Mathematical model as an abstract representation for a physical system. ➢ Analyze systems based on models by simulation. ➢ Understanding the closed loop systems as control system, PID controller and the automatic control system as the fundamental structure for automation.
7.2	Specific objectives	➢ Finding the mathematical model for a physical system as transfer function and / or state equations ➢ Stability analysis of a system (Routh-Hurwitz and Nyquist method) ➢ Finding and analyzing the response of a system in the time and frequency domain ➢ Using design methods for control systems using: Root Location and Bode Diagrams, Nyquist ➢ Designing control systems with P, PI, PD, PID control law and analyzing the performances of response

8. Contents

8.1. Lecture (syllabus)	Number of hours	Teaching methods	Notes
Course # 1: Introduction, concepts, definitions, signals, systems, regulation problem, non / feedback systems	2		

Course # 2: Modeling linear systems. Laplace transform. Properties. Linearization of nonlinear systems. Dynamics of electrical, mechanical and electro-mechanical systems.	2	PPT presentations, videoproiector, On-line Teams	
Course # 3: SISO systems, transfer functions, block diagrams. MIMO systems, variables and state equations, Conversion from Transfer Function to State Equations.	2		
Course # 4: Analysis of the system responses in time domain. Transient response and response parameters. Stabilized response. Static errors. Simulation and analysis of the output response.	2		
Course # 5: Stability analysis. Routh-Hurwitz stability criterion.	2		
Course # 6: Feedback control systems. Classic P, PI, PD, PID and relay type regulation laws.	2		
Course # 7: Root Locus Method.	2		
Course # 8: Design of automatic control systems by the method Root Locus Techniques. Nichols-Zigler PID tunning	2		
Course # 9: Analysis of systems response in frequency domain. Bode diagrams. Performance specification. Gain margin and Phase margin.	2		
Course # 10: Frequency Stability Analysis, Nyquist Criterion.	2		
Course # 11: Designing control systems based on frequency response (Bode Diagrams). Compensators with advance and phase delay.	2		
Course # 12: Modeling MIMO systems. Method of state variables. Equations of state.	2		
Course # 13: Analysis of control systems in the state space. Stability study.	2		
Course # 14: Designing control systems in the state space by the method of pole allocation.	2		

Bibliography

1. Călin RUSU, Teoria si Controlul Sistemelor, note de curs 2016.
2. Marius HANGANUT, Teoria Sistemelor Vol I si vol II Lito Universitatea Tehnica Cluj 1994
3. K. OGATA, Modern Control Engineering 4rd Ed, Prentice Hall, 1999.
4. B. C. KUO, Automatic Control Systems 7th ed, John Wiley, 1997
5. Richard C. DORF, Robert H. BISHOP, Modern Control Systems, 11TH Ed. Prentice hall, 2001, New Jersey
6. Călin RUSU , Programarea in Matlab a aplicatiilor cu Arduino, UTPress, 2019, ISBN 978-606-737-412-4, http://biblioteca.utcluj.ro/editura
7. Digital control system design, Călin RUSU, Casa cartii de stiinta, 2000, 973-686-092-2, Cluj Napoca
8. Ingineria robotilor: cinematica, dinamica si control, Călin RUSU, Mediamira, 2001, 973-9358-36-5, Cluj Napoca

8.2. Seminar /Laboratory/Project	Number of hours	Teaching methods	Notes
Laplace transform of usual signals. Matlab /Simulink	4	Practical laboratory works based on	
Modeling of SISO systems. Transfer functions. Block diagrams, linearization of nonlinear systems.	4		
Modeling MIMO systems, state variables, state equations.	4		

The transient regime response. The response of the stable regime.	4	modelling, simulations with Matlab/Simulink. Model Based Development Controller with Arduino MEGA/DUE	
Stability. Control systems. Classical regulation laws P, PI, PD, PID.	4		
The place of the roots in Matlab. Frequency response. Bode diagrams.	4		
Stability, Nyquist Criterion. Dynamic compensation. PID compensator, lead, lag.	4		

Bibliography

1. Calin G RUSU, SZŐKE Enikő, KREISZER RADIAN Melinda – Matlab in modelarea simularea si controlul sistemelor. Ghid practic pentru studenti, Editura UT PRESS 2008,
2. Călin RUSU, SZŐKE Enikő - Aplicatii Matlab in controlul sistemelor, Ed Mediamira, Cluj, 2006
3. Călin RUSU, SZŐKE Enikő - Matlab in controlul sistemelor. Ghid practic pentru studenti si ingineri, Ed Mediamira, 2005
4. Matlab 7.1 Student version release 14 with Service Pack3, Matworks , www.matworks.com
5. Simulink 6.3 Student version release 14 with Service Pack3, Matworks 2005, www.matworks.com
6. Calin G. RUSU. – Teoria Sistemelor, note de curs, http://bavaria.utcluj.ro/~rcalin

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7. Control Tutorials for Matlab (internet) www.engin.umich.edu/group/ctm/index.html
8. Internet, www.matworks.com,
9. Motoare de cautare Google, Yahoo - www.google.com, www.yahoo.com
10. SCILAB/XCOS v5.5.2

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

- understanding and systemic analysis of technical problems based on mathematical models, regardless of the field applications
- Analysis and design technical solutions based on a systemic vision

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	Knowledge and ability to use creatively the acquired knowledge		50%
10.5 Seminar/ Laboratory/Project	Homework / Laboratory Theme /Course project	verification	50%
10.6 Minimum standard of performance			

Date of filling in:	15.04.2021	Title Surname Name	Signature
15.04.2021	Lecturer	Prof. dr. eng. Calin Gh. Rusu	
	Teachers in charge of application	Sl.dr.eng. SZÖKE Enikö	
		Sl.dr.eng. Salcu Sorin Ionuţ	

Date of approval in the department ……..

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Head of department
Conf.dr.eng. Teodosescu Doru Petre

Date of approval in the faculty ……

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Dean
Conf.dr.eng. Cziker Andrei Cristinel