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 Subject code	34.00

2. Data about the subject

2.1 Subject name	***System identification***				
2.2 Course responsible/lecturer	Prof. dr. ing. Lucian Busoniu – Lucian.Busoniu@aut.utcluj.ro				
2.3 Teachers in charge of applications	Prof. dr. ing. Lucian Busoniu – Lucian.Busoniu@aut.utcluj.ro Assist. Dr. ing. Zoltan Nagy – Zoltan.Nagy@aut.utcluj.ro				
2.4 Year of study	3	2.5 Semester	1	2.6 Assessment *(E/C/V)*	E
2.7 Type of subject	*DF – fundamental, DID – in the field, DS – specialty, DC – complementary*				DD, DI
	DOB – compulsory, DOP – elective, FAC – optional				DOB

3. Estimated total time

3.1 Number of hours per week	5	of which:	Course	2	Seminar	0	Laboratory	2	Project	1
3.2 Number of hours per semester	70	of which:	course	28	Seminar	0	Laboratory	28	Project	14
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										10
(d) Tutoring										2
(e) Exams and tests										3
(f) Other activities:										10

3.4 Total hours of individual study (sum of (3.3(a)...3.3(f)))	55
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	Physics; electrotechnics; electronic circuits; mechanics; analysis; process modeling; system theory
4.2 Competence	Special mathematics; Linear algebra and analytical geometry; numerical calculus; Programming and experimental competencies, analytical spirit

5. Requirements (where appropriate)

5.1. For the course	Exposition, questions, discussions
5.2. For the applications	Solving the laboratory assignments is mandatory

6. Specific competences

6.1 Professional competences	C3. Fundamental usage of automation, modeling, simulation, identification and analysis of systems; of computer-assisted design techniques C3.1 Identification of fundamental concepts of systems theory, of control engineering, of basic principles of modeling and simulation, as well as system analysis techniques, with the goal of explaining the fundamental problems in the field.
6.2 Cross competences	

7. Course objectives

7.1 General objective	Form the student to choose and apply system identification methods in MATLAB, given an unknown system
7.2 Specific objectives	The student will have the following skills: - choose the experiment and input signal - choose model type and order - identify model parameters from experimental data - validate the model and select the best model among several alternatives

8. Contents

8.1 Lecture	No.hours	Teaching methods	Notes
1. Introduction to system identification	2	- Exposition using slides and whiteboard - Interactive questions and exercises - Discussions with students - Lecture quiz	
2. Transient analysis of step responses	2		
3. Transient analysis of impulse responses	2		
4. Mathematical background: Linear regression and statistics	2		
5. Correlation analysis	2		
6. Prediction error methods: ARX identification	2		
7. Input signals	2		
8. Prediction error methods: model structures and general implementation 1	2		
9. Prediction error methods: general implementation part 2; optimization	2		
10. Instrumental variable methods	2		
11. Closed-loop identification	2		
12. Recursive identification	2		
13. Model validation methods	2		
14. Practical considerations	2		
Bibliography 1.Ljung L. System Identification - Theory for the User. Prentice Hall, New York, 2006. 2.Söderström T., Stoica P. System Identification. Prentice Hall Inc., Hertfodshire, 1989. Disponibilă online: http://user.it.uu.se/~ts/bookinfo.html			

8.2 Aplications (seminar/laboratory/project)	No.hours	Teaching methods	Notes
1. (Re)Introduction to Matlab	2	- Lab quiz - Matlab implementation - Verification and discussions of solutions with students	
2. Transient analysis of step responses	2		
3. Transient analysis of impulse responses	2		
4. Linear regression for function approximation	2		
5. Correlation analysis	2		
6. ARX identification	2		
7. Pseudo-random binary sequences	2		
8. Lab test 1	2		
9. Identification of OE models with the Gauss-Newton method	2		
10. Instrumental variable methods	2		
11. Closed-loop identification	2		
12. Recursive identification	2		
13. Model validation methods	2		
14. Lab test 2	2		
Project: 14 hours of project, divided in 2 parts: multidimensional function approximation (7 hours); nonlinear ARX system identification (7 hours).	14		
Bibliography 1.Ljung L. System Identification - Theory for the User. Prentice Hall, New York, 2006. 2.Söderström T., Stoica P. System Identification. Prentice Hall Inc., Hertfodshire, 1989. Disponibilă online: http://user.it.uu.se/~ts/bookinfo.html			

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

The course offers methods for system identification of unknown linear systems. These methods are essential as a precondition to apply control engineering: the model is the first and essential step in analyzing the system, designing controllers and estimators, etc. These considerations apply equally to industry applications of control engineering, as well as research and development.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Correct solution of proposed problems	A combination of the following: written exam, online exam using Microsoft Teams, online quiz using Moodle or ClassMarker	30%
Seminar	N/A	N/A	N/A
Laboratory	Using Matlab for identification	Lab solutions submitted electronically, verified with Matlab Grader or by direct execution and discussion with the students; plagiarism-checked with MOSS; lab tests (30%) Lab quizzes via Moodle or ClassMarker (10%)	40%
Project	Practical experience	Project report submitted via Dropbox File Request; and project presentation, the latter done either live or online using Microsoft Teams. Project part 1 15%, part 2 15%	30%
Minimum standard of performance: labs and project solved correctly and originally, rounded combined grade at exam, lab tests, and project above 5			

Date of filling in:		**Title Firstname NAME**	**Signature**
1 July 2022	Course	Prof. dr. eng. Lucian Busoniu	
	Aplications	Prof. dr. eng. Lucian Busoniu	

Date of approval by the Department Board

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Head of Departament
Prof.dr.ing. Honoriu VĂLEAN

Date of approval by the Faculty Council

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Dean
Prof.dr.ing. Liviu Cristian MICLEA