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	Systems Engineering
1.5 Cycle of studies	Bachelor
1.6 Study Programme/Qualification	Automation and Applied Informatics (English)
1.7 Form of education	Full-time education
1.8	

2. Course information

2.1 Course title		**System Identification**		Course code		**34.00**
2.2 Course lecturer		Prof. dr. ing. Lucian Busoniu – Lucian.Busoniu@aut.utcluj.ro				
2.3 Seminar / Laboratory / Project Lecturer		Prof. dr. ing. Lucian Busoniu – Lucian.Busoniu@aut.utcluj.ro				
2.4 Year of study	3	2.5 Semester	I	2.6 Type of assessment		E
2.7 Course status	Formative category *(DF, DS, DC)*					DS
	Optionality *(DI, DO, DFac)*					DOB

3.Total estimated time

3.1 Number of hours per week	5	of which:	Lecture	2	Seminar	0	Laboratory	2	Project	1
3.2 Number of hours per semester	70	of which:	Lecture	28	Seminar	0	Laboratory	28	Project	14

3.3 Distribution of time allocation (hours per semester) for:	
(a) Study based on textbook, course support, bibliography, and notes	20
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	10
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	10
(d) Tutoring	2
(e) Examinations	3
(f) Other activities:	10
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	55
3.5 Total hours per semester (3.2+3.4)	125
3.6 Number of credits per semester	5

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	Physics; Mathematical analysis; Process modelling; System theory; Fundamentals of electronic circuits; Mechanics
4.2 Competency Prerequisites	Special mathematics; Linear algebra and analytical geometry; Numerical calculus; Analytic, programming, and experimental competencies

5. Conditions (where applicable)

5.1. Course Organization Conditions	Amphitheatre, Technical University of Cluj-Napoca
5.2. Seminar / Laboratory / Project organization conditions	Solving the laboratory assignments is mandatory

6. Specific Competencies Acquired

Professional Competencies	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.

Transversal Competencies	Experimental design and execution, data interpretation Technical project execution, reporting, and presentation

7. Learning outcomes

Knowledge:	The development of theoretical and experimental knowledge in the field of system modeling, simulation, identification, and analysis.
Skills:	- use the concept of dynamical model for control - 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
Responsibility and autonomy:	Technical project execution, reporting, and presentation

8. Course Objectives

8.1 General objective of the course	The student will be formed to choose and apply system identification methods in MATLAB, given an unknown system
8.2 Specific objectives	The student will have the following skills: - use the concept of dynamical model for control - 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

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
1. Foundations of system identification (dynamical models for control)	2 hours	- Exposition using the video-projector and the board - Interactive questions and exercises - Discussions with students - Optional lecture quizzes	
2. Identification of first and second order systems from the step response (zero and non-zero initial conditions)	2 hours		
2. Identification of first and second order systems from the impulse response (zero and non-zero initial conditions)	2 hours		
4. Mathematical foundations: Linear regression and statistics	2 hours		
5. Correlation analysis	2 hours		
6. Prediction error methods: ARX identification	2 hours		
7. Input signals and properties (step, impulse, PRBS, multisine; persistent excitation)	2 hours		
8. Prediction error methods: model structures and identification procedure	2 hours		
9. Prediction error methods: identification procedure; optimization	2 hours		
10. Instrumental variable methods	2 hours		
11. Closed-loop identification	2 hours		
12. Recursive identification	2 hours		
13. Model validation	2 hours		
14. Practical considerations and closing	2 hours		

Bibliography
1.Eykhoff P. System Identification: Parameter and State Estimation. John Wiley, London, 1974.
2.Goodwin G.C., Payne R.L. Dynamic System Identification: Experiment Design and Data Analysis. Academic Press,
3.New York, 1984.
4.Isermann R. Special Issue on System Identification. Automatica, 17(1), 1981.

5.Söderström T., Stoica P. System Identification. Prentice Hall Inc., Hertfodshire, 1989. Disponibilă online: http://user.it.uu.se/~ts/bookinfo.html
6.Ljung L. System Identification - Theory for the User. Prentice Hall, New York, 2006.
7.Landau I.D. Adaptive Control - The Model Reference Approach. Dekker, New York, 1979.
8.Ljung L., Söderström T. Theory and Practice of Recursive Identification. MIT Press, Cambridge, Massachusetts, 1983.
9.Landau I.D. Lecture Notes on Adaptive Control. University of California, Continuing Education in Engineering, Berkeley, California, 1983.
10.Goodwin G.C., Sin K.S. Adaptive Filtering Prediction and Control. Prentice Hall, New Jersey, 1984.
11.Landau I.D. A Feedback System Approach to Adaptive Filtering. IEEE Trans. on Information Theory, April, 1984.

9.2 Seminar / laboratory / project	Hours	Teaching methods	Obs.
Using MATLAB for identification experiments	2	Theoretical and experimental demonstration, conversation, observation, and analysis.	Where feasible, laboratory work is performed on a real DC motor system.
Identification of first and second order systems from the step response	2		
Identification of first and second order systems from the impulse response	2		
Linear regression	2		
Correlation analysis	2		
The ARX method	2		
Input generation and analysis: pseudo binary random signal	2		
Gauss-Newton method for parameter identification	2		
Identification of output-error models	2		
The instrumental variables method	2		
Closed-loop identification	2		
Recursive least squares and ARX	2		
Model validation	2		
Practical considerations	2		
Project: Linear regression with polynomial regressors. Nonlinear ARX with a polynomial representation.	14		

Bibliography

1.Söderström T., Stoica P. System Identification. Prentice Hall Inc., Hertfodshire, 1989. Available at: http://user.it.uu.se/~ts/bookinfo.html
2.Ljung L. System Identification - Theory for the User. Prentice Hall, New York, 2006.
3. H. Peng et al., RBF-ARX model-based nonlinear system modeling and predictive control with application to a NOx decomposition process, Control Engineering Practice 12, pages 191–203, 2007. Here the model is explained in Sections 2.1-2.2, and uses tunable radial basis functions instead of polynomials.
4. L. Ljung, System Identification, Wiley Encyclopedia of Electrical and Electronics Engineering, 2007. Available as technical report LiTH-ISY-R-2809. See Section 4 for nonlinear models.

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

Laboratory work focused in the fields of interest of companies active in the local/regional market, as well as internationally.
Identification methods are a prerequisite for the application of automation: system analysis, controller design, state feedback controllers, etc. These considerations apply to both industry and R&D.

11. Evaluation

Activity Type	Evaluation criteria	Evaluation methods	Weight in final grade
11.1 Lecture	Correct solution of proposed problems	A combination of the following: written exam, online exam, online quiz, lecture homework	30-60%

11.2 Seminar/ Laboratory/Project	Using Matlab/Scilab for identification. Practical experience	A combination of the following: lab activity, validated lab solutions; anti-plagiarism check; lab test; lab quizzes. Project report and/or presentation	40-70%
11.3 Minimum Performance Standard Minimum standard of performance: labs and project solved correctly and originally; rounded combined grade at exam, lab tests, and project at least 5		Project report and/or presentation	

Date of completion:	Lecturers	Title First Name LAST NAME	Signature
10.07.2026	Course	Prof. dr. eng. Lucian Busoniu	
	Applications	Prof. dr. eng. Lucian Busoniu	

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