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	34.00

2. Course information

2.1 Course title					**System Identification**	
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 *(DOB, DOP, DFac)*					DOB

3.Total estimated time

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

3.3 Distribution of time allocation (hours per semester) for:	HEI	CO
(a) Study based on textbook, course support, bibliography, and notes	17	
(b) Additional documentation in library, specialized electronic platforms, and fieldwork		
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	10	
(d) Tutoring		
(e) Examinations	3	
(f) Other activities:		
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	30	
3.5 Total hours per semester (3.2+3.4)	100	
3.6 Number of credits per semester	4	

(HEI = Higher Education Institution, CO = Company)

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	• PC02 Analyse test data • PC05 Conduct quality control analysis • PC08 Design automation components • PC12 Gather technical information • PC19 Prepare production prototypes • 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 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-	
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	projector and the board - Interactive questions and exercises - Discussions with students - Optional lecture quizzes	
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.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.

9.2 Seminar / laboratory / project	Hours HEI	Hours CO	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	Written exam, lecture quizzes.	30%
11.2 Seminar/ Laboratory/Project	Using Matlab for identification. Practical experience.	Validated lab solutions; anti-plagiarism check; lab test; lab quizzes; project report and/or presentation.	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			

Date of completion: 15.09.2025	Lecturers		Signature
	Course	Prof. dr. eng. Lucian Busoniu	
	Applications	Prof. dr. eng. Lucian Busoniu	

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