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	16.00

2. Course information

2.1 Course title				**Statistics and Numerical Calculus**		
2.2 Course lecturer				*Vlad Mihaly – vlad.mihaly@aut.utcluj.ro*		
2.3 Seminar/Laboratory Lecturer				*Vlad Mihaly – vlad.mihaly@aut.utcluj.ro*		
2.4 Year of study	2	2.5 Semester	1	2.6 Type of assessment		
2.7 Course status	Formative category *(DF, DS, DC)*					DF
	Optionality *(DOB, DOP, DFac)*					DOB

3.Total estimated time

3.1 Number of hours per week	4	of which:	HEI	Lecture	2	Seminar	1	Laboratory	1	Project	0
			CO		0		0		0		0
3.2 Number of hours per semester	56	of which:	HEI	Lecture	28	Seminar	14	Laboratory	14	Project	0
			CO		0		0		0		0

3.3 Distribution of time allocation (hours per semester) for:	HEI	CO
(a) Study based on textbook, course support, bibliography, and notes	28	0
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	10	0
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	28	0
(d) Tutoring	0	0
(e) Examinations	3	0
(f) Other activities:	0	0
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	69	0
3.5 Total hours per semester (3.2+3.4)	125	0
3.6 Number of credits per semester	5	0

(HEI = Higher Education Institution, CO = Company)

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	Linear Algebra, Calculus, Computer Programming
4.2 Competency Prerequisites	• Basic knowledge in linear algebra (matrix computations), calculus, and computer programming.

5. Conditions (where applicable)

5.1. Course Organization Conditions	• Blackboard, Video Projector
5.2. Seminar / Laboratory / Project organization conditions	• Blackboard, Video Projector

6. Specific Competencies Acquired

Professional Competencies	• PC02 Analyze test data • PC24 Think abstractly • PC27 Execute analytical mathematical calculations • PC32 Perform data analysis
Transversal Competencies	• TC02 Think analytically • TC05 Interpret mathematical information

7. Learning outcomes

Knowledge:	• Understand error sources in numerical computation and the impact on solution accuracy and stability; • Explain key numerical methods (root-finding, numerical integration, interpolation, differential equation solvers); • Describe basic statistical concepts (probability distributions, hypothesis testing, regression).
Skills:	• Apply appropriate numerical techniques to solve mathematical problems commonly arising in engineering design, simulation, and analysis; • Analyze, visualize, and interpret engineering data using statistical tools and methods; • Implement numerical and statistical algorithms using programming tools; • Design and conduct computational experiments, analyze results, and draw conclusions supported by quantitative reasoning.
Responsibility and autonomy:	• Critically evaluate the reliability and limitations of computational results and statistical conclusions; • Collaborate effectively in multidisciplinary teams on numerical/statistical analysis projects; • Practice academic integrity in data handling, algorithm development, and interpretation of results.

8. Course Objectives

8.1 General objective of the course	• The course aims to equip students with the fundamental knowledge and practical skills in numerical methods and applied statistics necessary for solving engineering problems, analyzing data, and supporting decision-making in multidisciplinary contexts. • The course emphasizes the integration of mathematical modeling, computational tools, and statistical reasoning to enhance students' ability to design, simulate, and interpret real-world systems with confidence, accuracy, and critical insight.
8.2 Specific objectives	Specific objectives of the course are: • to apply numerical algorithms for solving nonlinear equations; • to numerically integrate/differentiate functions; • to interpolate curves by given intermediate points;

	• to use statistical techniques to describe, analyze, and draw conclusions from data; • to implement numerical and statistical methods using appropriate software tools; • to interpret and validate computational and statistical results with attention to error, stability, and reliability.

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
C1. Introduction to Numerical Computing	2	Interactive lecturing, case-based teaching, conceptual walkthroughs.	
C2. Root-Finding Algorithms for Nonlinear Equations	2		
C3. Direct and Iterative Methods for Solving Linear Systems	2		
C4. Function Approximation and Interpolation Techniques	2		
C5. Numerical Differentiation and Error Analysis	2		
C6. Numerical Integration Methods	2		
C7. Solving Ordinary Differential Equations (ODEs) Numerically	2		
C8. Introduction to Probability Theory and Random Variables	2		
C9. Descriptive Statistics and Data Visualization in Engineering	2		
C10. Statistical Inference: Estimation and Hypothesis Testing	2		
C11. Linear Regression Models	2		
C12. Analysis of Variance and Design of Experiments	2		
C13. Statistical Process Control and Quality Engineering	2		
C14. Time Series Analysis and Forecasting	2		

Bibliography

[1]. R. Khoury, *Numerical Methods and Modelling for Engineering,* Springer International Publishing AG, 2018.
[2]. A.K. Jana, *Numerical Methods in Engineering - Theory and Process Applications*, Cambridge University Press, 2023.
[3]. N.J. Higham, *Accuracy and Stability of Numerical Algorithms*, SIAM, 2002.
[4]. J. Stoer, R. Bulirsch, R. Bartels, W. Gautschi, *Introduction to Numerical Analysis*, Springer-Verlag New York, 2010.
[5]. G.H. Golub, *Matrix Computations*, Johns Hopkins University Press, 2013.
[6]. C. Heumann, *Introduction to Statistics and Data Analysis*, Springer International Publishing, 2018.
[7]. J.L. Hodges, E.L. Lehmann, Basic Concepts of Probability and Statistics, SIAM, 2004.

9.2 Seminar / laboratory / project	Hours HEI	Hours CO	Teaching methods	Obs.
Introduction to MATLAB	2	0	Guided coding exercises, collaborative pair programming, mini-labs with real-world data	
Root-Finding Algorithms Implementations	2	0		
Methods for Solving Linear Systems	2	0		
Interpolation Methods	2	0		
Numerical Integrations and Differential Methods	6	0		
Introduction to Python	2	0		
Basic Statistic Concepts in Python	2	0		

Linear Regression Models	4	0		
Statistical Analysis in Python	4	0		
Time Series Analysis and Forecasting	2	0		

Bibliography

[1]. P. Bruce, A. Bruce, P. Gedeck, *Practical Statistics for Data Scientists*, O'Reilly, 2020.
[2]. C. Woodford, *Numerical Methods with Worked Examples: MATLAB Edition*. Springer Nature, 2011.

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

The course content reflects the expectations of the academic and professional community by equipping students with essential computational techniques and statistical tools widely used in engineering practice, scientific research, and data-driven decision-making, aligning with the standards demanded by industry and professional bodies.

11. Evaluation

Activity Type	**Evaluation criteria**	**Evaluation methods**	**Weight in final grade**
11.1 Lecture	Ability to solve problems and implement algorithms.	Final exam (written and coding)	50%
11.2 Seminar/ Laboratory/Project	Ability to implement algorithms.	Homeworks and lab exam	50%

11.3 Minimum Performance Standard

Students must demonstrate the ability to apply fundamental numerical and statistical methods to solve standard engineering problems, interpret results accurately, and justify their approaches with a minimum of 50% overall performance.

Date of completion:	Lecturers		Signature
15.05.2025	Course	PhD. Eng. Vlad Mihai MIHALY	
	Applications	PhD. Eng. Vlad Mihai MIHALY	

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