SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Automation
1.4 Field of study	System's Engineering
1.5 Cycle of study	Master
1.6 Program of study / Qualification	Cyber-Physical Systems
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Mathematical Foundation of Data Science***				Subject code	**1.00**
2.2 Course responsible / lecturer	Ioan Radu Peter ioan.radu.peter@math.utcluj.ro					
2.3 Teachers in charge of seminars / Laboratory / project	Ioan Radu Peter ioan.radu.peter@math.utcluj.ro					
2.4 Year of study	1	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V – verification)		E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary					DA
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)					DI

3. Estimated total time

3.1 Number of hours per week	3	of which:	Course	1	Seminars	0	Laboratory	2	Project	0
3.2 Number of hours per semester	42	of which:	Course	14	Seminars	0	Laboratory	28	Project	0
3.3 Individual study:										
(a) Manual, lecture material and notes, bibliography										14
(b) Supplementary study in the library, online and in the field										28
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays										13
(d) Tutoring										0
(e) Exams and tests										3
(f) Other activities:										0

3.4 Total hours of individual study (suma (3.3(a)…3.3(f)))	58
3.5 Total hours per semester (3.2+3.4)	100
3.6 Number of credit points	4

4. Pre-requisites (where appropriate)

4.1 Curriculum	-
4.2 Competence	Basic mathematical knowledge

5. Requirements (where appropriate)

5.1. For the course	-
5.2. For the applications	Presence at the laboratory is mandatory

6. Specific competence

6.1 Professional competences	• Analyzes test data • Manage research data • Thinks abstractly • Performs data analysis • Synthesizes information
6.2 Cross competences	• Show initiative • Think analytically • Work in teams

7. Expected Learning Outcomes

Knowledge	The student will know • advanced concepts, principles, and methodologies in systems engineering, automation, and cyber-physical systems • interdisciplinary concepts from mathematics, signal processing, automation, control theory, and computer science applicable to the design and optimization of complex systems
Skills	The student will be able to • analyze technical data, evaluate alternatives, and apply problem-solving strategies to complex engineering challenges • use modeling, simulation, AI, machine learning, and AR/VR tools to develop intelligent, autonomous, and automated solutions
Responsibilities and autonomy	The student will be responsible for • ensuring ethical conduct, academic integrity, and proper management of research and experimental data • promoting collaboration, teamwork, knowledge transfer, and innovation within professional and research environments

8. Discipline objective (as results from the *key competences gained*)

8.1 General objective	Modelling and simulation methods for control systems, including how to develop and analyse dynamic models of industrial and cyber-physical systems
8.2 Specific objectives	Understanding basic algorithms in data science, ML, problem-solving techniques.

9. Contents

9.1 Lectures	Hours	Teaching methods	Notes
Introduction.	1	Presentation from course notes and references, questions and answers, case studies.	
Data normalization. Meanings, uses.	1		
Generalized Inverse I.	1		
Generalized Inverses II. Applications.	1		
Factorization (QR, LD)	1		
Singular values, SVD decompositions.	1		
Applications in "large" systems.	1		
Values and own vectors. Gram matrices.	1		
Frome Jordan, diagonalizing.	1		
Rayleigh Gates. Machine Learning Applications.	1		
Methods of Oppression in ML and Meanings.	1		
Matrix optimizations and ML algorithms.	1		
Restricted optimizations. Karush Kuhn Tucker Method.	1		
Discussions. Approach to problems and algorithms.	1		

Bibliography:

- Matrix-Based Introduction to Multivariate Data Analysis 2nd ed. 2020 Edition by Adachi (Author)
- The Matrix Calculus You Need For Deep Learning, Terence Parr and Jeremy Howard
- Deep Learning, MIT Press, Ian Goodfellow and Yoshua Bengio and Aaron Courville

9.2 Applications - Seminars/Laboratory/Project	Hours	Teaching methods	Notes
Introduction.	2	Documentation reading, presentation and exemplification, individual exercises, problem solving within a team, project.	
Data normalization. Meanings, uses.	2		
Generalized Inverse I.	2		
Generalized Inverses II. Applications.	2		
Factorization (QR, LD)	2		
Singular values, SVD decompositions.	2		
Applications in "large" systems.	2		
Values and own vectors. Gram matrices.	2		
Frome Jordan, diagonalizing.	2		
Rayleigh Gates. Machine Learning Applications.	2		
Methods of Oppression in ML and Meanings.	2		
Matrix optimizations and ML algorithms.	2		
Restricted optimizations. Karush Kuhn Tucker Method.	2		
Discussions. Approach to problems and algorithms.	2		

Bibliography

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**Se vor preciza, după caz: tematica seminariilor, lucrările de laborator, tematica și etapele proiectului.*

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

The course will provide a mathematical foundation and a real understanding of the inner workings of machine learning algorithms and applications in data science. The material is continuously adapted to the requirements of potential employers and feedback from graduates already employed.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Exam	Exam	50%
Seminar			
Laboratory	Project	Project presentation	50%
Project			
Minimum standard of performance: Mark M>=5, M=0, 5*E+0,5*P, where E= exam (minimum result 50%), P=Project presentation (minimum result 50%)			

Date of filling in: 01.09.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Prof.dr.math. Ioan Radu Peter	
	Applications	Prof.dr.math. Ioan Radu Peter	

Date of approval in the department of Automation _____	Head of department, Prof.dr.eng. Honoriu VĂLEAN
Date of approval in the Faculty of Automation and Computer Science Council _____	Dean, Prof.dr.eng. Vlad MUREȘAN