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 Department
1.4	Field of study	Systems Engineering
1.5	Cycle of study	Research Master's
1.6	Program of study/Qualification	Cyber Physical Systems
1.7	Form of education	Full time
1.8	Subject code	1.00

2. Data about the subject

2.1	Subject name			Mathematical Foundation of Data Science			
2.2	Subject area			Mathematics, Applied			
2.2	Course responsible/lecturer			Prof. dr. Ioan Radu Peter, Ioan.Radu.Peter@math.utcluj.ro			
2.3	Teachers in charge of seminars			Prof. dr. Ioan Radu Peter, Ioan.Radu.Peter@math.utcluj.ro			
2.4 Year of study	1	2.5 Semester	1	2.6 Assessment			E
2.7 Subject category	Formative category						DA
	Optionality						DI

3. Estimated total time

3.1 Number of hours per week	3	of which	3.2 Course	1	3.3 Seminar	0	3.3 Laboratory work	2	3.3 Project	0
3.4 Total hours in the curriculum	42	of which	3.5 Course	14	3.6 Seminar	0	3.6 Laboratory work	28	3.6 Project	0

3.7 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

3.8 Total hours of individual study (summ (3.7(a)...3.7(f)))	58
3.9 Total hours per semester (3.4+3.8)	100
3.10 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	Laboratory attendance is mandatory

6. Specific competences

Professional competences	Analysis and solution of modeling and design problems in the case of cyber-physical systems using knowledge of advanced mathematics and fundamental concepts of automation
Cross competences	Identifying the needs and opportunities for continuous training, demonstrating critical and innovative thinking skills and effectively utilizing learning resources for personal development.

7. Discipline objectives (as results from the *key competences gained*)

7.1	General objective	The course will add mathematical foundation and really understanding of the inner workings of machine learning algorithms and applications in data science.
7.2	Specific objectives	Understanding mathematical tools used in data science.

8. Contents

8.1. Lecture (syllabus)	Number of hours	Teaching methods	Notes
Introduction.	2	Presentation and reading from course notes and references, questions and answers, case studies.	
Data normalization. Meanings, why and how?	2		
Generalized Inverse I.	2		
Generalized Inverse II. Applications.	2		
Factorizations (QR, LD)	2		
Singular value decomposition.	2		
Applications in lare systems.	2		
Eigenvectors, eigenvalues, Gramm matrices.	2		
Jordan forms, diagonalizations.	2		
Rayleigh quotients. Applications in Machine Learning.	2		
Optimization methods and ML.	2		
Matrix optimization and algorithms related to principal directions.	2		

Optimizations with constraints. Karush Kuhn Tucker type methods.	2		
Discussions. Thinking algorithms.	2		

Bibliography

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

8.2. Seminars /Laboratory/Project	Number of hours	Teaching methods	Notes
Introduction.	2	Documentation reading, presentation and exemplification, individual exercises, problem solving within a team, project.	
Data normalization. Meanings, why and how?	2		
Generalized Inverse I.	2		
Generalized Inverse II. Applications.	2		
Factorizations (QR, LD)	2		
Singular value decomposition.	2		
Applications in lare systems.	2		
Eigenvectors, eigenvalues, Gramm matrices.	2		
Jordan forms, diagonalizations.	2		
Rayleigh quotients. Applications in Machine Learning.	2		
Optimization methods and ML.	2		
Matrix optimization and algorithms related to principal directions.	2		
Optimizations with constraints. Karush Kuhn Tucker type methods.	2		
Discussions. Thinking algorithms.	2		

Bibliography

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3. Deep Learning, MIT Press, Ian Goodfellow and Yoshua Bengio and Aaron Courville

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

The course will add mathematical foundation and really 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 to the feedback of already employed graduates.

10. Evaluation

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade
10.4 Course	Exam	Exam	50%
10.5 Seminars /Laboratory/Project	Project	Project presentation	50%
10.6 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:		**Title Surname Name**	**Signature**
16.03.2023	Lecturer	Prof. Dr. Ioan Radu Peter	
	Teachers in charge of application	Prof. Dr. Ioan Radu Peter	

Date of approval in the Department of Automation

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Head of department
Prof.dr.ing. Honoriu Valean

Date of approval in the Faculty of Automation and Computer Science

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Dean
Prof.dr.ing. Liviu Miclea