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	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Master of Science
1.6 Program of study / Qualification	Data Science
1.7 Form of education	Full time
1.8 Subject code	5.00

2. Data about the subject

2.1 Subject name				**Mathematical Models for Machine Learning**	
2.2 Subject area				Mathematics	
2.2 Course responsible / lecturer				Prof. dr. Peter Ioan-Radu - Ioan.Radu.Peter@math.utcluj.ro	
2.3 Teachers in charge of seminars				Prof. dr. Peter Ioan-Radu - Ioan.Radu.Peter@math.utcluj.ro	
2.4 Year of study	I	2.5 Semester	1	2.6 Assessment	E
2.7 Subject category	Formative category: DA – advanced, DS – speciality, DC – complementary				DS
	Optionality: DI – imposed, DO – optional (alternative), DF – optional (free choice)				DFac

3. Estimated total time

3.1 Number of hours per week	2	of which:	Course	1	Seminar	1	Laborator	-	Proiect	-
3.4 Total hours in the curriculum	24	of which:	Course	14	Seminar	14	Laborator	-	Proiect	-

3.7 Individual study:	
(a) Manual, lecture material and notes, bibliography	25
(b) Supplementary study in the library, online and in the field	25
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	20
(d) Tutoring	
(e) Exams and tests	2
(f) Other activities	

3.8 Total hours of individual study (summ (3.7(a)...3.7(f)))	72
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	Master of PhD student
4.2 Competence	

5. Requirements (where appropriate)

5.1 For the course	Computer, projector
5.2 For the applications	70% presence for entrance to the fnal exam

6. Specific competences

6.1 Professional competences	Understanding mathematical models in machine learning, deep learning.

6.2 Cross competences	The ability to apply mathematics for understanding major algorithms, the ability to choose algorithms in problems.

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

7.1 General objective	Understanding mathematical models in machine learning, deep learning.
7.2 Specific objectives	The ability to apply mathematics for understanding major algorithms, the ability to choose algorithms in problems.

8. Contents

8.1 Lectures	Hours	Teaching methods	Notes
Introduction.	2		
Norms. Vector normalizations, meaning.	2		
Generalized Inverse I	2		
Generalized Inverse II	2		
Factorizations (QR, LD etc)	2		
Singular Value Decomposition.	2		
Sparse systems.	2		
Eigenvalues, eigenvectors. Gram Matrices.	2		
Rayleigh quotients. Applications in Machine Learning.	2		
Optimization methods related to Machine Learning.	2		
Classical algorithms using matrix optimization. Principal directions, PCA.	2		
Constrained optimization. Karush-Kuhn-Tucker methods.	2		
Final discussion. Approach methods.	2		
Bibliography: Papers related to topics, which have online access. Papers in journals, tutorials, Lecture notes.			
8.2 Applications - Seminars / Laboratory / Project	Hours	Teaching methods	Notes
Vector normalization. Generalized inverse I.	2		
Generalized inverse II, factorizations.	2		
Eigenvectors, eigenvalues.	2		
Rayleigh quotients. Applications in Machine Learning.	4		
Constrained optimization. Karush-Kuhn-Tucker methods.	2		
Final discussion. Approach methods.	2		
Bibliography: Papers in journals, tutorials, Lecture notes.			

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

Understanding mathematical models in Machine Learning, Deep learning is a cornerstone for efficient design of algorithms.

10. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Understanding the teorethical notions, their relations with algorithms.	Written exam.	75%

Seminars	Understanding “hidden” mathematical models in different algorithms.	Seminar grade.	25%
Minimum standard of performance: Ability to model/present topics and working with them.			

Date of filling in: 26.02.2025	**Responsible**	**Title First name Last name**	**Signature**
	Course	Prof. dr. Ioan-Radu PETER	
	Applications	Prof. dr. Ioan-Radu PETER	

Date of approval in the department 17.09.2025	Head of department Prof.dr.eng. Rodica Potolea
Date of approval in the Faculty Council 19.09.2025	Dean Prof.dr.eng. Vlad Mureșan