COURSE SYLLABUS

1. Program information

Faculty	Faculty of Electrical Engineering and Computer Science
Department	Computer Science
Field of study	Computers and Information Technology
Cycle of studies	Master's Degree
Study Program	Artificial Intelligence & Social Robotics Applied to Global Health

2. Course information

Course name		**MATHEMATICS FOR ARTIFICIAL INTELLIGENCE**				
Year of study	1	Semester	1	Type of assessment	Exam	
Course regime		Course category by educational content: DF – Fundamental, DS – Specialization, DC – Complementary				DS
		Course category by optionality: DOB – Compulsory, DOP – Optional, DFA – Elective				DOB

3. Total estimated time (hours allocated to teaching activities)

I a) Number of hours per week	2	Lecture	1	Seminar	-	Laboratory / practical work	1	Project	-
I b) Total number of hours per semester according to curriculum	28	Lecture	14	Seminar	-	Laboratory / practical work	14	Project	-

Distribution of time allocation per semester (hours)	No. hours
II. Individual study	94
III. Examinations	3
IV. Other activities (specify):	-

Total individual study hours (II+III)	97
Total hours per semester (I.b+II+III+IV)	125
Number of credits	5

4. Specific competencies acquired

Transversal competencies	-
Professional / general competencies	CP4 – develop data processing applications CP5 – apply statistical analysis techniques CP6 – analyze big data

5. Learning outcomes

Knowledge	**Skills**	**Responsibility and autonomy**
The student/graduate identifies, critically evaluates, and applies specialized concepts and methods from the field of artificial intelligence and advanced data analytics as a foundation for original thinking and/or research.	The student/graduate integrates specialized knowledge of mathematics (matrix, differential, and multivariable calculus) and statistics (hypothesis testing and inferential statistical techniques) with artificial intelligence concepts to effectively address research problems.	The student/graduate autonomously manages design and development activities by applying artificial intelligence techniques and assumes responsibility for the validity of the mathematical, statistical, and scientific foundations.

6. **Course objectives** (derived from the grid of specific competencies acquired)

General objective of the course	Development of advanced competencies in the use of mathematical concepts for artificial intelligence, including the identification and formulation of machine learning problems, inferential statistics techniques, vector and matrix operations, multivariate calculus and partial derivatives, evaluation of algorithmic complexity.

7. Teaching and learning content

Lectures	No. of hours	Teaching methods	Remarks / Notes
1. Introduction 1.1. Presentation of mathematical concepts for Artificial Intelligence. 1.2. Data, Models and Learning.	1	Lecture, discussion, exemplification, demonstration	
2. Linear Algebra 2.1. Matrices. 2.2. Linear Equations. 2.3. Vector spaces. 2.4. Linear Independence. 2.5. Eigenvalues and Eigenvectors 2.6. Examples of AI Algorithms and Data Processing Techniques	2		
3. Tensors 3.1 Basic operations with tensors 3.2 Examples of Tensors Decomposition Techniques	1		
4. Logic and Set Theory 4.1 Propositional Logic 4.2 Set Theory 4.3. Examples of AI Algorithms	1		
5. Sequences and Series 5.1 Sequences 5.2 Series 5.3 Examples of AI Algorithms	1		
6. Analytic Geometry 6.1. Norms. 6.2. Inner Products and Outer Products. 6.3. Lengths and Distances. 6.4. Orthonormal Basis. 6.5. Orthogonal Complements and Orthogonal Projections. 6.6. Examples of AI Algorithms	2		
7. Differential Calculus 7.1. Derivatives. 7.2. Jacobian Matrices. 7.3. Second-Order and Higher-Order Derivatives. 7.4. Examples of AI Algorithms	2		
8. Probability and Distributions 8.1. Probability Space. 8.2. Continuous and Discrete Probabilities. 8.3. Probability Distributions. 8.4. Statistics. 8.5. Examples of AI Algorithms	2		
9. Machine Learning Foundations 9.1. Parameter Estimation. 9.2. Probabilistic Modeling and Inference. 9.3. Model Selection and Evaluation.	2		

Recommended minimum bibliography

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong. (2020). *Mathematics for Machine Learning.* Cambridge University Press. https://mml-book.github.io/book/mml-book.pdf
2. Jean Gallier, Jocelyn Quaintance. (2025). *Algebra, Topology, Differential Calculus, and Optimization Theory for Computer Science and Machine Learning*. Jean Gallier, USA. https://www.cis.upenn.edu/~jean/math-deep.pdf
3. Christophe Giraud. (2023). *Mathematics for Artificial Intelligence*. Universite Paris Saclay. https://www.imo.universite-paris-saclay.fr/~christophe.giraud/Orsay/MIA.pdf
4. Saman Siadati. (2021). *Mathematical and Statistical Foundations of AI*. https://doi.org/10.5281/zenodo.15713364
5. Laura-Bianca Bilius, Ştefan-Gheorghe Pentiuc, Radu-Daniel Vatavu. (2023). TIGER: A Tucker-based

instrument for gesture recognition with inertial sensors. *Pattern Recognition Letters 165, C* (Jan 2023), 84–90. https://doi.org/10.1016/j.patrec.2022.11.028

Applications (Laboratory)	**No. of hours**	**Teaching methods**	**Remarks / Notes**
The practical activities consist of implementing computational methods and mathematical models in Python.			
1. Python Computing for AI (numpy, scipy, sympy, matplotlib, pandas, scikit-learn, keras, tensorflow).	2	Practical work, experiment, discussion, case study	
2. Matrix operations and applications in data representation and processing using Python. Applications to AI algorithms on real-world datasets.	2		
3. Sets and set operations, propositional logic, sequences, series. Applications to AI algorithms on real-world datasets.	2		
4. Analytic geometry and similarity metrics for data analysis in AI using Python. Applications to AI algorithms on real-world datasets.	2		
5. Differential and multivariate calculus for data representation using Python. Applications to AI algorithms on real-world datasets.	2		
6. Probability theory, inferential statistics, and parameter estimation for data analysis and probabilistic modeling using Python. Applications to AI algorithms on real-world datasets.	2		
7. Project presentation and evaluation.	2	Demonstration	
Attendance at compulsory activities is regulated by USV's "Framework Regulation on Student Assessment". Make-up for mandatory practical activities scheduled during the semester is carried out in accordance with the provisions of this regulation. Practical activities scheduled throughout the semester may be replaced by the completion and presentation of high-complexity projects from the course syllabus, with the approval of the course instructor.			
Recommended minimum bibliography			
1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong. (2020). *Mathematics for Machine Learning.* Cambridge University Press. https://mml-book.github.io/book/mml-book.pdf 2. Jean Gallier, Jocelyn Quaintance. (2025). *Algebra, Topology, Differential Calculus, and Optimization Theory for Computer Science and Machine Learning*. Jean Gallier, USA. https://www.cis.upenn.edu/~jean/math-deep.pdf 3. Christophe Giraud. (2023). *Mathematics for Artificial Intelligence*. Universite Paris Saclay. https://www.imo.universite-paris-saclay.fr/~christophe.giraud/Orsay/MIA.pdf 4. Saman Siadati. (2021). *Mathematical and Statistical Foundations of AI*. https://doi.org/10.5281/zenodo.15713364 5. Laura-Bianca Bilius, Ştefan-Gheorghe Pentiuc, Radu-Daniel Vatavu. (2023). TIGER: A Tucker-based instrument for gesture recognition with inertial sensors. *Pattern Recognition Letters 165, C* (Jan 2023), 84–90. https://doi.org/10.1016/j.patrec.2022.11.028			

8. Evaluation

Type of activity	**Evaluation criteria**	**Evaluation methods**	**Weight in final grade**
Final evaluation	Critical understanding and appropriate application of mathematical and statistical concepts and methods relevant to AI, with justified interpretation of results.	Written test, followed by oral verification of the extent to which the requirements in the written work are met.	50%
Evaluation of ongoing practical activities	Design, implementation and evaluation of computational solutions in Python, with appropriate methodological choices and autonomous validation of results.	Project evaluation and systematic observation.	50%

Physical accessibility: activities are conducted in classrooms and laboratories accessible to wheelchair users via ramps/lifts (USV buildings C/D); **Accessibility of teaching materials:** documents are available in digital PDF format with selectable text and slides with large fonts; **Evaluation accessibility:** ongoing evaluation through projects; possibility of extended time for the written tests and oral verification.

Date	Academic title, Name, Surname, Signature of Course Instructor	Academic title, Name, Surname, Signature of Practical Work Instructor
23.09.2026	Ș.l. dr. inf. Laura-Bianca BILIUS	Ș.l. dr. inf. Laura-Bianca BILIUS

Date of approval	Academic title, Name, Surname, Signature of Program Coordinator
24.09.2026	Prof. univ. dr. ing. Radu-Daniel VATAVU

Date of departmental approval	Academic title, Name, Surname, Signature of Head of Department
24.09.2026	Prof. univ. dr. ing. Ovidiu-Andrei SCHIPOR

Date of Faculty Council Approval	Academic title, Name, Surname, Signature of Dean
25.09.2026	Prof. univ. dr. ing. Laurentiu-Dan MILICI