SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş-Bolyai University**
1.2 Faculty	**Faculty of Mathematics and Computer Science**
1.3 Department	**Department of Computer Science**
1.4 Field of study	**Computer Science**
1.5 Study cycle	**Bachelor**
1.6 Study programme / Qualification	**Artificial Intelligence**

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)			Mathematical Optimization (Optimizare matematică)				
2.2 Course coordinator			Lect.. Anca Grad, Ph. D.				
2.3 Seminar coordinator			Lect. Anca Grad, Ph. D.				
2.4. Year of study	4	2.5 Semester	8	2.6. Type of evaluation	E	2.7 Type of discipline	**Compulsory DS**
2.8 Code of the discipline		MLE0005					

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	2 S
3.4 Total hours in the curriculum	36	Of which: 3.5 course	24	3.6 seminar/laboratory	12
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					30
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					9
Evaluations					10
Other activities:					

3.7 Total individual study hours	89
3.8 Total hours per semester	125
3.9 Number of ECTS credits	5

4. Prerequisites (if necessary)

4.1. curriculum	• Algebra 1 (Linear Algebra) • Mathematical Analysis 2 (Differential Calculus on R^n)
4.2. competencies	• Ability to use basic theoretical notions and practical methods of linear algebra and mathematical analysis.

5. Conditions (if necessary)

5.1. for the course	• Beamer projector and internet connection
5.2. for the seminar /lab activities	• Standard infrastructure

6. Specific competencies acquired

Professional competencies	C3.1 Identifying classes of problems and solving methods that are specific to computing systems C3.2 Using interdisciplinary knowledge, solution patterns and tools, making experiments and interpreting their results C3.4 Comparatively and experimentaly evaluation of the alternative solutions for performance optimization
Transversal competencies	CT1 Honorable, responsible, ethical behavior, in the spirit of the law, to ensure the professional reputation CT3 Demonstrating initiative and pro-active behavior for updating professional, economical and organizational culture knowledge

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	Study the mathematical foundations of several important optimization techniques, which are currently used in Operational Research.
7.2 Specific objective of the discipline	Students should acquire knowledge about: • Convex analysis; • Linear optimization; • Matrix game theory; • Convex optimization.

8. Content

8.1 Course	Teaching methods	Remarks
1. Optimization problems in general setting; classical models	Direct instruction, mathematical proof, exemplification	
2. Level sets; existence and unicity of optimal solutions	Direct instruction, mathematical proof, exemplification	
3. Convex sets; extreme points	Direct instruction, mathematical proof, exemplification	
4. Convex functions and some properties of their extrema	Direct instruction, mathematical proof, exemplification	
5. Linear optimization problems; duality theorems	Direct instruction,	

	mathematical proof, exemplification	
6. Primal feasible bases, dual feasible bases, and optimal bases	Direct instruction, mathematical proof, exemplification	
7. The Simplex Algorithm in primal form	Direct instruction, mathematical proof, exemplification	
8. The Simplex Algorithm in dual form	Direct instruction, mathematical proof, exemplification	
9. Dual problems and extended problems - involving additional constraints	Direct instruction, mathematical proof, exemplification	
10. Matrix games	Direct instruction, mathematical proof, exemplification	
11. The relationship between the matrix games and the linear optimization problems	Direct instruction, mathematical proof, exemplification	
12. Convex optimization problems	Direct instruction, mathematical proof, exemplification	

Bibliography

1. BOYD, S., VANDENBERGHE, L., Convex Optimization, Cambridge University Press, 2004.
2. BRECKNER, B.E., POPOVICI, N., Convexity and Optimization. An Introduction, EFES, Cluj-Napoca, 2006.
3. BRECKNER, W.W., Cercetare operaţională, Universitatea Babeş-Bolyai, Cluj-Napoca, 1981.
4. POPOVICI, N., Optimizare vectorială, Casa Cărţii de Ştiinţă, Cluj-Napoca, 2005.
5. MORDUKHOVICH, B.S., NAM, N.M., An easy path to convex analysis and applications, Morgan & Claypool Publishers, Milton Keynes, 2014.
6. VANDERBEI, R., Linear Programming. Foundations and Extensions, Springer, Boston, 2008.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Special classes of convex sets	Problem-based instruction, debate, mathematical proofs	4 hours
2. Convex functions; generalized convexity	Problem-based instruction, debate, mathematical proofs	4 hours
3. Optimization problems solved by the Simplex Algorithm in primal form	Problem-based instruction, debate, mathematical proofs	4 hours
4. Optimization problems solved by the Simplex Algorithm in dual form	Problem-based instruction, debate, mathematical proofs	4 hours
5. Matrix games	Problem-based instruction, debate, mathematical proofs	4 hours
6. Unconstrained convex optimization problems	Problem-based instruction, debate, mathematical proofs	4 hours

Bibliography
1. BRECKNER, B.E., POPOVICI, N., Probleme de analiză convexă în R^n. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2003.
2. BRECKNER, B.E., POPOVICI, N., Probleme de cercetare operaţională, EFES, Cluj-Napoca, 2006.
3. BRECKNER, W.W., DUCA, D., Culegere de probleme de cercetare operaţională, Universitatea Babeş-Bolyai, Facultatea de Matematică, Cluj-Napoca, 1983.
4. DUREA, M., O introducere în teoria optimizării neliniare, Tehnopress, Iaşi, 2012.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- Knowledge of theoretical concepts and capacity to rigorously prove the main theorems;
- - Ability to solve practical exercises and theoretical problems

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	- Knowledge of theoretical concepts and capacity to rigorously prove the main theorems; - Ability to solve practical exercises and theoretical problems	Written exam	60%
10.5 Seminar/lab activities	Attendance and active class participation	Continuous evaluation	40%
10.6 Minimum performance standards			
The final grade should be greater than or equal to 5			

Date 20.04.2023

Signature of course coordinator
Lect. Anca Grad, Ph.D.

Signature of seminar coordinator
Lect. Anca Grad, Ph.D.

Date of approval
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Signature of the head of department
Prof. Andrei Mărcuș, Ph. D.