SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş-Bolyai University, Cluj-Napoca**
1.2 Faculty	**Faculty of Mathematics and Computer Sciences**
1.3 Department	**Department of Mathematics**
1.4 Field of study	**Mathematics**
1.5 Study cycle	**Licence**
1.6 Study programme / Qualification	**Mathematics and Computer Science**

2. Information regarding the discipline

2.1 Name of the discipline	Optimization Techniques						
2.2 Course coordinator	Lect. dr. GRAD ANCA						
2.3 Seminar coordinator	Lect. dr. GRAD ANCA						
2.4. Year of study	3	2.5 Semester	6	2.6. Type of evaluation	Written exam	2.7 Type of discipline	compulsory
2.8 Discipline code	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	1
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					21
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					10
Tutorship					10
Evaluations					13
Other activities:					

3.7 Total individual study hours	64
3.8 Total hours per semester	100
3.9 Number of ECTS credits	4

4. Prerequisites (if necessary)

4.1. curriculum	• Linear algebra • Calculus 1 and 3
4.2. competencies	• Mathematical thinking, logical thinking

5. Conditions (if necessary)

5.1. for the course	• Lecture hall with large board and beamer
5.2. for the seminar /lab activities	• Seminar hall with large board

6. Specific competencies acquired

Professional competencies	C4.1. Defining basic concepts, theory and mathematical models C4.2 Interpretation of mathematical models C4.3 Identifying the appropriate models and methods for solving real-life problems C4.5 Embedding formal models in applications from various areas
Transversal competencies	CT1 Application of efficient and rigorous working rules, manifest responsible attitudes towards the scientific and didactic field, respecting the professional and ethical principles. CT3 Use of efficient methods and techniques for learning, information, research and development of abilities for knowledge acquiring, for adapting to the needs of dynamic society and for communication in Romanian as well as in a widely used foreign language.

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

7.1 General objective of the discipline	➢ Acquiring knowledge about classical optimization notions and solving algorithms
7.2 Specific objective of the discipline	➢ Presentation of the basic notions and concepts of convex analysis ➢ Linear optimization ➢ Duality ➢ Newton Method, Gradient Descent

8. Content

8.1 Course	Teaching methods	Remarks
1. General statement of an optimization problem. The objective function, constraint set and optimality notions.	Lecture, discussion, didactic proofs	
2. Convex sets and extreme points	Lecture, discussion, didactic proofs	
3. Convex functions. Local and global extreme points	Lecture, discussion, didactic proofs	
4. Level sets. Optimality conditions for convex optimization problems.	Lecture, discussion, didactic proofs	
5. Linear optimization problems.	Lecture, discussion, didactic proofs	
6. Duality for linear optimization problems.	Lecture, discussion, didactic proofs	

7. The primal simplex algorithm	Lecture, discussion, didactic proofs	
8. The dual simplex algorithm	Lecture, discussion, didactic proofs	
9. Nonlinear optimization	Lecture, discussion, didactic proofs	
10. The Newton algorithm	Lecture, discussion, didactic proofs, numerical simulations	
11. Gradient Descent	Lecture, discussion, didactic proofs, numerical simulations	
12. Dual Gradient	Lecture, discussion, didactic proofs, numerical simulations	

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, Bost

8.2 Seminar / laboratory	**Teaching methods**	**Remarks**
1. Special classes of convex sets.	Discussions, problematisation, self-tanking, team-work	
2. Convex functions.	Discussions, problematisation, self-tanking, team-work	
3. Linear optimization problems. The graphical approach	Discussions, problematisation, self-thinking, team-work	
4. Primal and dual simplex algorithm	Discussions, problematisation, self-thinking, team-work	
5. Nonlinear optimization algorithms	Discussions, problematisation, self-thinking, team-work	
6. Nonlinear optimization algorithms	Discussions, problematisation, self-thinking, team-work	

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

The content of this course can be encountered in the syllabus of every respected university in land or abroad. It represents a basic part not only for mathematics teachers but also for researchers..

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	knowledge of the basic notions and results	Final written exam	60%

	knowledge of the proofs for the main theoretical results		
10.5 Seminar/lab activities	Homework including problems based on the theory presented at the lecture. Application of the theoretical results to practical problems	Continuous during the lecture or the seminar	40%
10.6 Minimum performance standards			
➢ The definitions, the statement of the theoretical results and straight-forward applications ➢ Idenfitication and proper selection of the solving methods for various practical problems			

Date	Signature of course coordinator	Signature of seminar coordinator
30.04.2024	Lect. dr. GRAD ANCA	Lect. dr. GRAD ANCA

Date of approval ..... Signature of the head of department

Prof. dr. ANDREI MĂRCUȘ