SYLLABUS

1. Information regarding the programme

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

2. Information regarding the discipline

2.1 Name of the discipline			Optimization Techniques				
2.2 Course coordinator			Prof. Nicolae Popovici, Ph.D. Habil.				
2.3 Seminar coordinator			Prof. Nicolae Popovici, Ph.D. Habil.				
2.4. Year of study	3	2.5 Semester	6	2.6. Type of evaluation	Exam	2.7 Type of discipline	Compulsory

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

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar	1
3.4 Total hours in the curriculum	36	Of which: 3.5 course	24	3.6 seminar	12
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					24
Additional documentation (in libraries, on electronic platforms, field documentation)					6
Preparation for seminars/labs, homework, papers, portfolios and essays					12
Tutorship					12
Evaluations					10
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	• 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
5.2. for the seminar /lab activities	• Standard infrastructure

6. Specific competencies acquired

Professional competencies	**C1.4** Identify the appropriate mathematical models and methods for solving real-life problems. **C3.1** Identify the fundamental notions and results needed to develop numerical algorithms.
Transversal competencies	**CT1** Work effectively and rigorously; adopt a responsible attitude towards science and learning; use the own creative potential; obey the rules and principles of professional ethic.

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 vectoriala, Casa Cartii de Stiinta, 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	Teaching methods	Remarks
1-2. Special classes of convex sets.	Problem-based instruction, debate, mathematical proofs	
3-4. Convex functions; Generalized convexity.	Problem-based instruction, debate, mathematical proofs	
5-6. Optimization problems solved by the Simplex Algorithm in primal form.	Problem-based instruction, debate, mathematical proofs	
7-8. Optimization problems solved by the Simplex Algorithm in dual form.	Problem-based instruction, debate, mathematical proofs	
9-10. Matrix games.	Problem-based instruction, debate, mathematical proofs	
11-12. Convex optimization problems.	Problem-based instruction, debate, mathematical proofs	

Bibliography

1. BRECKNER, B.E., POPOVICI, N., Probleme de analiza convexa in R^n. Casa Cartii de Stiinta, Cluj-Napoca, 2003.
2. BRECKNER, B.E., POPOVICI, N., Probleme de cercetare operationala, EFES, Cluj-Napoca, 2006.
3. BRECKNER, W.W., DUCA, D., Culegere de probleme de cercetare operationala, Universitatea Babes-Bolyai, Facultatea de Matematica, Cluj-Napoca, 1983.
4. DUREA, M., O introducere in teoria optimizarii neliniare, Tehnopress, Iasi, 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

- The course ensures a solid theoretical background, according to national and international standards, within bachelor programmes, on optimization theory, operations research, management, etc.
- The optimization techniques are currently applied in industry, medicine, insurance, etc.

10. Evaluare

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	75%
10.5 Seminar/lab activities	Attendance and active class participation	Continuous evaluation	25%
10.6 Minimum performance standards			
The final grade should be greater than or equal to 5.			

Date	Signature of course coordinator	Signature of seminar coordinator
29.04.2022	Prof. Nicolae Popovici, Ph.D. Habil.	Prof. Nicolae Popovici, Ph.D. Habil.

Date of approval	Signature of the head of department
29.04.2022	Prof. Octavian Agratini, Ph.D.