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 Mathematics
1.4 Field of study	Computer Science
1.5 Study cycle	Master
1.6 Study programme / Qualification	Distributed Systems in Internet

2. Information regarding the discipline

2.1 Name of the discipline			Optimization models				
2.2 Course coordinator			Prof. Nicolae Popovici, PhD. habil.				
2.3 Seminar coordinator			Prof. Nicolae Popovici, PhD. habil.				
2.4. Year of study	1	2.5 Semester	1	2.6. Type of evaluation	Exam	2.7 Type of discipline	Optional

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	42	Of which: 3.5 course	28	3.6 seminar	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					42
Additional documentation (in libraries, on electronic platforms, field documentation)					7
Preparation for seminars/labs, homework, papers, portfolios and essays					28
Tutorship					7
Evaluations					24
Other activities:					-

3.7 Total individual study hours	108
3.8 Total hours per semester	150
3.9 Number of ECTS credits	6

4. Prerequisites (if necessary)

4.1. curriculum	• Linear algebra; • Mathematical analysis.
4.2. competencies	Basic notions of linear algebra and differential calculus in the n-dimensional Euclidean space.

5. Conditions (if necessary)

5.1. for the course	Lecture room equipped with a beamer
5.2. for the seminar /lab activities	Internet connection

6. Specific competencies acquired

Professional competencies	• To understand, in-depth, some concepts and results of optimization theory. • Ability to use mathematical methods and implementable algorithms for solving practical optimization problems.
Transversal competencies	To apply rigorous and efficient work rules, by adopting a responsible attitude towards the scientific and didactic activities. To develop the own creative potential in specific areas, following the professional ethical norms and principles.

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

7.1 General objective of the discipline	The aim of this course is to present several classes of practical optimization models along with numerical solution algorithms.
7.2 Specific objective of the discipline	Students should acquire knowledge about: • Scalar optimization; • Vector (multicriteria) optimization; • Dynamic optimization.

8. Content

8.1 Course	Teaching methods	Remarks
1. Linear optimization models; Duality theorems	Direct instruction, mathematical proof, exemplification	
2. The Simplex algorithm in primal form	Direct instruction, mathematical proof, exemplification	
3. The Simplex algorithm in dual form	Direct instruction, mathematical proof, exemplification	
4. Extended linear optimization problems	Direct instruction, mathematical proof, exemplification	
5. Integer optimization problems	Direct instruction, mathematical proof, exemplification	
6. Matrix games	Direct instruction, mathematical proof, exemplification	
7. Matrix games via linear optimization problems	Direct instruction, mathematical proof, exemplification	
8. Convex optimization models	Direct instruction, mathematical proof, exemplification	
9. The cutting-hyperplanes method	Direct instruction, mathematical proof, exemplification	
10. The best approximation problem	Direct instruction, mathematical proof, exemplification	

11. Multicriteria optimization models	Direct instruction, mathematical proof, exemplification	
12. Multicriteria location problems	Direct instruction, mathematical proof, exemplification	
13. Dynamic optimization models	Direct instruction, mathematical proof, exemplification	
14. Network traffic flow optimization models	Direct instruction, mathematical proof, exemplification	

Bibliography
1. BOYD, S., VANDENBERGHE, L.: Convex Optimization, Cambridge University Press, 2004.
2. BRECKNER, W.W.: Cercetare operaţională, Universitatea "Babeş-Bolyai", Facultatea de Matematică, Cluj-Napoca, 1981.
3. EHRGOT, M.: Multicriteria Optimization. Springer, Berlin Heidelberg New York, 2005.
4. LOWNDES, V., BERRY, S., PARKES, C., BAGDASAR, O., POPOVICI, N.: Further Use of Heuristic Methods, Chapter 7 in: Berry, S., Lowndes, V., Trovati, M. (Eds.), Guide to Computational Modelling for Decision Processes: Theory, Algorithms, Techniques and Applications, Springer, 2017.
5. POPOVICI, N.: Optimizare vectorială, Casa Carţii de Ştiinţă, Cluj-Napoca, 2005.
6. VANDERBEI, R.: Linear Programming. Foundations and Extensions, Springer, Boston, 2008.

8.2 Seminar	Teaching methods	Remarks
1. Linear optimization problems solved by means of the Simplex algorithm in primal form.	Problem-based instruction, debate, mathematical proofs	2 hours
2. Linear optimization problems solved by means of the Simplex algorithm in dual form.	Problem-based instruction, debate, mathematical proofs	2 hours
3. Integer optimization problems solved by the Gomory's method.	Problem-based instruction, debate, mathematical proofs	2 hours
4. Matrix games solved via linear optimization.	Problem-based instruction, debate, mathematical proofs	2 hours
5. Convex optimization problems solved by the cutting-hyperplanes method	Problem-based instruction, debate, mathematical proofs	2 hours
6. Multicriteria linear optimization problems solved by scalarization methods	Problem-based instruction, debate, mathematical proofs	2 hours
7. Network-type dynamic optimization problems	Problem-based instruction, debate, mathematical proofs	2 hours

Bibliography
1. BRECKNER, B.E., POPOVICI, N.: Probleme de cercetare operaţională, EFES, Cluj-Napoca, 2006.
2. BRECKNER, W.W., DUCA, D.: Culegere de probleme de cercetare operationala, Universitatea Babes-Bolyai, Facultatea de Matematica, Cluj-Napoca, 1983.
3. MORDUKHOVICH, B.S., NAM, N.M., An easy path to convex analysis and applications, Morgan & Claypool Publishers, Milton Keynes, 2014.

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

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	70%
10.5 Seminar/lab activities	- Attendance and active class participation	Continuous evaluation	30%
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
29.04.2020	Prof. Nicolae Popovici, Ph.D. Habil.	Prof. Nicolae Popovici, PhD. Habil.

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