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	Component-based programming

2. Information regarding the discipline

2.1 Name of the discipline			Mathematical foundations of decision-making process				
2.2 Course coordinator			Assoc. Prof. Nicolae Popovici, Ph.D.				
2.3 Seminar coordinator			Assoc. Prof. Nicolae Popovici, Ph.D.				
2.4. Year of study	1	2.5 Semester	1	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	42	Of which: 3.5 course	28	3.6 seminar	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					63
Additional documentation (in libraries, on electronic platforms, field documentation)					7
Preparation for seminars/labs, homework, papers, portfolios and essays					21
Tutorship					7
Evaluations					35
Other activities:					-

3.7 Total individual study hours	133
3.8 Total hours per semester	175
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1. curriculum	• Algebra • Geometry • Mathematical Analysis
4.2. competencies	Basic notions of linear algebra, analytical geometry and differential calculus in the n-dimensional Euclidean space

5. Conditions (if necessary)

5.1. for the course	•
5.2. for the seminar /lab activities	•

6. Specific competencies acquired

Professional competencies	• Ability to understand and manipulate advanced concepts and results in the field of optimization theory. • Ability to use mathematical methods and implementable algorithms for solving optimization problems.
Transversal competencies	• Ability to model and analyze from a mathematical point of view practical decision-making processes from other sciences, economics and engineering.

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

7.1 General objective of the discipline	The study of fundamental mathematical concepts and practical methods relevant to the study of decision-making processes as optimization problems.
7.2 Specific objective of the discipline	Students should acquire knowledge about: • Partially ordered spaces; • Preference relations induced by utility functions; optimality concepts; decisional processes as scalar or vector optimization problems; • Elements of convex analysis; • Linear optimization; the Simplex algorithm in primal and dual form; • Matrix games and their solution by means of linear programming; • The cutting planes algorithm for nonlinear constrained optimization.

8. Content

8.1 Course	Teaching methods	Remarks
1. Preference relations induced by utility functions; decisional processes modeled as scalar or vector (multicriteria) optimization problems	Direct instruction, mathematical proof, exemplification	
2. Optimality concepts: ideal efficiency, Pareto efficiency, weak efficiency, proper efficiency.	Direct instruction, mathematical proof, exemplification	
3. Level sets and their role in the study of optimal solutions; the existence and the unicity of optimal solutions	Direct instruction, mathematical proof, exemplification	
4. Convex sets and cones; the characterization of convex cones and their relationship with linear order relations	Direct instruction, mathematical proof, exemplification	
5. Convex functions; characterizations; local versus global minimal points; properties of the level sets	Direct instruction, mathematical proof, exemplification	
6. Mathematical foundations of linear programming; duality theorems.	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. Methods for solving the dual problem via the primal problem	Direct instruction, mathematical proof, exemplification	
10. Solution of some extended optimization problems obtained by adding a new constraint	Direct instruction, mathematical proof, exemplification	
11. Mathematical foundations of game theory. Two-player zero-sum matrix games.	Direct instruction, mathematical proof, exemplification	
12. Characterizations of optimal strategies. Geometrical solution of certain matrix games.	Direct instruction, mathematical proof, exemplification	
13. Numerical solution of matrix games by means of linear optimization problems	Direct instruction, mathematical proof, exemplification	
14. Optimization problems involving a linear objective function and nonlinear constraints; the cutting hyperplanes algorithm	Direct instruction, mathematical proof, exemplification	

Bibliography

1. ANDERSON, D.R., SWEENEY, D.J., WILLIAMS, T.A., An Introduction to Management Science. Quantitative Approaches to Decision Making, South-Western College Publishing, Cincinnati, 2000.
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. EHRGOT, M.: Multicriteria Optimization, Springer, Berlin Heidelberg New York, 2005.
5. POPOVICI, N.: Optimizare vectoriala, Casa Cartii de Stiinta, Cluj-Napoca, 2005.
6. YU, P.L.: Multiple Criteria Decision Making: Concepts, Techniques and Extensions, Plenum Press, New York - London, 1985.

8.2 Seminar	Teaching methods	Remarks
1. Mathematical modeling of some practical decision problems	Problem-based instruction, debate, exemplification, mathematical proofs	
2. Exercises involving binary relations and related topics	Problem-based instruction, debate, mathematical proofs	
3. The geometric description of the level sets of some important classes of functions; applications to the solution of some particular scalar and bicriteria optimization problems	Problem-based instruction, debate, mathematical proofs	
4. Exercises involving convex sets and cones	Problem-based instruction, debate, mathematical proofs	
5. The study of the convexity and other regularity properties of certain real-valued functions	Direct instruction, exemplification, mathematical proofs	
6. The best approximation (metric projection) problem and the Fermat-Weber location problem	Direct instruction, exemplification, mathematical proofs	
7. Applications of the Simplex algorithm in primal form	Problem-based instruction, debate, mathematical proofs	
8. Exercises involving parameters in the Simplex	Problem-based	

algorithm in primal form	instruction	
9. Applications of the Simplex algorithm in dual form	Problem-based instruction	
10. Exercises involving parameters in the Simplex algorithm in dual form	Problem-based instruction, debate	
11. Mathematical modeling of various decisional problems as matrix games	Problem-based instruction, debate, mathematical proofs	
12. Geometrical solution of certain matrix games	Problem-based instruction, debate, mathematical proofs	
13. Solution of different matrix games by means of linear programming	Problem-based instruction	
14. Applications of the cutting hyperplane algorithm	Problem-based instruction, debate, mathematical proofs	

Bibliography

1. BRECKNER, B.E., POPOVICI, N.: Probleme de cercetare operationala, 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.

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 grade [as weighted average (70 * Written exam +30 * Continuous evaluation)/100] should be greater than or equal to 5.			

Date	Signature of course coordinator	Signature of seminar coordinator
May 3, 2015	Assoc. Prof. Nicolae Popovici, Ph.D.	Assoc. Prof. Nicolae Popovici, Ph.D.

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