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	High Performance Computing and Big Data Analytics

2. Information regarding the discipline

2.1 Name of the discipline	Optimization models						
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	2	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					56
Additional documentation (in libraries, on electronic platforms, field documentation)					7
Preparation for seminars/labs, homework, papers, portfolios and essays					28
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	• Mathematical foundations of decision-making process • Mathematical Analysis • Dynamical Systems
4.2. competencies	Basic knowledge of linear optimization, convex analysis, differential calculus, and dynamical systems

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 optimization 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 aim of this course is to present classical as well as modern optimization models, from both theoretical and practical points of view
7.2 Specific objective of the discipline	Students should acquire knowledge about: • Integer programming • Multicriteria optimization • Transportation problems. • Nonlinear optimization models; numerical methods for solving unconstrained or constrained optimization problems (gradient methods, penalty and barrier functions methods). • Dynamic programming models; applications to economics and network-type problems. • Optimization models via calculus of variations.

8. Content

8.1 Course	Teaching methods	Remarks
1. Classical models of optimization	Direct instruction, mathematical proof, exemplification	
2. Special instances of linear optimization; integer programming; the Gomory algorithm	Direct instruction, mathematical proof, exemplification	
3. Multicriteria linear optimization; the weighted-sum scalarization method	Direct instruction, mathematical proof, exemplification	
4. Bicriteria linear optimization; the parametric scalarization method	Direct instruction, mathematical proof, exemplification	
5. Transportation problems; statement of the problem and existence of solutions	Direct instruction, mathematical proof, exemplification	
6. Graphs associated to a transportation problem	Direct instruction, mathematical proof, exemplification	
7. Numerical solution of transportation problems	Direct instruction, mathematical proof, exemplification	

8. Nonlinear optimization problems; optimality conditions	Direct instruction, mathematical proof, exemplification	
9. Gradient methods for solving unconstrained optimization problems	Direct instruction, mathematical proof, exemplification	
10. The penalty function method for solving constrained optimization problems	Direct instruction, mathematical proof, exemplification	
11. The barrier function method for solving constrained optimization problems	Direct instruction, mathematical proof, exemplification	
12. Dynamic optimization models; the Bellman's principle of dynamic optimization and applications to economics and network-type problems.	Direct instruction, mathematical proof, exemplification	
13. Optimization models via calculus of variations: preliminary results concerning integrals depending on parameters;the fundamental Lemma in variational calculus	Direct instruction, mathematical proof, exemplification	
14. The fundamental problem of the calculus of variations; the Euler equation and some of its special cases; applications.	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. CHIANG, A.C.: Elements of Dynamic Optimization. McGraw-Hill, New York, 1992.
4. EHRGOT, M.: Multicriteria Optimization. Springer, Berlin Heidelberg New York, 2005.
5. MARUŞCIAC, I.: Programare matematică, Universitatea Babeş-Bolyai, Cluj-Napoca, 1975.
6. POPOVICI, N.: Optimizare vectorială, Casa Carţii de Ştiinţă, Cluj-Napoca, 2005.
7. VANDERBEI, R.: Linear Programming. Foundations and Extensions, Springer, New York, 2008.

8.2 Seminar	Teaching methods	Remarks
1. Mathematical modeling of different real-life optimization problems	Direct instruction, case studies, debate	
2. Integer optimization problems solved by the Gomory algorithm	Problem-based instruction, debate	
3. Multicriteria optimization problems solved by the weighted-sum scalarization method	Problem-based instruction, debate	
4. Bicriteria linear optimization problems solved by the parametric scalarization method	Problem-based instruction, debate	
5. Theoretical exercises concerning transportation problems	Direct instruction, exemplification, mathematical proofs	
6. Numerical solution of transportation problems	Problem-based instruction, debate, mathematical proofs	
7. Different practical problems which can be modelled as transportation problems	Problem-based instruction, case studies, debate	
8. Nonlinear optimization problems solved by using the optimality conditions	Problem-based instruction, debate	
9. Nonlinear optimization problems solved by the gradient method	Problem-based instruction, debate	
10. Constrained optimization problems solved by	Problem-based	

the penalty function method	instruction, debate	
11. Constrained optimization problems solved by the barrier function method	Problem-based instruction, debate	
12. Economic problems solved by dynamic optimization, based on Bellman's principle in continuous case	Problem-based instruction, debate	
13. Economic problems solved by dynamic optimization, based on Bellman's principle in discrete case	Problem-based instruction, debate	
14. Network-type problems solved by dynamic optimization	Problem-based instruction, debate	

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.: Probleme de cercetare operaţională, 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.

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
April 30, 2014	Assoc. Prof. Nicolae Popovici, Ph.D.	Assoc. Prof. Nicolae Popovici, Ph.D.

Date of approval

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Signature of the head of department

Prof. Octavian Agratini, Ph.D.