COURSE DESCRIPTION

1. Program Information

1.1 University	**“Alexandru Ioan Cuza” University of Iaşi**
1.2 Faculty	**Faculty of Computer Science**
1.3 Department	**Department of Computer Science**
1.4 Study Domain	**Computer Science**
1.5 Study Cycle	**Master studies**
1.6 Study Program / Qualification	**Computer Science/Master Graduate în Artifial Intelligence and Optimization, Distributed Systems, Advanced Studies in Computer Science.**

2. Course Information

2.1 Course Name		**Operations Research**					
2.2 Course Teacher		**Lect. Dr. Olariu Emanuel Florentin**					
2.3 Seminary Teacher		**Lect. Dr. Olariu Emanuel Florentin**					
2.4 Year of study	2	**2.5** Semester	2	**2.6** Evaluation	M	**2.**7 Course status*	OB

** OB – Compulsory / OP – Optional*

3. Total estimated hours (hours per semester and didactic activities)

3.1 Hours per week	**4**	in which: **3.2** course	**2**	**3.3** seminary	**2**
3.4 Hours in *curriculum*	**56**	in which: **3.5** course	**28**	**3.6** seminary	**28**

Time Distribution	hours
Manual study, Course support, Bibliography, and others	**20**
Supplementary Documentation in library, in electronic forums, and on the field	**20**
Seminaries/laboratories preparation, homeworks, reports, portfolios and essays	**40**
Tutoring	
Evaluation	**4**
Other activities (consultations per student)	

3.7 Total hours individual study	**80**
3.8 Total hours per semester	**140**
3.9 Credits	**5**

4. Preconditions (if necessary)

4.1 Of Curriculum	**Linear Algebra, Mathematical Analysis**
4.2 Of Skills	**--**

5. Conditions (if necessary)

5.1 For Course Operation	--
5.2 For Seminary Operation	

6. Specific Skills Acquired

Professional Skills	Upon successful completion of this discipline, students will be able to: **C1.** Present the specific concepts of Operations Research (OR).

	C2. Learn how to model real life problems. **C3.** Describe and use the algoritms mainly in Linear Programming (LP) – Primal/Dual Simplex and Interior point methods. **C4.** Model and solve Integer linear Programming (ILP) problems. **C5.** Describe other OR methods like Decision Analysis, Game Theory, Combinatorial Auctions. **C6.** Implement and run of the above algorithms.
Transversal Skills	Upon successful completion of this discipline, students will be able to: **CT1.** Apply the specific methods of OR to various discrete or continuous optimization problems. **CT2.** Model and solve combinatorial optimization problems with OR techniques.

7. **Course Objectives** (from the grid of specific skills acquired)

7.1 General Objective	Taming of concepts, of methods of modelling and of basic and medium-advanced algorithms from LP/ILP. Learning the basic notions of Decision Analysis, Game Theory, and Combinatorial Auctions.
7.2 Specific Objectives	At the end of this course, the students will be able to: **O1.** Explain the concepts of LP problems, relaxing problems, basic/non-basic variables, and duality theory. **O2.** Describe primal/dual Simplex Algorithm, Two phase method, Interior point methods. **O3.** Use and modify the above algorithms. **O4.** Analyze the results of a model or of a solution to a specific problem.

	Lectures	**Teaching Methods**	**Observations** (hours and bibliographic references)
1	Introduction, Motivation, Examples, Geometric Linear Programming.	Exposition.	2, [1]-[4], [6]
2	Algebraic Approach, Basic Feasible Solutions, Extreme Points.	Exposition.	2, [1]-[4], [6]
3	Algebra of Simplex, Simplex Algorithm, Tableau Implementation.	Exposition.	2, [1]-[4], [6], [7]
4	Simplex Special Situations, Two Phase Method, Big M Method.	Exposition.	2, [1]-[4], [6], [7]
5	Dual Problem, Duality Theory, Dual Simplex Algorithm.	Exposition.	2, [1]-[4], [6]
6	Integer Programming, Models, Totally Unimodular Matrices.	Exposition.	2,[1], [5], [9]-[11]
7	Branch and Bound Algorithm. Cutting Plane Method.	Exposition.	2, [1], [2], [6]

8			
9	Interior Point Methods.	Exposition.	2, [1], [7]
10	Decision Analysis.	Exposition.	2, [2], [3], [6]
11	Column Generation.	Exposition.	2, [14]
12	Perfect Formulations of Discrete Optimization Problems.	Exposition.	2, [10], [11]
13	Game Theory: Cooperative and Non-cooperative Games.	Exposition.	2, [2], [6]
14	Combinatorial Auctions.	Exposition.	2, [13]

Bibliography

Main references:

[1] Bertsimas, D., J. N. Tsitsiklis, *Introduction to Linear Optimization*, Athena Scientific, Belmont, Massachusetts, 1997.

[2] Griva, F. S., G. J. Lieberman, , *Introduction to Operations Research*, McGraw Hill, 7th edition, 2001.

[3] Hillier, I., S. G. Nash, A. Sofer, *Linear and Nonlinear Optimization*, 2nd edition, SIAM, 2009.

[4] Kolman, B., R. E. Deck, *Elementary Linear Programming with Applications*, Elsevier Science and Technology Books, 1995.

[5] Schrijver, A., *Theory of Linear and Integer Programming*, Wiley & Sons, New York, 1999.

[6] Taha, H. A., *Operations Research: An Introduction*, Prentice Hall International, 8th edition, 2007.

[7] Vanderbei, R. J., *Linear Programming - Foundations and Extensions*, International Series in Operations Research & Management Science, Springer Science, 4th edition, 2014.

Supplementary references:

[8] Bhat, U. N., An Introduction to Queueing Theory – Modeling and Analysis in Applications, Birkhäuser, 2008

[9]Chekuri, C., *Topics in Research Combinatorial*, University of Illinois Urbana-Champaign, Lecture Notes, 2010.

[10] Conforti, M., G. Cornuejols, G. Zambelli, *Integer Programming*, Graduate Texts in Mathematics, Springer, 2004.

[11] Schrijver, A., *A Course in Combinatorial Optimization*, Electronic Edition, 2013.

[12] Vries, S. de, Vohra, R. V., Combinatorial Auctions: A Survey, INFORMS Journal of Computing, vol. 15, Issue 3, pp. 284-309, 2003

[13] Yang, X.-S., *Introduction to Mathematical Optimization - From Linear Programming to Metaheuristics*, Cambridge International Science Publishing, 2008.

[14] Desrosiers, J., M. E. Lubbecke, A primer in column generation in Column Generation, Desaulniers, G., J. Desrosiers, M.M. Solomon (Eds.), Springer, 2005.

	Seminary	**Teaching methods**	**Observations** (hours and bibliographic references)
1	Vocabulary of Graph Theory.	Course memento, exercice examples and exercices solving.	2, [1]-[4], [6]
2	Vocabulary of Graph Theory.	idem	2, [1]-[4], [6]

3	Vocabulary of Graph Theory. Shortest path problems in (di)graphs.	idem	2, [1]-[4], [6], [7]
4	Shortest path problems in (di)graphs.	idem	2, [1]-[4], [6], [7]
5	Connectivity problems in (di)graphs (Menger's, Konig's, Hall's theorems).	idem	2, [1], [2], [6]
6	Minimum spanning trees problem (Prims's and Kruskal's algorithms). Maximum matchings and minimum edge-covers.	idem	2,[1], [5], [9]-[11]
7	Maximum matching problem. Berge's and Tutte's theorems. Hopcroft Karp algorithm. Network flows.	idem	2, [1], [2], [6]
8			
9	Interior Point Methods.	Course memento, laboratory woks examples and individual works.	2, [1], [7]
10	Decision Analysis.	idem	2, [2], [3], [6]
11	Perfect Formulations of Discrete Optimization Problems.	idem	2, [14]
12	Game Theory: Cooperative and Non-cooperative Games.	idem	2, [10], [11]
13	Combinatorial Auctions.	idem	2, [2], [6]
14	Queueing Systems.	idem	2, [13]

8. Course content synchronization with the expectations of the community representatives, professional associations and employers from the program domain

OR lectures are dedicated to accomodation and to deep learning the classical and modern solving tools of – mainly – linear problems with applications in a wide range of discrete and continuous optimization problems.

9. Evaluation

Activity Type	9.1 Evaluation criteria	9.2 Evaluation methods	9.3 The weight of each evaluation form (%)
9.4 Course	Understand and manipulate OR concepts and results for modeling and solve combinatorial problems.	Written exam.	50.00%
9.5 Laboratory	Implement and manipulate OR related techniques and algorithms and - optional - understand a scientific paper using OR methods (for Project readings).	Homework and presentation evaluations.	50.00%
9.6 Minimal performance standards: model and solve combinatorial and real-life problems using LP/OR techniques.			

Date	Course and Seminary Teacher	Seminary Teacher
26.09.2025	Lect. Dr. Olariu Emanuel Florentin	Lect. Dr. Olariu Emanuel Florentin

Department Date of Approval

Director of the Department
Conf. Andrei Arusoaie, PhD