COURSE DESCRIPTION

Graph Theory and Algorithms

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeş Bolyai University
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Department	Department of Computer Science
1.4. Field	Computer Science
1.5. Level of study	Bachelor
1.6. Degree programme / Qualification	Artificial Intelligence
1.7. Form of education	Full Time

2. Course-related data

2.1. Course title	**Graph Theory and Algorithms**			Course code	**MLE5246**
2.2. Course coordinator	Mihai Andrei				
2.3. Seminar coordinator	Mihai Andrei				
2.4. Year of study	3	2.5. Semester	6	2.6. Type of assessment	E
2.7. Course status	Opțional			2.8. Course type	DS

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**6**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**4**
3.4. Total of hours in the curriculum	72	of which: 3.5. course	24	3.6. seminar/ laboratory	**48**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					20
Additional research in the library, on subject-specific electronic platforms, and on-site					15
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					30
Tutoring (professional guidance)					5
Examinations					4
Other activities					4
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**78**	
3.8. Total hours per semester				**150**	
3.9. Number of credits				**6**	

4. Prerequisites (where applicable)

4.1. curriculum-related	Data Structures and Algorithms
4.2 skills-related	Average skills in analysis and design of algorithms and data structures, including implementing them in a programming language. Basic knowledge of Python programming language.

5. Specific conditions (where applicable)

5.1. course-related	

5.2. seminar/laboratory-related	Laboratory with computers; with Python developing environment.

6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

Professional competencies	
Competency code	**Competency**
CP1	create software
CP10	use software libraries
Transversal competencies	
Competency code	**Competency**
CT2	Solve problems
CT3	Think analytically
CT4	Schedule and organize

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
CP1	The student/graduate identifies, explains and justifies fundamental concepts of data structures, algorithms, and programming paradigms, as well as computer architecture.	The student/graduate designs, develops and demonstrates complex software solutions using efficient algorithms and diverse programming paradigms.
CP10	The student/graduate selects, describes, analyzes and explains modern programming paradigms, including functional, object-oriented and parallel programming, using current languages and frameworks.	The student/graduate designs, plans, builds, develops scalable software applications, and efficiently uses hardware and software resources.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. The graduate knows graph theoretical concepts and can use these concepts in the problem modelling.
2. The graduate knows how to solve different types of problems using graphs and specific graph algorithms.
Specific academic skills
1. The graduate can analyse problems and model them around the main topics of graph: connectivity, shortest paths, modelling prerequisites and activity planning, flows, traveling salesman problem, planar graphs
2. The graduate can implement the graph algorithms in a programming language.

8. Contents

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes. If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

8.1. Course	Teaching and learning methods	Remarks[3]
1. Basic graph theory definitions (graph, multigraph, directed graph/multigraph, walk, trail, path), basics on graph representations	Exposure, description, explanation, examples, debate	
2. Pseudocode. Walks. Graph measurements: length, distance, diameter, eccentricity, radius, center. Traversals.	Exposure, description, explanation, examples, debate	
3. Minimum-cost walk in a graph. Dijkstra's algorithm (classic), Uniform cost search algorithm (Dijkstra variant),	Exposure, description, explanation, examples, debate	
4. Heuristics, Best First Search, A* and Greedy Search.	Exposure, description, explanation, examples, debate	
5. Bellman-Ford algorithm. Floyd-Warshall algorithm. Subgraphs. Connectivity, connected and strongly-connected components.	Exposure, description, explanation, examples, debate	
6. Trees and forests. Minimum spanning trees. Kruskal and Prim algorithms.	Exposure, description, explanation, examples, debate	
7. Dependency graphs. Topological sorting algorithms. Matchings. Finding Strongly connected components.	Exposure, description, explanation, examples, debate	
8. Matchings. Maximum matching in a bipartite graph algorithm.	Exposure, description, explanation, examples, debate	
9. Eulerian cycle. Planar graphs: Euler's relation, K5 and K3,3 graphs, relations between number of edges and vertices.	Exposure, description, explanation, examples, debate	
10. NP-complete problems. Hamiltonian cycle, Traveling Salesman Problem, clique, vertex cover, colouring.	Exposure, description, explanation, examples, debate	
11. Transport networks. Maximum flow. Cuts.	Exposure, description, explanation, examples, debate	
12. Ford-Fulkerson algorithm. Maximum flow of minimum cost.	Exposure, description, explanation, examples, debate	
Bibliography T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein. Introduction to Algorithms, 4th edition. MIT press, 2022. Santosh Kumar Yadav, Advanced Graph Theory, Springer, 2023. K. Erciyes, Algebraic Graph Algorithms - A Practical Guide Using Python, Springer, 2021. T. Toadere, Grafe. Teorie, algoritmi si aplicatii, Editura Albastra, 2009. K. Erciyes, Guide to Graph Algorithms - Sequential, Parallel and Distributed, Springer, 2018. Shimon Even and Guy Even, Graph Algorithms 2nd edition, 2012. Saidur Rahman, Basic Graph Theory, Springer, 2017. Thomas H. Cormen et. al, Introduction to Algorithms, third edition, 2009, MIT Press.		
8.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
Graph representations	Exposure, description, explanation, examples, debate	
More on graph representations. Iterators and traversals.	Exposure, description, explanation, examples, debate	
Minimum cost walks.	Exposure, description, explanation, examples, debate	
Dependency graphs. Minimum spanning trees. Connectivity.	Exposure, description, explanation, examples, debate	
Eulerian circuits. Homeomorphism. Bipartite matching.	Exposure, description, explanation, examples, debate	

[3] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

Finishing the lab activity.	Exposure, description, explanation, examples, debate	

Bibliography
T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein. Introduction to Algorithms, 4th edition. MIT press, 2022.
Santosh Kumar Yadav, Advanced Graph Theory, Springer, 2023.
K. Erciyes, Algebraic Graph Algorithms - A Practical Guide Using Python, Springer, 2021.
T. Toadere, Grafe. Teorie, algoritmi si aplicatii, Editura Albastra, 2009.
K. Erciyes, Guide to Graph Algorithms - Sequential, Parallel and Distributed, Springer, 2018.
Shimon Even and Guy Even, Graph Algorithms 2nd edition, 2012.
Saidur Rahman, Basic Graph Theory, Springer, 2017.
Thomas H. Cormen et. al, Introduction to Algorithms, third edition, 2009, MIT Press.

9. Evaluation

Type of activity	9.1 Evaluation criteria[4]	9.2 Evaluation methods[5]	9.3 Percentage in the final grade
9.4. Course	- know the basic principles of the domain - apply the course concepts - problem solving	Written exam	60%
9.5. Seminar/ laboratory	be able to implement course concepts and algorithms	Verifying the practical works.	40%
9.6 Minimum standard for passing			
• At least a grade of 5 at the written exam. • At least a grade of 5 for the overall grade.			

10. SDG labels (Sustainable Development Goals)[6]

	○ Sustainable Development Generic Label							
	2 FOAMETE „ZERO"	3 SĂNĂTATE ȘI BUNĂSTARE	4 EDUCAȚIE DE CALITATE	5 EGALITATE DE GEN	6 APĂ CURATĂ ȘI SANITAȚIE	7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE	8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ	9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ
○	○	○	○	○	○	○	○	●
10 INEGALITĂȚI REDUSE	11 ORAȘE ȘI COMUNITĂȚI DURABILE	12 CONSUM ȘI PRODUCȚIE RESPONSABILE	13 ACȚIUNE CLIMATICĂ	14 VIAȚA ACVATICĂ	15 VIAȚA TERESTRĂ	16 PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE	17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR	No label applies
○	○	○	○	○	○	○	○	○

[4] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[5] Both final evaluation methods and ongoing evaluation strategies should be established.

[6] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*

Date of entry:
20.05.2026

Signature of course coordinator

Digitally signed by
ANDREI MIHAI
Date: 2026.05.21 06:43:02 +03'00'

Signature of seminar coordinator

Date of approval in the department:
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Signature of the head of department

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