COURSE DESCRIPTION

Numerical Analysis

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University
1.2. Faculty	Mathematics and Computer Science
1.3. Department	Mathematics
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	**Numerical Analysis**			Course code	MLE0027
2.2. Course coordinator	Assoc. Prof. Teodora Catinas				
2.3. Seminar coordinator	Assoc. Prof. Teodora Catinas				
2.4. Year of study	2	2.5. Semester	4	2.6. Type of assessment	Viva voce
2.7. Course status	Compulsory			2.8. Course type	Specialisation subject

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

3.1. Number of hours per week	**4**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**2**
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. seminar/ laboratory	**28**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					30
Additional research in the library, on subject-specific electronic platforms, and on-site					20
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays (greater than or equal to the total number of hours specified in the course calendar for evaluation tasks)					29
Tutoring (professional guidance)					10
Examinations					5
Other activities [i.e.: two-way communication with the course coordinator/tutor]					
3.7. Total hours of individual study (IS) and self-taught activities (ST)				94	
3.8. Total hours per semester				**150**	
3.9. Number of credits				**6**	

4. Prerequisites (where applicable)

4.1. curriculum-related	• knowledge of main notions and procedures of numerical analysis and ability to work with them. • Ability to program in MATLAB for implementing numerical algorithms.
4.2 skills-related	ability to work and solve problems with concepts of Numerical Analysis.

5. Specific conditions (where applicable)

5.1. course-related	Blackboard, projector
5.2. seminar/laboratory-related	Laboratory with computers.

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

[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

Professional competencies	
Competency code	**Competency**
CP1	dezvolta strategii de soluționare a problemelor *develop problem-solving strategies*
CP4	dezvolta software cu sursa deschisa *develop open source software*
CP5	sintetizează informații *synthesize information*
CP7	comunică informații matematice *communicate mathematical information*
CP8	studiază relații între cantități *study relationships between quantities*
CP9	utilizează tehnici de prelucrare a datelor *use data processing techniques*
CP11	realizează analize de date perform data analysis
Transversal competencies	
Competency code	**Competency**
CT1	Interpretează informații matematice *Interpret mathematical information*
CT2	Utilizează dispozitivele și aplicațiile digitale *Use digital devices and applications*
CT4	Soluționează probleme *Solve problems*
CT5	Gândește analitic *Think analitically*

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**
CP5 **CP8**	9. Studentul/absolventul definește conceptele din disciplinele de bază de informatică și/sau matematici aplicate. *9. The student/graduate defines the concepts from basic computer science and/or applied mathematics disciplines.*	9. Studentul/absolventul identifică și aplică tehnicile adecvate pentru rezolvarea exercițiilor și problemelor din disciplinele majore ale matematicii. *9. The student/graduate identifies and applies suitable techniques to solve exercises and problems from the major disciplines of mathematics..*

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.

CP9 **CP11**	11. Studentul/absolventul formulează observații și diferențiază noțiuni, proprietăți și aserțiuni din disciplinele de bază de informatică și/sau matematici aplicate prin exemple și contraexemple. *11. The student/graduate formulates observations and differentiates notions, properties, and assertions from the basic computer science and/or applied mathematics disciplines through examples and counterexamples.*	11. Studentul/absolventul descrie probleme din lumea reală în termeni matematici, identifică ipotezele de lucru, construiește modele matematice adecvate și explică limitările modelelor astfel obținute. *11. The student/graduate describes real-world problems in mathematical terms, identifies the working hypotheses, constructs suitable mathematical models, and explains the limitations of the resulting models.*

7. Subject-specific learning outcomes (referred to by each subject coordinator across the range of competencies and learning outcomes at the level of the degree programme)

Knowledge and comprehension
1. The student knows the fundamental notions of Numerical Anlysis and knows how to apply them in other domains of Mathematics and Computer Science.
2. The student is able to solve problems applying Numerical Analysis concepts.
Specific academic skills
1. The student has the ability to work independently to obtain extended results for some others areas of Mathematics or Computer Science.
2. The student has the ability to work independently to obtain numerical algorithms that can be applied in practical problems from real life.
3. The student is able to proof some theorems using mathematical language.
4. The student is able to implement numerical algorithms using MATLAB

8. Content

8.1 Course	**Teaching and learning methods**	**Remarks[3]**
1. Introductive notions. Finite and divided differences (definitions and properties). Taylor's formula.	Exposure: description, explanation, examples.	
2. Lagrange interpolation: interpolation polynomial, interpolation formula, study of the error.	Exposure: description, explanation, examples, proofs.	
3. Lagrange interpolation: Neville's and Aitken's algorithms, Newton's formula.	Exposure: description, explanation, examples.	
4. Hermite interpolation: interpolation polynomial, interpolation formula, study of the error. Hermite interpolation with double nodes.	Exposure: description, explanation, examples, proofs.	
5. Birkhoff interpolation: interpolation polynomial, interpolation formula, study of the error.	Exposure: description, explanation, examples, proofs.	
6. Spline interpolation method. Least squares approximation.	Exposure: description, explanation, examples, proofs, dialogue.	
7. Numerical differentiation and integration (introductive notions). Newton-Cotes	Exposure: description, explanation, examples.	

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

quadrature formulas. Repeated quadrature formulas.		
8. Romberg's algorithm. Adaptive quadratures formulas. General quadrature formulas. Gauss-type quadrature formulas.	Exposure: description, explanation, examples.	
9. Numerical methods for solving linear systems - direct methods (Gauss, Gauss-Jordan). Conditioning of a linear system.	Exposure: description, explanation, examples.	
10. Numerical methods for solving linear systems - direct methods (LU-methods).	Exposure: description, explanation, examples.	
11. Numerical methods for solving linear systems - iterative methods (Jacobi, Gauss-Seidel, SOR).	Exposure: description, explanation, examples.	
12. Methods for solving nonlinear equations in R: one-step methods (Newton (tangent) method, succesive approximation method).	Exposure: description, explanation, examples, proofs.	
13. Methods for solving nonlinear equations in R: multi-step methods (secant, bisection and false position methods). Inverse interpolation.	Exposure: description, explanation, examples.	
14. Methods for solving nonlinear systems of equations.	Exposure: description, explanation, examples.	

Bibliography

1. O. Agratini, I. Chiorean, Gh. Coman, R.T. Trîmbitaş, *Analiză Numerică şi Teoria Aproximării*, vol. III, Ed. Presa Univ. Clujeană, 2002;
2. R. L. Burden, J. D. Faires, *Numerical Analysis,* PWS Publishing Company, 1985.
3. I. Chiorean, T. Cătinaş, R. Trîmbitaş, *Analiză numerică*, Ed. Presa Univ. Clujeană, 2010.
4. Gh. Coman, T. Cătinaş, şi alţii, *Interpolation operators*, Ed. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2004.
5. Gh. Coman, I. Chiorean, T. Cătinaş, *Numerical Analysis. An Advanced Course*, Ed. Presa Univ. Clujeană, 2007.
6. S. D. Conte, Carl de Boor, *ELEMENTARY NUMERICAL ANALYSIS. An Algorithmic Approach,* SIAM, 2017.
7. W. Gander, M.J. Gander, F. Kwok, *Scientific Computing,* Springer Internat. Publishing, 2014.
8. D.D. Stancu, Gh. Coman, O. Agratini, R. Trimbitas, *Analiză Numerică şi Teoria Aproximării*, vol. I, Ed. Presa Univ. Clujeană, 2001;
9. D.D. Stancu, Gh. Coman, P. Blaga, *Analiză Numerică şi Teoria Aproximării*, vol. II, Ed. Presa Univ. Clujeană, 2002;
10. R. Trîmbitaş, *Numerical Analysis*, Ed. Presa Univ. Clujeană, 2007.

8.2 Seminary/Laboratory	Teaching methods	Remarks
1. Introductory examples and problems in Matlab.	Explanation, dialogue.	
2. Problems with orthogonal polynomials and Taylor polynomials. Computation of finite and divided differences.	Explanation, dialogue, examples.	
3. Lagrange interpolation. Computation of Lagrange polynomial using barycentric formula.	Explanation, dialogue, practical examples.	
4. Applied problems to Lagrange interpolation using Neville's and Aitken's algorithms.	Explanation, dialogue, practical examples. Evaluation.	
5. Applied problems to Newton's method.	Explanation, dialogue, practical examples. Evaluation.	

6. Applied problems to Hermite interpolation.	Explanation, dialogue, practical examples. Evaluation.	
7. Applied problems to spline interpolation.	Explanation, dialogue, practical examples. Evaluation.	
8. Applied problems to least squares approximation method.	Explanation, dialogue, practical examples.	
9. Problems with simple and repeated integration formulas and with Romberg's algorithm.	Explanation, dialogue, examples. Evaluation.	
10. Applied problems to Gauss type quadrature formulas and adaptive quadratures.	Explanation, dialogue, examples.	
11. Solving linear systems using direct methods.	Explanation, dialogue, practical examples. Evaluation.	
12. Study of perturbations of a linear system.	Explanation, dialogue, examples. Evaluation.	
13. Solving linear systems using iterative methods.	Explanation, dialogue, practical examples. Evaluation.	
14. Solving nonlinear equations using one-step and multi-step methods.	Explanation, dialogue, practical examples. Evaluation.	
Bibliography 1 R. L. Burden, J. D. Faires, *Numerical Analysis,* PWS Publishing Company, 1985. 2 R. Trîmbitaş, *Numerical Analysis*, Ed. Presa Univ. Clujeană, 2007.		

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 Numerical Analysis;	Written exam	60%
	- apply the course concepts in problem solving		
9.5. Seminar/ laboratory	- be able to implement course concepts and algorithms	Evaluation and continuous observations during the semester.	Lab 30% Seminary 10%
	- apply techniques for different practical problems		
9.6 Minimum standard for passing			
• At least grade 5 (from a scale of 1 to 10) at both written exam and laboratory work.			

[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.

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

	○	Sustainable Development Generic Label

								
○	○	○	○	○	○	○	○	x
								No label applies
○	○	○	○	○	○	○	○	○

Date:
17.04.2026

Signature of course coordinator

Conf. Dr. Teodora Cătinaș

Signature of seminar coordinator

Conf. Dr. Teodora Cătinaș

Date of approval:
25.05.2026

Signature of the head of department

Prof. dr. Andrei Mărcuș

[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."*