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 Computer Science**
1.4 Field of study	**Computer Science**
1.5 Study cycle	**Bachelor**
1.6 Study programme / Qualification	**Computer Science**

2. Information regarding the discipline

2.1 Name of the discipline	**Numerical Calculus**						
2.2 Course coordinator	**Assoc. Prof. Teodora Catinas**						
2.3 Seminar coordinator	**Assoc. Prof. Teodora Catinas**						
2.4. Year of study	**3**	2.5 Semester	**6**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Compulsory**

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	4	Of which: 3.2 course	2	3.3 seminar/laboratory	2 lab
3.4 Total hours in the curriculum	48	Of which: 3.5 course	24	3.6 seminar/laboratory	24
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					20
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					7
Evaluations					20
Other activities:					-

3.7 Total individual study hours	77
3.8 Total hours per semester	125
3.9 Number of ECTS credits	5

4. Prerequisites (if necessary)

4.1. curriculum	•
4.2. competencies	• Knowledge of main notions and procedures of numerical analysis and the ability to work with them. Programming skills in MATLAB for implementing numerical algorithms.

5. Conditions (if necessary)

5.1. for the course	•
5.2. for the seminar /lab activities	• Laboratory with computers.

6. Specific competencies acquired

Professional competencies	C3.1 Description of concepts, theory and models used in application domain C3.2 Identify and explain the basic computer science models corresponding to application domain C3.3 Use of computer science and mathematical models and tools for solving specific problems in the application field C3.4 Data and model analysis C4.1 Defining basic concepts, theory and mathematical models C4.2 Interpretation of mathematical models C4.3 Identifying the appropriate models and methods for solving real-life problems C4.5 Embedding formal models in applications from various areas
Transversal competencies	CT1 Application of efficient and organized work rules, of responsible attitudes towards the didactic-scientific domain, to creatively value one's own potential, with the respect towards the principles and norms of professional etic. CT3 Use of efficient methods and techniques to learn, inform, research and develop the abilities to value the knowledge, to adapt to requirements of a dynamic society and to communicate in Romanian language and in a language of international circulation.

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

7.1 General objective of the discipline	• Be able to understand and use basic concepts of Numerical Analysis • Be able to implement numerical algorithms in order to solve practical problems.
7.2 Specific objective of the discipline	• Acquire theoretical and practical knowledge about the basic numerical algorithms regarding approximation of functions, numerical integration of functions, numerical solving of linear/nonlinear systems of equations and differential equations. • Ability to apply numerical algorithms to solve practical and real life problems.

8. Content

8.1 Course	Teaching methods	Remarks
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: Aitken's algorithm and 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. Least squares approximation.	Exposure: description, explanation, examples, proofs.	
6. Numerical differentiation and integration (introductive notions). Newton-Cotes quadrature formulas. Repeated quadrature formulas.	Exposure: description, explanation, examples, proofs, dialogue.	

7. Romberg's algorithm. Adaptive quadratures formulas. General quadrature formulas. Gauss-type quadrature formulas.	Exposure: description, explanation, examples.	
8. Numerical methods for solving linear systems - direct methods (Gauss, Gauss-Jordan, LU-methods). Conditioning of a linear system.	Exposure: description, explanation, examples.	
9. Numerical methods for solving linear systems - iterative methods (Jacobi, Gauss-Seidel, SOR).	Exposure: description, explanation, examples.	
10. Methods for solving nonlinear equations in R: one-step methods (Newton (tangent) method) and multi-step methods (secant, bisection and false position methods).	Exposure: description, explanation, examples.	
11. Methods for solving nonlinear equations in R: Lagrange, Hermite and Birkhoff inverse interpolation. Methods for solving nonlinear systems: successive approximation and Newton methods.	Exposure: description, explanation, examples, proofs.	
12. Numerical methods for solving differential equations: Taylor interpolation, Euler and Runge-Kutta methods.	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 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 Aitken's algorithm and Newton's method.	Explanation, dialogue, practical examples. Evaluation.	
5. Applied problems to Hermite interpolation.	Explanation, dialogue, practical examples. Evaluation.	

6. Applied problems to least squares approximation method.	Explanation, dialogue, practical examples. Evaluation.	
7. Problems with simple and repeated integration formulas and with Romberg's algorithm.	Explanation, dialogue, practical examples.	
8. Applied problems to Gauss type quadrature formulas and adaptive quadratures.	Explanation, dialogue, examples. Evaluation.	
9. Solving linear systems using direct methods. Study of perturbations of a linear system.	Explanation, dialogue, examples.	
10. Solving linear systems using iterative methods.	Explanation, dialogue, examples. Evaluation.	
11. Solving nonlinear equations using Newton, secant and bisection methods. Solving nonlinear systems using Newton's method.	Explanation, dialogue, practical examples. Evaluation.	
12. Solving some differential equations using Euler and Runge-Kutta methods. Ending of evaluation for laboratories	Explanation, dialogue, practical examples. Evaluation.	

Bibliography

1 R. L. Burden, J. D. Faires, *Numerical Analysis*, PWS Publishing Company, 1985.
2 A. Kharab, R. B. Guenther, *An introduction to numerical methods. A Matlab approach*, Taylor&Francis Group, 2006.
3 R. Trîmbitaş, *Numerical Analysis*, Ed. Presa Univ. Clujeană, 2007.

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 exists in the studying program of all major universities in Romania and abroad;
- The content of the course is important for seeing the application of mathematical knowledge in solving practical and real life problems.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	- know the basic principles of Numerical Analysis; - apply the course concepts - problem solving	Written exam	70%
10.5 Seminar/lab activities	- be able to implement course concepts and algorithms - apply techniques for different practical problems	Evaluation and continuous observations during the semester.	30%
10.6 Minimum performance standards			
➢ At least grade 5 (from a scale of 1 to 10) at both written exam and laboratory work.			

Date — Signature of course coordinator — Signature of seminar coordinator

18.04.2018

Date of approval — Signature of the head of department