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	• Cl.1 Description of specific programming paradigms and language mechanisms, as well as the identification of the differences between the semantic and syntactic aspects. • C3.3 Utilization of informatical and mathematical models and instruments for solving specific problems from the aplicability domain.
Transversal competencies	• CT3. Utilization of some efficient methods and techniques of learning, information, research and development of capacities of exploitation of knowledge, of adaptation to the requirements of a dynamical society and communication in Romanian and English.

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. W. Gander, M.J. Gander, F. Kwok, *Scientific Computing*, Springer Internat. Publishing, 2014.
7. R. Plato, *Concise Numerical Mathematics*, Amer. Math. Soc., 2003.
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	Explanation, dialogue, practical examples.	

algorithm.		
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

20.04.2017

Date of approval Signature of the head of department