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 Mathematics**
1.4 Field of study	**Mathematics**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Advanced Mathematics**

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)			**Approximation and Numerical Calculus Techniques (Tehnici de aproximare si de calcul numeric)**				
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 evaluation	**E**	2.7 Type of discipline	**Optional**
2.8 Code of the discipline		MME3162					

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

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	36	Of which: 3.5 course	24	3.6 seminar/laboratory	12
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					54
Additional documentation (in libraries, on electronic platforms, field documentation)					30
Preparation for seminars/labs, homework, papers, portfolios and essays					55
Tutorship					20
Evaluations					30
Other activities:					-

3.7 Total individual study hours	189
3.8 Total hours per semester	225
3.9 Number of ECTS credits	9

4. Prerequisites (if necessary)

4.1. curriculum	•
4.2. competencies	• Knowledge of some classical and modern procedures of Numerical Analysis and the ability to work with them. Improvment of programming skills in MATLAB for implementing numerical algorithms.

5. Conditions (if necessary)

5.1. for the course	•
5.2. for the seminar /lab activities	• Room with blackboard and computers.

6. Specific competencies acquired

Professional competencies	• C1.1: Identifications of notions, descriptions of theories and use of the specific language • 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 • C5.3: Construction and development of logic proofs for some mathematical results, with identification of hypotesis and conclusions
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	• Knowledge, understanding and use of some classical and modern concepts of Numerical Analysis and the improvment of the capacity of using them in problems. • Be able to implement numerical algorithms in order to solve practical problems.
7.2 Specific objective of the discipline	• Consolidation of theoretical and practical knowledge about the basic numerical algorithms. • Acquire some theoretical and practical knowledge regarding classical and modern procedures of numerical analysis. • Ability to understand and manipulate advanced concepts, results and theories in the fields of mathematics. • Ability to use mathematical software and advanced methods of numerical analysis and programming for numerical solving of problems. • Ability to apply numerical algorithms to solve practical and real life problems. • Ability to model and analyze from a mathematical point of view real processes from other sciences, economics and engineering.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introductory notions.	Exposure: description, explanation, examples.	
2. Numerical methods for solving nonlinear equations in R-one-step methods. Newton type methods.	Exposure: description, explanation, dialogue.	
3. Numerical methods for solving nonlinear equations in R-multi-step methods. Inverse interpolation of Lagrange, Hermite and Birkhoff type.	Exposure: description, explanation, dialogue.	
4. Numerical methods for solving nonlinear systems: successive approximation method and Newton's method	Exposure: description, explanation, dialogue.	
5. Least square approximation. Discrete least squares approximation: linear and polynomial least squares.	Exposure: description, explanation, examples, proofs.	
6. Gram-Schmidt process. Least squares approximation using orthogonal polynomials. QR and SVD decompositions.	Exposure: description, explanation, examples, proofs.	
7. Positive linear operators: preliminaries, definitions properties, Bohman-Korovkin theorems. Modulus of continuity. Properties.	Exposure: description, explanation, examples, proofs, dialogue.	
8. Modulus of smoothness. Properties. The approximation error.	Exposure: description, explanation, examples, proofs.	
9. Bernstein operators. Casteljau algorithm.	Exposure: description, explanation, examples, proofs.	
10. Operators of Bernstein type: Schurer, Cheney-Sharma	Exposure: description, explanation, examples, proofs, dialogue.	
11. Operators of Bernstein type: Stancu, Kantorovich and Durrmeyer operators.	Exposure: description, explanation, examples, proofs, dialogue.	
12. Extensions of some classical univariate interpolation methods to multivariate case.	Exposure: description, explanation, examples.	
13. Extensions of some classical univariate interpolation methods to multivariate case.	Exposure: description, explanation, examples, proofs.	
14. Some applications of the interpolation processes to surfaces generation.	Exposure: description, explanation, examples, proofs.	

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, 2010.
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. W. Gautschi, *Numerical Analysis. An introduction*, Birkhauser, Basel, 1997
9. R. Plato, *Concise Numerical Mathematics*, Amer. Math. Soc., 2003.
10. D.D. Stancu, Gh. Coman, O. Agratini, R. Trimbitas, *Analiză Numerică şi Teoria Aproximării*, vol. I, Ed. Presa Univ. Clujeană, 2001;
11. D.D. Stancu, Gh. Coman, P. Blaga, *Analiză Numerică şi Teoria Aproximării*, vol. II, Ed. Presa Univ. Clujeană, 2002;
12. R. Trîmbitaş, *Numerical Analysis*, Ed. Presa Univ. Clujeană, 2007.

8.2 Seminar/Laboratory	Teaching methods	Remarks
1-2 Introductory examples and problems.	Explanation, dialogue, practical examples.	
3-4 Applied problems to numerical methods for solving nonlinear equations and systems.		
5-6 Discrete least square approximation (linear and polynomial) and continuous least square approximation. Practical examples.	Explanation, dialogue, examples.	
7-8 Gram-Schmidt algorithm. QR and SVD decompositions.	Explanation, dialogue, examples.	
9-10 Generation of some Bernstein-type operators. Casteljau algorithm.	Explanation, dialogue, examples.	
11-12 Some applications of extensions of classical univariate interpolation methods to multivariate case. Presentation of a syntesis work. Ending of evaluation for seminar/lab work.	Explanation, dialogue, examples.	

Bibliography

1. R. L. Burden, J. D. Faires, *Numerical Analysis*, PWS Publishing Company, 2010.
2. W. Gander, M.J. Gander, F. Kwok, *Scientific Computing*, Springer Internat. Publishing, 2014.
3. A. Kharab, R. B. Guenther, *An introduction to numerical methods. A Matlab approach*, Taylor&Francis Group, 2006.
4. 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 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.	60%

10.5 Seminar/lab activities	- be able to implement course concepts and the numerical algorithms - apply techniques for different practical problems	Evaluation and continuous observations during the semester. Study for preparing a synthesis work.	Lab activities 30% Project 10%
10.6 Minimum performance standards			
➢ At least grade 5 (from a scale of 1 to 10) at Sections 10.4 and 10.5.			

Date	Signature of course coordinator	Signature of seminar coordinator
19.04.2023	Conf. univ. Teodora Cătinaş	Conf. univ. Teodora Cătinaş

Date of approval

Signature of the head of department

Prof. Dr. Andrei Mărcuş