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)			**Numerical Methods with Applications** **Metode numerice cu aplicatii**				
2.2 Course coordinator			**Assoc. Prof. Teodora Cătinaş**				
2.3 Seminar coordinator			**Assoc. Prof. Teodora Cătinaş**				
2.4. Year of study	**1**	2.5 Semester	**2**	2.6. Type of evaluation	**C**	2.7 Type of discipline	**Compulsory**
2.8 Code of the discipline		MME3157					

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	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	40
Additional documentation (in libraries, on electronic platforms, field documentation)	44
Preparation for seminars/labs, homework, papers, portfolios and essays	50
Tutorship	10
Evaluations	14
Other activities:	-

3.7 Total individual study hours	158
3.8 Total hours per semester	200
3.9 Number of ECTS credits	8

4. Prerequisites (if necessary)

4.1. curriculum	• Mathematical Analysis • Special Topics in Numerical Analysis
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.

	• Comparative assessment and efficient use of various methods of demonstration

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	• Assimilation of modern techniques of approximation of functions. • 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. Introductive notions: linear spaces, spaces of functions, Peano type theorems	Exposure: description, explanation, examples.	
2. Classical interpolation methods. Study of the interpolation error.	Exposure: description, explanation, examples, dialogue.	
3. Polynomial spline interpolation operators. Cubic spline interpolation.	Exposure: description, explanation, examples, proofs.	
4. Spline interpolation operators of Lagrange type, Hermite and Birkhoff type. Study of the interpolation error.	Exposure: description, explanation, examples, proofs.	
5. Interpolation operators on rectangular domains.	Exposure: description, explanation, examples, proofs, dialogue.	
6. Exemples of interpolation operators for square.	Exposure: description, explanation, examples, proofs, dialogue.	
7. Interpolation operators on simplex domains.	Exposure: description, explanation, examples, proofs, dialogue.	
8. Exemples of interpolation operators for triangle	Exposure: description, explanation, examples, proofs, dialogue.	
9. Interpolation operators on arbitrary domains. Univariate Shepard interpolation.	Exposure: description, explanation, examples.	
10. Bivariate Shepard interpolation.	Exposure: description, explanation, examples.	
11. Numerical differentiation and integration. Newton-Cotes quadrature formulas.	Exposure: description, explanation, dialogue.	
12. Romberg's algorithm. Adaptive quadratures formulas. General quadrature formulas.	Exposure: description, explanation, dialogue.	
13. Gauss type quadrature formulas. Chebyshev type quadrature formulas.	Exposure: description, explanation, dialogue.	
14. Colloquium on the subject of the course	Description, explanation, examples, proofs.	

Bibliography

1. O. Agratini, *Aproximare prin operatori liniari,* Ed. Presa Univ. Clujeană, 2000.
2. O. Agratini, I. Chiorean, Gh. Coman, R.T. Trîmbitaş, *Analiză Numerică şi Teoria Aproximării,* vol. III, Ed. Presa Univ. Clujeană, 2002;
3. R. L. Burden, J. D. Faires, *Numerical Analysis,* PWS Publishing Company, 2010.
4. T. Cătinaş, Interpolation of scattered data, Ed. Casa Carţii de Ştiinţă, 2007.
5. I. Chiorean, T. Cătinaş, R. Trîmbitaş, *Analiză numerică*, Ed. Presa Univ. Clujeană, 2010.
6. Gh. Coman, T. Cătinaş, şi alţii, *Interpolation operators*, Ed. Casa Cărţii de Ştiinţă, Cluj-Napoca, 2004.
7. Gh. Coman, I. Chiorean, T. Cătinaş, *Numerical Analysis. An Advanced Course,* Ed. Presa Univ. Clujeană, 2007.
8. S. D. Conte, Carl de Boor, *Elementary Numerical Analysis. An Algorithmic Approach,* SIAM, 2017.

9. W. Gander, M.J. Gander, F. Kwok, *Scientific Computing,* Springer Internat. Publishing, 2014.
10. W. Gautschi, *Numerical Analysis. An introduction*, Birkhauser, Basel, 1997
11. D.D. Stancu, Gh. Coman, O. Agratini, R. Trimbitas, *Analiză Numerică şi Teoria Aproximării*, vol. I, Ed. Presa Univ. Clujeană, 2001;
12. D.D. Stancu, Gh. Coman, P. Blaga, *Analiză Numerică şi Teoria Aproximării*, vol. II, Ed. Presa Univ. Clujeană, 2002;
13. 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 polynomial interpolation.	Explanation, dialogue, examples.	
5-6 Applied problems to polynomial spline interpolation.	Explanation, dialogue, examples.	
7-8 Computation of some tensorial product and boolean sum operators for square and triangle. Graphical representations.	Explanation, dialogue, examples.	
9-10 Examples of some univariate and bivariate Shepard interpolation operators.	Explanation, dialogue, examples.	
11-12 Numerical integrations formulas and algorithms: examples and applied problems for Newton-Cotes quadratures formulas, Romberg's algorithms and adaptive quadratures formulas, Gauss type quadrature formulas.	Explanation, dialogue, examples.	
13-14. Presentation of a synthesis work. Possible research directions. Ending of evaluation for seminar/lab work. Final results	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. W. Gautschi, *Numerical Analysis. An introduction*, Birkhauser, Basel, 1997
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.	Labs 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
15.04.2023	Conf. univ. Teodora Cătinaş	Conf. univ. Teodora Cătinaş

Date of approval	Signature of the head of department
	Prof. Dr. Andrei Mărcuş