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	**Applied Mathematics**

2. Information regarding the discipline

2.1 Name of the discipline	**Special Chapters of Numerical Analysis**						
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**

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	24	3.6 seminar/laboratory	12

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	30
Additional documentation (in libraries, on electronic platforms, field documentation)	20
Preparation for seminars/labs, homework, papers, portfolios and essays	33
Tutorship	20
Evaluations	30
Other activities:	-

3.7 Total individual study hours	133
3.8 Total hours per semester	175
3.9 Number of ECTS credits	8

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	• Ability to understand and manipulate advanced concepts, results and theories in the fields of mathematics.
Transversal competencies	• Ability to use mathematical software and advanced methods of numerical analysis and programming for numerical solving of problems. • Ability to model and analyze from a mathematical point of view real processes from other sciences, economics and engineering.

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 approximation and interpolation for different types of domains, numerical integration methods, 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: linear spaces, spaces of functions, Peano type theorems. Classical interpolation methods. Study of the interpolation error.	Exposure: description, explanation, examples.	
2. Some linear and positive approximation operators.	Exposure: description, explanation, examples.	
3. Polynomial spline interpolation operators. Spline interpolation operators of Lagrange type.	Exposure: description, explanation, examples, proofs.	
4. Spline interpolation operators of Hermite and Birkhoff type. Study of the interpolation error.	Exposure: description, explanation, examples, proofs.	

5. Interpolation operators on rectangular domains. Exemples of interpolation operators for square.	Exposure: description, explanation, examples, proofs, dialogue.	
6. Interpolation operators on simplex domains. Exemples of interpolation operators for triangle.	Exposure: description, explanation, examples, proofs, dialogue.	
7. Interpolation operators on arbitrary domains. Univariate Shepard interpolation. Bivariate Shepard interpolation.	Exposure: description, explanation, examples.	
8. Numerical differentiation and integration. Newton-Cotes quadrature formulas. Romberg's algorithm. Adaptive quadratures formulas. General quadrature formulas.	Exposure: description, explanation, examples.	
9. Gauss type quadrature formulas. Chebyshev type quadrature formulas.	Exposure: description, explanation, examples.	
10. Numerical methods for solving nonlinear equations in R: one-step methods and multi-step methods. Inverse interpolation of Lagrange, Hermite and Birkhoff type.	Exposure: description, explanation, examples, proofs, dialogue.	
11. Numerical methods for solving nonlinear systems: succesive approximation method and Newton's method.	Exposure: description, explanation, examples.	
12. Numerical methods for solving diferential equations: Taylor interpolation method, Euler and Runge-Kutta methods.	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. W. Gander, M.J. Gander, F. Kwok, *Scientific Computing,* Springer Internat. Publishing, 2014.
7. W. Gautschi, *Numerical Analysis. An introduction*, Birkhauser, Basel, 1997
8. A. Kharab, R. B. Guenther, *An introduction to numerical methods. A Matlab approach,* Taylor&Francis Group, 2006.
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. Introductory examples and problems.	Explanation, dialogue, practical examples.	
2. Applied problems to polynomial interpolation and to linear/positive operators.	Explanation, dialogue, examples.	
3. Computation of some tensorial product and boolean sum operators for square and triangle. Graphical representations.	Explanation, dialogue, examples.	
4. Exemples of univariate and bivariate Shepard interpolation operators.	Explanation, dialogue, examples.	

5. Exemples and applied problems for Newton-Cotes quadratures formulas, Romberg's algorithm and adaptive quadratures formulas. Applied problems to Gauss type quadrature formulas.	Explanation, dialogue, examples.	
6. Exemples of numerical methods for solving nonlinear equations and systems. Solving some differential equations using Euler and Runge-Kutta methods. 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.	70%
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.	30%
10.6 Minimum performance standards			
➢ At least grade 5 (from a scale of 1 to 10) at written exam and laboratory work.			

Date Signature of course coordinator Signature of seminar coordinator

09.06.2017

Date of approval Signature of the head of department