SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babeş-Bolyai University Cluj-Napoca
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	Bachelor
1.6 Study programme / Qualification	Computer Mathematics

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)	**Numerical Methods in Mechanics** **Metode Numerice in Mecanica**						
2.2 Course coordinator	**Prof. Dr. Teodor Grosan**						
2.3 Seminar coordinator	**Prof. Dr. Teodor Grosan**						
2.4. Year of study	**3**	2.5 Semester	**5**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**DS/Optional**
2.8 Code of the discipline	MLE0062						

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
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					20
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					30
Tutorship					20
Evaluations					4
Other activities:					

3.7 Total individual study hours	94
3.8 Total hours per semester	150
3.9 Number of ECTS credits	6

4. Prerequisites (if necessary)

4.1. curriculum	• Numerical analysis
4.2. competencies	• Matlab, programming

5. Conditions (if necessary)

5.1. for the course	• Video projector

5.2. for the seminar /lab activities	• Matlab software

6. Specific competencies acquired

Professional competencies	C4.1 Defining basic concepts, theory and numerical models C4.2 Ability to work independently or in a team to model and solve concrete problems C4.3 Programming using mathematical software
Transversal competencies	CT1 Ability to numerically model concrete real-life problems. CT2 Ability to choose the most appropriate numerical model CT3 Improving the skills of use and programming using mathematical software

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

7.1 General objective of the discipline	• Knowledge, understanding and use of main concepts and results related to numerical methods.
7.2 Specific objective of the discipline	• Mathematical manipulation of mathematical theories, concepts and numerical methods.

8. Content

8.1 Course	Teaching methods	Remarks
1. Polynomial interpolation. Efficient algorithms for polynomial interpolation. Divided differences.	exposure, problematization, exemplify, discussion, discussion of case.	
2. Interpolate Spline. B-splines.	exposure, problematization, exemplify, discussion, discussion of case.	
3. Least Squares Method.	exposure, problematization, exemplify, discussion, discussion of case.	
4. Linear regression. Linear models and forecasts. Curves fitting.	exposure, problematization, exemplify, discussion, discussion of case.	
5. Initial values problems. Explicit and implicit Euler's method. Taylor series expansions. Euler's modified method, Heun's method.	exposure, problematization, exemplify, discussion, discussion of case.	
6. Runge-Kutta methods. Stability Convergence. Global error asymptotics. Global error estimation. Richardson's extrapolation	exposure, problematization, exemplify, discussion, discussion of case.	

and nested methods.		
7. Step control. Stiff problems. Method Euler's implicit and trapeze method	exposure, problematization, exemplify, discussion, discussion of case.	
8. Bvp problems. Introduction, Finite differences. Shooting method	exposure, problematization, exemplify, discussion, discussion of case.	
9. Keller-Box method.	exposure, problematization, exemplify, discussion, discussion of case.	
10. Matlab ode and bvp solvers.	exposure, problematization, exemplify, discussion, discussion of case.	
11. Partial derivative equations. Parabolic equations (1d).	exposure, problematization, exemplify, discussion, discussion of case.	
12. 2d and 3d parabolic equations.	exposure, problematization, exemplify, discussion, discussion of case.	
13. Consistency. Convergence. Stability. Elliptic equations.	exposure, problematization, exemplify, discussion, discussion of case.	
14. Hyperbolic equations	exposure, problematization, exemplify, discussion, discussion of case.	

Bibliografie

Agratini, O., Blaga, P., Chiorean, I., Coman,Gh., Stancu ,D.D., Trîmbitas, R.,: Analiza numerica si teoria aproximarii (vol.I,II,III), Presa Univ.Clujeana, 2002

Coman,Gh., Chiorean, I.,Catinas, T., Advance Course on Numerical Analysis, Presa Univ. Clujeana, Cluj Napoca, 2007

Faires, J.D., Burden, R.L., Numerical Analysis, 3th ed., Brooks Cole, 2002

Isaacson, E., Keller, H.B., Analysis of numerical methods, John Wiley & Sons, New York, 1966.

Iserles, A., A First Course in the Numerical Analysis of Differential Equations, Cambridge University Press 1996

Morton, K.W., Mayers, D. F., Numerical Solution of Partial Differential Equations. An introduction, 2nd ed. Cambridge University Press, New York, 2005

Patankar, S.V., Numerical Heat Transfer and Fluid Flow, Hemisfere, 1980

Smith, G.D., Numerical Solution of Partial Differential Equations, Finite diference methods, 3th ed., Clarendon Press, Oxford, 1985

Serban M.A., Ecuatii si sisteme de ecuatii diferentiale, Presa Univ.Clujeana, 2009

Trîmbitas, R.,: Analiza numerica. O introducere bazata pe MATLAB. Presa Univ. Clujeana 2005.

8.2 Seminar / laborator	Teaching methods	Remarks
1. Lagrange interpolation	Discussion, problem solving, self-study, team work.	

2. Least square method. Linear regression.	Discussion, problem solving, self-study, team work.	
3. Initial value problems.	Discussion, problem solving, self-study, team work. .	
4. Runge-Kutta methods.	Discussion, problem solving, self-study, team work.	
5. Boundary value problems.	Discussion, problem solving, self-study, team work.	
6. Parabolic equations.	Discussion, problem solving, self-study, team work.	
7.Elliptic and hyperbolic equations	Discussion, problem solving, self-study, team work	

Bibliografie

Agratini, O., Blaga, P., Chiorean, I., Coman,Gh., Stancu ,D.D., Trîmbitas, R.,: Analiza numerica si teoria aproximarii (vol.I,II,III), Presa Univ.Clujeana, 2002

Faires, J.D., Burden, R.L., Numerical Analysis, 3th ed., Brooks Cole, 2002

Iserles, A., A First Course in the Numerical Analysis of Differential Equations, Cambridge University Press 1996

Morton, K.W., Mayers, D. F., Numerical Solution of Partial Differential Equations. An introduction, 2nd ed. Cambridge University Press, New York, 2005

Patankar, S.V., Numerical Heat Transfer and Fluid Flow, Hemisfere, 1980

Smith, G.D., Numerical Solution of Partial Differential Equations, Finite diference methods, 3th ed., Clarendon Press, Oxford, 1985

Trîmbitas, R.,: Analiza numerica. O introducere bazata pe MATLAB. Presa Univ. Clujeana 2005.

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 this discipline is in accordance with the curricula of the most important universities in Romania and abroad. This discipline is useful in preparing future teachers and researchers in, as well as those who use mathematical models and advanced methods of study in other areas.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Knowledge of concepts and basic results	Final Project	50%
	Ability to apply theory in modeling and solving problems		
10.5 Seminar/lab activities	Ability to apply theory in numerical models	Mid Term Project	50%

10.6 Minimum performance standards
➢ At least grade 5 (from a scale of 1 to 10).

Date	Signature of course coordinator	Signature of seminar coordinator
22.04.2023.....	...Prof. dr. Teodor Grosan	Prof. .dr. Teodor Grosan

Date of approval	Signature of the head of department
29.04.2023	Professor Andrei Marcus