SYLLABUS

MATHEMATICAL MODELING

University year 2025-2026

1. Information regarding the programme

1.1. Higher education institution	Babes-Bolyai University Cluj-Napoca
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Department	Department of Mathematics
1.4. Field of study	Computer Science
1.5. Study cycle	Master
1.6. Study programme/Qualification	Applied Computational Intelligence
1.7. Form of education	Full time

2. Information regarding the discipline

2.1. Name of the discipline	**Mathematical Modeling**					Discipline code	**MME3030**
2.2. Course coordinator				**Assoc. Prof. PhD. Marcel-Adrian Şerban**			
2.3. Seminar coordinator				**Assoc. Prof. PhD. Marcel-Adrian Şerban**			
2.4. Year of study	1	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Discipline regime	Compulsory

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

3.1. Hours per week	**3**	of which: 3.2 course	**2**	3.3 seminar	**1**
3.4. Total hours in the curriculum	42	of which: 3.5 course	**28**	3.6 seminar/laborator	**14**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					20
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					20
Evaluations					28
Other activities:					
3.7. Total individual study hours	**108**				
3.8. Total hours per semester	**150**				
3.9. Number of ECTS credits	**6**				

4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

5. Conditions (if necessary)

5.1. for the course	
5.2. for the seminar /lab activities	

6.1. Specific competencies acquired [1]

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

Professional/essential competencies	• C1.2 Correct explanation and interpretation of mathematical concepts, using specific language • C 2.4 Comparative analysis of the results obtained by solving problems with pre-existing data • C4.2 Explain and interpret mathematical models
Transversal competencies	• CT 1. Applying the rules of rigorous and efficient work, manifesting responsible attitudes towards the scientific and didactic field, for the optimal and creative capitalization of one's own potential in specific situations, respecting the principles and norms of professional ethics. • CT 3. Efficient use of information sources and resources of communication and assisted professional training, both in Romanian and in a language of international circulation

6.2. Learning outcomes

Knowledge	The student knows: • Specific concepts related to mathematics disciplines necessary for completing assignments. • Fundamental concepts of discrete and continuous dynamical systems. • Methods for creating and analyzing mathematical models from different fields of science modeled by difference equations and differential equations using MAPLE
Skills	The student is able to: • Construct clear and well-supported mathematical arguments to explain problems, topics, and mathematical ideas in writing. • Improved modeling abilities: mathematical modelling, model analysis, numerical simulations using MAPLE
Responsibility and autonomy:	The student has the ability to: • Independently explore certain mathematical content, relying on already acquired ideas and tools, to expand their knowledge. • Independently extend already acquired mathematical ideas and arguments to a mathematical topic that has not been previously studied.

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

7.1 General objective of the discipline	• Be able to describe real world phenomena in mathematical language • Improved modeling abilities: mathematical modelling, model analysis, numerical simulations using MAPLE
7.2 Specific objective of the discipline	• Acquire knowledge about discrete and continuous dynamical systems • Apply discrete and continuous dynamical systems in mathematical modelling of real world phenomena • Understand and work with mathematical models

8. Content

8.1 Course	Teaching methods	Remarks
1. Mathematical Models. Modelling Change with Difference Equation	Interactive exposure Explanation	

	Conversation Didactical demonstration	
2. Solving Difference Equations with MAPLE	Interactive exposure Explanation Conversation Didactical demonstration	
3. First Order Difference Equations. Equilibrium Points. Periodic Points. Stability	Interactive exposure Explanation Conversation Didactical demonstration	
4. Higher Order Difference Equations, Systems of Difference Equations. Equilibrium Points. Stability	Interactive exposure Explanation Conversation Didactical demonstration	
5. Mathematical Models Given by Difference Equations	Interactive exposure Explanation Conversation Didactical demonstration	
6. Mathematical Models Given by Systems of Difference Equations	Interactive exposure Explanation Conversation Didactical demonstration	
7. Solving Differential Equations with MAPLE	Interactive exposure Explanation Conversation Didactical demonstration	
8. Approximate Solutions for Differential Equations	Interactive exposure Explanation Conversation Didactical demonstration	
9. Autonomous Differential Equations. Equilibrium Solutions. Stability	Interactive exposure Explanation Conversation Didactical demonstration	
10. Mathematical Models Given by First Order Differential Equations	Interactive exposure Explanation Conversation Didactical demonstration	
11. Mathematical Models for Single Population	Interactive exposure Explanation Conversation Didactical demonstration	
12. Mathematical Models for Interacting Populations	Interactive exposure Explanation Conversation Didactical demonstration	
13. Mathematical Models in Epidemiology	Interactive exposure Explanation Conversation Didactical demonstration	
14. Trends and Future Directions in Mathematical Modeling with Dynamical Systems	Interactive exposure Explanation Conversation Didactical demonstration	

Bibliography

1. Saber Elaydi, An Introduction to Difference Equations, Springer, 2005
2. F.R. Giordano, M.D. Weir, W.P. Fox, A first course in mathematical modeling, Brooks/Coole, 2003.
3. D.K. Arrowsmith, Dynamical systems, Differential equations, maps and chaotic behaviour, Chapmann and Hall, 1992.
4. Lynch S. Dynamical systems with applications using MAPLE, Birkhauser, 2001.
5. Ronald W. Shonkwiler, Mathematical Biology. An Introduction with Maple and Matlab, Springer, 2009.
6. J.D. Murray, Mathematical biology, Springer, 2001

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Modelling Change with Di¤erence Equations	Exercise Explanation Didactical demonstration	
2. Solving Difference Equations with MAPLE	Exercise Explanation Didactical demonstration	
3. Mathematical Models Given by Difference Equations and Systems of Difference Equations	Exercise Explanation Didactical demonstration	
4. Solving Differential Equations with MAPLE	Exercise Explanation Didactical demonstration	
5. Mathematical Models Given by Differential Equations	Exercise Explanation Didactical demonstration	
6. Mathematical Models Given by Systems of Differential Equations	Exercise Explanation Didactical demonstration	
7. Mathematical Models in Epidemiology	Exercise Explanation Didactical demonstration	

Bibliography

1. Saber Elaydi, An Introduction to Difference Equations, Springer, 2005
2. Lynch S. Dynamical systems with applications using MAPLE, Birkhauser, 2001.
3. Ronald W. Shonkwiler, Mathematical Biology. An Introduction with Maple and Matlab, Springer, 2009.

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 researchers in pure and applied mathematics, as well as those who use mathematical models and advanced methods of study in other areas.

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Knowledge of concepts and basic results		
	Ability to justify by proofs theoretical results	Final written exam	80%
10.5 Seminar/laboratory	Ability to apply concepts and results acquired during the course in problem solving	Two problem-solving assignment with solutions	20%
	Ability to apply concepts and results acquired		

	during the course in problem solving using mathematical software MAPLE		
10.6 Minimum standard of performance			
• Successful passing of the exam is conditioned by the final grade that must be at least 5.			

11. Labels ODD (Sustainable Development Goals)[2]

Not applicable.

Date: 11.04.2025	Signature of course coordinator Assoc. Prof. PhD. Marcel-Adrian ŞERBAN	Signature of seminar coordinator Assoc. Prof. PhD. Marcel-Adrian ŞERBAN

Date of approval: 25.04.2025	Signature of the head of department Prof. Dr. Andrei-Dorin MĂRCUŞ

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable*.”.