SYLLABUS

DYNAMICAL SYSTEMS

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	Bachelor
1.6. Study programme/Qualification	Artificial Intelligence
1.7. Form of education	Full-time

2. Information regarding the discipline

2.1. Name of the discipline	**Dynamical Systems**					Discipline code	**MLE0010**
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	2	2.5. Semester	3	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	**4**	of which: 3.2 course	**2**	3.3 seminar/laboratory	**1/1**
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laborator	14/14
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					10
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					10
Tutorship					20
Evaluations					19
Other activities:					
3.7. Total individual study hours	**69**				
3.8. Total hours per semester	**125**				
3.9. Number of ECTS credits	**5**				

4. Prerequisites (if necessary)

4.1. curriculum	Mathematical Analysis (I-II), Geometry (I)
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 differential equations theory and dynamical systems. • Methods for creating and analyzing mathematical models from different fields of science modeled by differential equations.
Skills	The student is able to: • Construct clear and well-supported mathematical arguments to explain problems, topics, and mathematical ideas in writing. • Demonstrate theorems using mathematical language and to present these results both orally and in writing.
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	• to present the main concepts and results in differential equations theory
7.2 Specific objective of the discipline	• basic methods for solvable differential equations • main concepts and results concerning the qualitative theory of differential equations • basic problems related to differential equations • mathematical models given by differential equations

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction to Differential Equations	Interactive exposure Explanation Conversation Didactical demonstration	
2. Analysis in Banach spaces. Contraction principle. Abstract data dependence principle	Interactive exposure Explanation Conversation Didactical demonstration	
3. The Cauchy problem. The existence and uniqueness theorem in the space	Interactive exposure Explanation Conversation Didactical demonstration	
4. The Cauchy problem. The existence and uniqueness theorem in the ball	Interactive exposure Explanation Conversation Didactical demonstration	
5. Mathematical models governed by differential equations (I)	Interactive exposure Explanation Conversation Didactical demonstration	
6. Mathematical models governed by differential equations (II)	Interactive exposure Explanation Conversation Didactical demonstration	
7. Linear differential equations	Interactive exposure Explanation Conversation Didactical demonstration	
8. Linear differential equations with constant coefficients	Interactive exposure Explanation Conversation Didactical demonstration	
9. Systems of linear differential equations of first order	Interactive exposure Explanation Conversation Didactical demonstration	
10. Systems of linear differential equations with constant coefficients	Interactive exposure Explanation Conversation Didactical demonstration	
11. Dynamical systems generated by autonomous scalar differential equations	Interactive exposure Explanation Conversation Didactical demonstration	
12. Dynamical systems generated by planar system of differential equations	Interactive exposure Explanation Conversation Didactical demonstration	
13. Applications of dynamical systems theory to some models	Interactive exposure Explanation Conversation Didactical demonstration	
14. Approximating methods for the Cauchy problem solutions	Interactive exposure Explanation Conversation Didactical demonstration	
Bibliography		

1. I. A. Rus, Ecuaţii diferenţiale, ecuaţii integrale si sisteme dinamice, Transilvania Press, Cluj-Napoca, 1996.
2. M.A. Şerban, Ecuaţii şi sisteme de ecuaţii diferenţiale, Ed. Presa Univ. Clujană, Cluj-Napoca, 2009.
3. S.L. Campbell, R. Haberman, Introduction to Differential Equations with Dynamical Systems, Princeton Univ. Press, 2008.

8.2 Seminar	Teaching methods	Remarks
1. Solvable first order differential equations: separable differential equations, Euler homogeneous differential equations, linear equations.	Exercise Explanation Didactical demonstration	
2. Second order differential equations : linear equations, fundamental system of solutions, linear equations with constant coefficients	Exercise Explanation Didactical demonstration	
3. Systems of linear differential equations: fundamental system of solutions, fundamental matrix of solutions, linear systems with constant coefficients	Exercise Explanation Didactical demonstration	
4. Problems attached to differential equations:	Exercise Explanation Didactical demonstration	
5. Test paper	Exercise	
6. Dynamical systems generated by scalar autonomous differential equations: flow, equilibrium points, stability	Exercise Explanation Didactical demonstration	
7. Dynamical systems generated by planar systems of autonomous differential equations: flow, equilibrium points, stability.	Exercise Explanation Didactical demonstration	

Bibliography
1. R. PRECUP, Ecuatii diferentiale, Risoprint, Cluj-Napoca, 2011.
2. G. MOROSANU, Ecuatii diferentiale. Aplicatii, Ed. Acad., Bucuresti, 1990.
3. G. MICULA, P. PAVEL, Ecuatii diferentiale si integrale prin exercitii si probleme, Ed. Dacia, Cluj, 1989.
4. M.A. Şerban, Ecuaţii şi sisteme de ecuaţii diferenţiale, Ed. Presa Univ. Clujană, Cluj-Napoca, 2009.

8.3 Laboratory	Teaching methods	Remarks
1. Introduction to MAPLE	Exercise Explanation Individual study	
2. Solving differential equations with MAPLE	Exercise Explanation Individual study	
3. Mathematical models given by differential equations	Exercise Explanation Individual study	
4. Systems of differential equations	Exercise Explanation Individual study	
5. Higher order linear differential equations	Exercise Explanation Individual study	
6. Equilibrium points. Stability	Exercise Explanation Individual study	
7. Laboratory test	Exercise Explanation Individual study	

Bibliography
1. S. Lynch, Dynamical Systems with Applications using MAPLE, Birkauser, 2001.
2. M.A. Şerban, Ecuaţii şi sisteme de ecuaţii diferenţiale, Ed. Presa Univ. Clujană, Cluj-Napoca, 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 syllabus of this course is focused on the differential equations theory, as a basis for a better understanding of the partial differential equations and mathematical models. Moreover, the course propose the following three important directions:
  1. the understanding of the main concepts and methods in the classical theory of differential equations;
  2. the use of Banach's contraction principle in the qualitative theory of differential equations
  3. the applications of the differential equations theory to real world problems.
- The content of this discipline is in accordance with the curricula of the most important universities in Romania and abroad.

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 Differential Equations in problem solving	Seminar written test	10%
	Ability to apply concepts and results acquired during the course in Differential Equations in problem solving using mathematical software	Laboratory practical test	10%
10.6 Minimum standard of performance			
• Fulfillment of the seminar / laboratory attendance criterion (75% seminar attendance, 90% laboratory attendance) • 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. PhD. Andrei 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.*".