SYLLABUS

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 Computer Science
1.4 Field of study	Computer Science
1.5 Study cycle	Bachelor
1.6 Study programme / Qualification	Artificial Intelligence

2. Information regarding the discipline

2.1 Name of the discipline	**Dynamical Systems**						
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 Type of discipline	**compulsory**
2.8 Code of discipline **MLE0010**							

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	70	Of which: 3.5 course	28	3.6 seminar/laboratory	14/14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					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	
4.2. competencies	

5. Conditions (if necessary)

5.1. for the course	

5.2. for the seminar /lab activities	

6. Specific competencies acquired

Professional competencies	• C4.2 Defining basic concepts and principles of computer science and mathematical theories and models • C4.2 Explain and interpret mathematical and computer science 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

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

7.1 General objective of the discipline	• Introduction to differential equations and mathematical modelling using differential equations and systems of differential equations
7.2 Specific objective of the discipline	• Solving the most important solvable differential equations. • Modelling phenomena by differential equations and systems of differential equations. • Analysis of dynamical systems generated by equations and systems of differential equations.

8. Content

8.1 Course	Teaching methods	Remarks
1. The notions of differential equation and solution. Examples of models leading to differential equations	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
2. Classes of first-order sovable differential equations: equations with separable variables, homogeneous equations, linear equations, Bernoulli equations, exact differential equations.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
3. Second order differential equations, linear equations, fundamental system of solutions, variation of constants method, linear equations with constant coefficients	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
4. Systems of linear differential equations, fundamental system of solutions, variation of constants, linear systems with constant coefficients	• Interactive exposure • Explanation • Conversation	

	• Didactical demonstration	
5. Mathematical models governed by first order differential equations: radioactive decay, C14 dating method, the bodies cooling law, escape velocity.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
6. Mathematical models governed by second order differential equations: mathematical pendulum, harmonic pendulum (free oscillations, forced oscillations)	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
7. Dynamical system of scalar autonomous differential equations, flow, equilibrium points, stability, phase portrait	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
8. Mathematical models governed by autonomous equations: the Malthus model, the Verhulst model, harvesting models in population dynamics	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
9. Dynamical system of planar autonomous systems, flow, equilibrium points, stability, phase portrait	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
10. Mathematical models governed by autonomous systems: prey-predator model, competition model, two-species symbiosis model, SIR epidemiological model	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
11. Stability of equilibrium points by Lyapunov functions	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
12. Methods of approximating solutions: successive approximation sequence, Taylor series method, power series method	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
13. Numerical methods for approximating solutions: Euler's method, Taylor's method, Runge-Kutta methods	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
14. Stability of numerical methods	• 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. D. Trif, Metode numerice în teoria sistemelor dinamice, Transilvania Press, 1997.

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. Solving systems of differential equations with MAPLE	• Exercise	

	• Explanation • Individual study	
4. Mathematical models given by differential equations	• Exercise • Explanation • Individual study	
5. Mathematical models given by second order differential equations	• Exercise • Explanation • Individual study	
6. Planar systems of autonomous differential equations	• Exercise • Explanation • Individual study	
7. Laboratory test		

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 content of this discipline is in accordance with the curricula of the most important universities in Romania and abroad.

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		
	• Ability to justify by proofs theoretical results	Final written exam	70%
10.5 Seminar/lab activities	• Ability to apply concepts and results acquired during the course in Differential Equations	Seminar written test Laboratory practical test	30%
10.6 Minimum performance standards			
• 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 has to be at least 5.			

Date	Signature of course coordinator	Signature of seminar coordinator
25.04.2023	Assoc. Prof. PhD. Marcel-Adrian ŞERBAN	Assoc. Prof. PhD. Marcel-Adrian ŞERBAN

Date of approval ..... Signature of the head of department ……