SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babes-Bolyai University
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	Computer Science

2. Information regarding the discipline

2.1 Name of the discipline	**Dynamical Systems**							
2.2 Course coordinator	Conf. dr. Adriana Buică							
2.3 Seminar coordinator	Conf. dr. Adriana Buică							
2.4. Year of study	**1**	2.5 Semester	**2**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**DC**	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	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	14
Additional documentation (in libraries, on electronic platforms, field documentation)	8
Preparation for seminars/labs, homework, papers, portfolios and essays	14
Tutorship	26
Evaluations	6
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, Linear Algebra, Basics of Geometry, Basics of Physics
4.2. competencies	Derivation and integration, Taylor expansion, properties of real functions, eigenvalues, the Kernel of a linear map, quadratic curves, the Newton's second law of motion

5. Conditions (if necessary)

5.1. for the course	Classroom with blackboard

5.2. for the seminar /lab activities	Computers for the laboratory activity

6. Specific competencies acquired

Professional competencies	• C4.5 The incorporation of formal models in specific applications from different domains
Transversal competencies	• CT1 The application of the rules of organized and efficient work, of responsible attitudes toward the didactic-scientific domain, for the creative valorization of their own potential, respecting the principles and the norms of the professional ethic. • CT3 The use of some efficient methods and techniques to learn, to inform themselves, to do research and to develop the abilities for the valorization of their knowledges, to adapt to a dynamical society, and to communicate.

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

7.1 General objective of the discipline	• Introduction to the basic problems of dynamical systems theory as well as the discussion of some related formal models
7.2 Specific objective of the discipline	• To understand the concepts of equilibrium point, orbit, periodic orbit, stability, chaos and to operate with them at least in some simple situations.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction to differential equations (notions, initial conditions, boundary conditions, examples, fundamental problems)	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
2. Linear differential equations (existence and uniqueness theorem, fundamental theorems)	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
3. Linear differential equations with constant coefficients.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
4. Linear differential equations. Applications (Newton's law of cooling, Pendulum equation, Harmonic	• Interactive exposure • Explanation • Conversation	

oscillations)	• Didactical demonstration	
5. Scalar first order linear differential equations	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
6. Linear differential systems	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
7. The dynamical system generated by a differential equation (main notions and first examples). Phase portraits of scalar equations.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
8. Stability of equilibria (definition, examples, stability of linear systems, the linearization method). The nonlinear pendulum equation.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
9. Phase portraits of planar systems.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
10. Numerical methods for ordinary differential equations (Euler and Runge-Kutta numerical formulas)	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
11. Linear recurrences (difference equations) with constant coefficients (fundamental theorems, Fibonacci sequence)	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
12. Linear systems of difference equations (convergent matrix, complex notation)	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
13. Nonlinear scalar discrete dynamical systems (notions, examples, stability of a fixed point)	• Interactive exposure • Explanation • Conversation • Didactical demonstration	
14. The logistic map. Euler numerical formula revisited.	• Interactive exposure • Explanation • Conversation • Didactical demonstration	

Bibliography		
1. The webpage of the course http://www.math.ubbcluj.ro/~abuica/dynsys.htm 2. A. Buică, Lecture notes uploaded in Teams 3. S.E. Elaydi, Discrete Chaos: with applications in science and engineering, CRC Press, 2008. 4. J. Hale, H. Kocak, Dynamics and Bifurcations, Springer, 1991. 5. M.W. Hirsch, S. Smale, R.L. Devaney, Differential Equations, Dynamical Systems and an Introduction to Chaos, Academic Press, 2004. 6. R.Precup, Ecuatii diferentiale, Risoprint, Cluj-Napoca, 2011.		
8.2 Seminar / laboratory	Teaching methods	Remarks
Seminar 1. Linear homogeneous differential equations with constant coefficients. General solutions and properties of solutions (periodicity, oscillations, boundedness…)	• Explanation • Conversation • Didactical demonstration	
Laboratory 1. Introduction to Maple. Basic notions.	• Explanation • Conversation • Didactical demonstration	
Seminar 2. Linear differential equations (the method of undetermined coefficients, the Lagrange method).	• Explanation • Conversation • Didactical demonstration	
Laboratory 2. The use of Maple to find the general solution of linear differential equations, to solve initial and boundary value problems and to study the properties of solutions	• Explanation • Conversation • Didactical demonstration	
Seminar 3. Linear differential equations. Test.	• Explanation • Conversation • Didactical demonstration	
Laboratory 3. The use of Maple to find the general solution to Euler equations and to linear systems. Power series method.	• Explanation • Conversation • Didactical demonstration	
Seminar 4. Phase portraits of scalar nonlinear dynamical systems and planar linear systems.	• Explanation • Conversation • Didactical demonstration	
Laboratory 4. Orbits and direction fields of planar systems.	• Explanation • Conversation • Didactical demonstration	
Seminar 5. Stability of linear systems and of equilibria of nonlinear systems.	• Explanation • Conversation • Didactical demonstration	
Laboratory 5. First integrals of planar systems around equilibria of center type.	• Explanation • Conversation • Didactical demonstration	

Seminar 6. Test. Introduction to linear recurrences.	• Explanation • Conversation • Didactical demonstration	
Laboratory 6. Numerical methods. Nonlinear scalar maps.	• Explanation • Conversation • Didactical demonstration	
Seminar 7. Linear recurrences. Nonlinear scalar maps.	• Explanation • Conversation • Didactical demonstration	
Laboratory 7. Test.	• Examination	

Bibliography

1. The webpage of the course http://www.math.ubbcluj.ro/~abuica/dynsys.htm
2. A. Buică, Lecture notes uploaded in Teams
3. S. Lynch, Dynamical systems with applications using MAPLE, Birkhauser, 2001.
4. Gh. Micula, P. Pavel, Ecuatii diferentiale si integrale prin probleme si exercitii, Ed. Dacia, Cluj-Napoca,1989
5. R. Precup, Ecuatii diferentiale, Risoprint, Cluj-Napoca, 2011.

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 synchronized with the curriculum of most of the important universities from our country and from abroad where the applied mathematics plays an important role.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	• To know the notions and their properties by examples or counterexamples. To be able to apply the theoretical results in concrete problems.	Exam	70%
10.5 Seminar/lab activities	• Solving problems skills	One test	10%
	• Interest and implication in each lab activity. One final test in the last lab.	Dialogue in each lab and one final test	20%
	•		
10.6 Minimum performance standards			
• Presence at least at 6 labs and 5 seminars. To obtain at least 7 points at the lab test and at least 15 points at the written exam. The minimum passing grade is 5.			

Date	Signature of course coordinator	Signature of seminar coordinator
	Conf. dr. Adriana Buică	Conf. dr. Adriana Buică

Date of approval	Signature of the head of department
	Prof. dr. Andrei Mărcuș