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 Mathematics
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 Buica						
2.3 Seminar coordinator	Conf. dr. Adriana Buica						
2.4. Year of study	1	2.5 Semester	2	2.6. Type of evaluation	E	2.7 Type of discipline	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/laboratory	14/14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					40
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					35
Tutorship					5
Evaluations					20
Other activities:					

3.7 Total individual study hours	120
3.8 Total hours per semester	176
3.9 Number of ECTS credits	5

4. Prerequisites (if necessary)

4.1. curriculum	• Mathematical Analysis
4.2. competencies	• Calculate derivatives and integrals for real functions

5. Conditions (if necessary)

5.1. for the course	•
5.2. for the seminar /lab activities	Computers for the laboratory acitvity

6. Specific competencies acquired

Professional competencies	• Understanding of basic concepts of dynamical systems theory and use them to problem-solving activities • Ability to understand and approach problems of modeling nature from other sciences
Transversal competencies	Ability to work independently and/or in a team in order to solve problems in defined professional contexts

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 mathematical 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)	Exposure: description, explanation, examples, dialogue	
2. Linear differential equations (existence and uniqueness theorem, fundamental theorems)	Exposure: description, explanation, examples, dialogue	
3. Linear differential equations with constant coefficients.	Exposure: description, explanation, examples, dialogue	
4. Linear differential equations. Applications (Newton's law of cooling, Pendulum equation, Harmonic oscillations)	Exposure: description, explanation, examples, dialogue	
5. The dynamical system generated by a differential equation (main notions and first examples)	Exposure: description, explanation, examples, dialogue	
6. Stability of equilibria (definition, examples, stability of linear systems, the linearization method)	Exposure: description, explanation, examples, dialogue	
7. Approximate solutions for differential equations (power series solutions, succesive approximations)	Exposure: description, explanation, examples, dialogue	
8. Numerical methods for ordinary differential equations (Euler and Runge-Kutta numerical formulas)	Exposure: description, explanation, examples, dialogue	
9. Linear recurrences (difference equations) with constant coefficients (fundamental theorems, Fibonacci sequence)	Exposure: description, explanation, examples, dialogue	
10. Linear systems of difference equations	Exposure: description,	

(convergent matrix, complex notation)	explanation, examples, dialogue	
11. Nonlinear scalar discrete dynamical systems (notions, examples, stability of a fixed point)	Exposure: description, explanation, examples, dialogue	
12. The logistic map. Euler numerical formula revisited.	Exposure: description, explanation, examples, dialogue	
13. Higher dimensional discrete dynamical systems (notions, examples, stability of the fixed points).	Exposure: description, explanation, examples, dialogue	
14. An overview. Free discussions on the importance of the field of dynamical systems in understanding the physical phenomena.	Exposure: description, explanation, examples, dialogue	

Bibliography

1. P. Blanchard, R.L. Devaney, G.R. Hall, Differential Equations, Brooks/Cole, Cengage Learning, 2012.
2. S. Lynch, Dynamical systems with applications using MAPLE, Birkhauser, 2001.
3. Gh. Micula, P. Pavel, Ecuatii diferentiale si integrale prin probleme si exercitii, Ed. Dacia, Cluj-Napoca,1989.
4. E.R. Scheinerman, Invitation to Dynamical Systems, internet version freely available at http://www.ams.jhu.edu/~ers/invite.html
5. Jon H. Davis, Differential Equations with MAPLE: an Interactive Approach, Birkhäuser, 2001

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Seminar 1. Linear homogeneous differential equations with constant coefficients. General solutions and properties of solutions (periodicity, oscillations, boundedness…)	Explanation, dialogue, examples	
2. Laboratory 1. Introduction to Maple. Basic notions.	Explanation, dialogue, examples	
3. Seminar 2. Linear differential equations (the method of undetermined coefficients, the Lagrange method).	Explanation, dialogue, examples	
4. 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, dialogue, examples	
5. Seminar 3. Linear differential equations. Test.	Explanation, dialogue, examples	
6. Laboratory 3. The use of Maple to find the general solution to Euler equations and to linear systems. Power series method.	Explanation, dialogue, examples	
7. Seminar 4. Phase portraits of scalar nonlinear dynamical systems and planar linear systems.	Explanation, dialogue, examples	
8. Laboratory 4. Orbits and direction fields of planar systems.	Explanation, dialogue, examples	
9. Seminar 5. Stability of linear systems and of equilibria of nonlinear systems.	Explanation, dialogue, examples	
10. Laboratory 5. First integrals of planar systems around equilibria of center type.	Explanation, dialogue, examples	
11. Seminar 6. Test. Introduction to linear recurrences.	Explanation, dialogue, examples	
12. Laboratory 6. Numerical methods.	Explanation, dialogue, examples	
13. Seminar 7. Linear recurrences.	Explanation, dialogue, examples	
14. Laboratory 7. Final test.	test	

Bibliography

1. P. Blanchard, R.L. Devaney, G.R. Hall, Differential Equations, Brooks/Cole, Cengage Learning, 2012.
2. S. Lynch, Dynamical systems with applications using MAPLE, Birkhauser, 2001.
3. Gh. Micula, P. Pavel, Ecuatii diferentiale si integrale prin probleme si exercitii, Ed. Dacia, Cluj-Napoca,1989.
4. E.R. Scheinerman, Invitation to Dynamical Systems, internet version freely available at http://www.ams.jhu.edu/~ers/invite.html
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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	65%
10.5 Seminar/lab activities	Solving problems skills	Two tests	20%
	Interest and implication in each lab activity. One final test in the last lab.	Dialogue in each lab and one final test	15%
10.6 Minimum performance standards			
➢ Presence at least at 90% from the lab activities, at least 10% points from the lab activity, at least 15% points from the written final exam and the minimum passing grade is 5.			

Date	Signature of course coordinator	Signature of seminar coordinator
30-04-2013	Conf. dr. Adriana Buica	Conf. dr. Adriana Buica

Date of approval	Signature of the head of department
30-04-2013	Prof. dr. Octavian Agratini