SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş Bolyai University of Cluj-Napoca**
1.2 Faculty	**Faculty of Mathematics and Computer Science**
1.3 Department	**Department of Mathematics**
1.4 Field of study	**Mathematics**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Master of Advanced Mathematics**

2. Information regarding the discipline

2.1 Name of the discipline	**Reaction-Diffusion Systems**								
2.2 Course coordinator	**Prof.PhD. Radu Precup**								
2.3 Seminar coordinator	**Prof.PhD. Radu Precup**								
2.4. Year of study	**2**	2.5 Semester	**3**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**DS**		

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

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1 sem
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					24
Additional documentation (in libraries, on electronic platforms, field documentation)					22
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					8
Evaluations					16
Other activities:					-

3.7 Total individual study hours	90
3.8 Total hours per semester	132
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1. curriculum	•
4.2. competencies	•

5. Conditions (if necessary)

5.1. for the course	• Partial differential equations; Functional analysis
5.2. for the seminar /lab activities	• Partial differential equations; Functional analysis

6. Specific competencies acquired

Professional competencies	• Use of the theory of linear partial differential equations and of the basic principles of functional analysis for the investigation of nonlinear evolution equations • Ability to apply abstract principles of nonlinear analysis to evolution problems
Transversal competencies	• Understand the role of partial differential equations in mathematical modelling of real evolution phenomena

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

7.1 General objective of the discipline	• Acquire knowledge about some main techniques of investigation of nonlinear problems for evolution equations and systems
7.2 Specific objective of the discipline	• Rewrite boundary value problems as operator equations using the solution operator • Apply general fixed point principles to the operator equations associated to evolution problems • Turing's theory of morphogenesis based on reaction-diffusion systems.

8. Content

8.1 Course	Teaching methods	Remarks
1. Summary of basic notions and results from the theory of linear evolution equations	Exposure: description, explanation, dialogue, examples	
2. The nonhomogeneous heat equation in H^{-1}	Exposure: description, explanation, dialogue, examples	
3. Operator formulation of semilinear problems for the heat equation	Exposure: description, explanation, dialogue, examples	
4. Application of Banach's fixed point theorem	Exposure: description, explanation, examples, proof, dialogue	
5. Application of Schauder's fixed point theorem	Exposure: description, explanation, examples, proof	
6. Application of Leray-Schauder's continuation principle.	Exposure: description, explanation, examples, proof, dialogue	
7. The nonhomogeneous wave equation in H^{-1}	Exposure: explanation, examples, dialogue	
8. Semilinear wave equation with a Lipschitz continuous nonlinearity	Exposure: description, explanation, examples	
9. More general existence results based on	Exposure: description,	

topological principles	explanation, examples, proofs	
10. Pattern formation. Turing instability	Exposure: description, explanation, examples	
11. Activator-inhibitor systems. Conditions for Turing instability	Exposure: description, explanation, examples, discussion of case studies	
12. Bifurcations with domain size	Exposure: description, explanation, examples	
13. Mechanochemical models	Exposure: description, explanation, proofs, examples	
14. Conclusions and further study	Exposure: description, examples, dialogue	

Bibliography

1. R. Precup, Linear and Semilinear Partial Differential Equations, De Gruyter, Berlin, 2012.
2. L.C. Evans, Partial Differential Equations, Amer. Math. Soc., 2010.
3. H. Brezis, Functional Analysis, Sobolev Spaces and Partial Differential Equations, Springer, New York, 2011
4. N. F. Britton, Essential Mathematical Biology, Springer, 2003.
5. J.D. Murray, Mathematical Biology, Springer, 2002.

8.2 Seminar	Teaching methods	Remarks
1. Exemplification of some basic notions and results from the theory of linear evolution partial differential equations	Exercise, dialogue, team work	
2. Heat, wave and Schreodinger equations	Exercise, dialogue, team work	
3. Heat equation with state-depending source; examples	Exercise, explanation, dialogue, team work	
4. Examples of parabolic problems with Lipschitz nonlinearities	Exercise, explanation, dialogue, team work	
5. Examples of parabolic problems with nonlinearities having a growth at most linear	Exercise, explanation, dialogue, team work	
6. Linear wave equations; basic formulas	Exercise, explanation, dialogue, team work	
7. Nonlinear wave equations; conservation of energy	Exercise, explanation, dialogue, team work	
8. Existence of solutions; Lipschitz nonlinearities	Exercise, explanation, dialogue, team work	
9. Sign conditions	Exercise, explanation, dialogue	
10. Problems of eigenvalues and eigenvectors	Exercise, explanation, dialogue, team work	
11. Pattern formation. Turing instability	Exercise, explanation, dialogue, team work	
12. Activator-inhibitor systems. Conditions for Turing instability	Exercise, explanation, dialogue	
13. Bifurcations with domain size	Exercise, explanation, dialogue, team work	
14. Conclusions	Exercise, explanation, dialogue, team work	

Bibliography

1. R. Precup, Linear and Semilinear Partial Differential Equations, De Gruyter, Berlin, 2012.
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5. J.D. Murray, Mathematical Biology, Springer, 2002.

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 contents of the course correspond to current research themes in nonlinear evolution equations in connexion with mathematical models from physics, chemistry and biology.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course		Written exam Continuous observations	60% 10%
10.5 Seminar/lab activities		-Practical examination -continuous observations	20% 10%
10.6 Minimum performance standards			
➢ At least grade 5 (from a scale of 1 to 10) at both written exam and seminar practical examination			

Date | Signature of course coordinator | Signature of seminar coordinator

April 9, 2019 | Prof.PhD. Radu Precup | Prof.PhD. Radu Precup

Date of approval | Signature of the head of department

April 15, 2019 | Prof.PhD. Octavian Agratini