SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babes-Bolyai University Cluj-Napoca**
1.2 Faculty	**Mathematics and Computer Science**
1.3 Department	**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. Ph.D. Radu Precup**						
2.3 Seminar coordinator	**Prof. Ph.D. Radu Precup**						
2.4. Year of study	**2**	2.5 Semester	**2**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Optional**

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
3.4 Total hours in the curriculum	36	Of which: 3.5 course	24	3.6 seminar/laboratory	12

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	54
Additional documentation (in libraries, on electronic platforms, field documentation)	52
Preparation for seminars/labs, homework, papers, portfolios and essays	40
Tutorship	18
Evaluations	15
Other activities:	10

3.7 Total individual study hours	189
3.8 Total hours per semester	225
3.9 Number of ECTS credits	9

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	Apply basic theory of linear partial differential equations to semilinear evolution equations; Use of the fundamental principles of nonlinear functional analysis. Understanding Turing theory of pattern formation
Transversal competencies	Understand the role of partial differential equations in mathematical modelling of real 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 boundary value problems for evolution equations • Understanding Turing theory of pattern formation
7.2 Specific objective of the discipline	• Rewrite boundary value problems as operator equations • Apply general fixed point principles to the operator equations associated to boundary value problems

8. Content

8.1 Course	Teaching methods	Remarks
1. Summary basic notions and results from the theory of linear partial differential equations	Exposure: description, explanation, dialogue, examples	
2. Fourier series in H^{-1}	Exposure: description, explanation, dialogue, examples	
3. The nonhomogeneous heat equation	Exposure: description, explanation, dialogue, examples	
4. Applications of Banach’s, Schauder’s and Leray-Schauder’s fixed point theorems	Exposure: description, explanation, dialogue, examples	
5. The nonhomogeneous wave equation	Exposure: description, explanation, dialogue, examples	
6. Applications of Banach’s and Schauder’s fixed point theorems	Exposure: description, explanation, dialogue, examples	
7. The nonhomogeneous Schrodinger equation	Exposure: description,	

	explanation, dialogue, examples	
8. Vector approach to systems of evolution equations	Exposure: description, explanation, dialogue, examples	
9. The Turing Mechanism; Some examples	Exposure: description, explanation, dialogue, examples	
10. Turing instability	Exposure: description, explanation, dialogue, examples	
11. Biological pattern formation	Exposure: description, explanation, dialogue, illustrations	
12. Some open problems and new research directions	Exposure: description, explanation	

Bibliography

1. R. Precup, Lectii de ecuatii cu derivate partiale, Presa Universitara Clujeana, 2004.
2. R. Precup, Linear and Semilinear Partial Differential Equations, De Gruyter, 2012.
3. H. Brezis, Functional Analysis, Sobolev Spaces and Partial Differential Equations, Springer, 2011.
4. J. Jost, Partial Differential Equations, Springer, 2007.
5. J. Murray, Mathematical Biology, Springer, 1989.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Some mathematical models given by evolution equations	Exercise, explanation, dialogue	
2. Eigenvalues and eigenfunctions	Exercise, explanation, dialogue, team work	
3. Several types of nonlinearities in semilinear evolution equations	Exercise, explanation, dialogue	
4. The heat equation; maximum principles	Exercise, explanation, dialogue, team work	
5. Semigroup theory	Exercise, explanation, dialogue, team work	
6. Hyperbolic equation; propagation of disturbances	Exercise, explanation, dialogue	
7. Symmetric hyperbolic systems	Exercise, explanation, dialogue, team work	
8. Traveling waves	Exercise, explanation, dialogue, team work	

9. Entropy and vanishing viscosity	Exercise, explanation, dialogue	
10. Student exposure	Exposure, discussion	
11. Student exposure	Exposure, discussion	
12. Student exposure	Exposure, discussion	

Bibliography

1. R. Precup, Lectii de ecuatii cu derivate partiale, Presa Universitara Clujeana, 2004.
2. R. Precup, Linear and Semilinear Partial Differential Equations, De Gruyter, 2012.
3. H. Brezis, Functional Analysis, Sobolev Spaces and Partial Differential Equations, Springer, 2011.
4. J. Jost, Partial Differential Equations, Springer, 2007.
5. L.C. Evans, Partial Differential Equations, AMS, 1998.

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 boundary value problems and make connexion to mathematical evolution models from physics, biology, medicine etc.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course		Written test Continuous observations	60% 10%
10.5 Seminar/lab activities		-Practical examination -continous observations	20% 10%
10.6 Minimum performance standards			

- Application of the fixed point technique to evolution problems
- Understanding of the Turing mechanism

Date	Signature of course coordinator	Signature of seminar coordinator
May 10, 2022	Prof.PhD. Radu Precup	Prof.PhD. Radu Precup

Date of approval	Signature of the head of department
May 18, 2022	Prof.PhD. Octavian Agratini