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	**Doctoral School in Mathematics and Computer Science**
1.4 Field of study	**Mathematics**
1.5 Study cycle	**Doctoral studies**
1.6 Study programme	**TRAINING PROGRAM BASED ON ADVANCED ACADEMIC STUDIES**

2. Information regarding the discipline

2.1 Name of the discipline		**Fixed Point Theory and Applications**					
2.2 Course coordinator		**Prof. Adrian Petruşel**					
2.3 Seminar coordinator		**Prof. Adrian Petruşel**					
2.4. Year of study	**1**	2.5 Semester	**1**	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 sem.
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	50
Additional documentation (in libraries, on electronic platforms, field documentation)	78
Preparation for seminars/labs, homework, papers, portfolios and essays	50
Tutorship	24
Evaluations	12
Other activities:	

3.7 Total individual study hours	214
3.8 Total hours per semester	250
3.9 Number of ECTS credits	10

4. Prerequisites (if necessary)

4.1. curriculum	Mathematical Analysis, Differential Equations, Functional Analysis
4.2. competencies	Use of advanced nonlinear analysis concept and results

5. Conditions (if necessary)

5.1. for the course	Video projector, Math software
5.2. for the seminar /lab activities	Laboratory with computers; high level of advanced mathematical analysis concepts

6. Specific competencies acquired

Professional competencies	· Ability to understand and manipulate advanced concepts, results and mathematical theories · Acquiring advanced methods of functional and nonlinear analysis · Ability to use the scientific language and to write scientific reports and papers.
Transversal competencies	· Ability to read, understand and work independently or in a team, in order to obtain original studies and to solve complex problems. · Ability for continuous self-perfecting and study. · Ability to use advanced and complementary knowledge to write reports and to realize a Ph.D. Thesis in Mathematics.

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

7.1 General objective of the discipline	- to present the basic concepts and results in nonlinear analysis with focus on fixed point theory for single-valued and multi-valued operators in metric and topological contexts.
7.2 Specific objective of the discipline	- basic concepts and results of metric fixed point theory - main concepts and results concerning topological fixed point theory - basic applications of the fixed point theory for single-valued and multi-valued operators

8. Content

8.1 Course	Teaching methods	Remarks
1. Picard and weakly Picard operator theory for single-valued operators (examples, characterization results, iteration methods)	**Expositions**: description, explanation, class lectures, dialog-based lectures, lectures with demonstrations, introductive lectures, synthesis lectures. **Conversations**: debate, dialog, introductive conversations, conversations for knowledge consolidation, conversations to systematize and synthesize knowledge **Use of problems**: use of problem questions, problems and problem situations.	4 courses
2. Picard and weakly Picard operator theory for multi-valued operators (examples, main results, iteration methods)	the same as before	4 courses
3. Applications of the fixed point theory in various domains: integral and differential equations and inclusions, optimization theory, mathematics of fractals,	the same as before	4 courses

applied functional analysis		
8.2 Seminar	Teaching methods	Remarks
1. Examples and exercises related to Picard and weakly Picard operator theory for single-valued operators	**Conversations**: debate, dialog, introductive conversations, conversations for knowledge consolidation, conversations to systematize and synthesize knowledge **Use of problems**: use of problem questions, problems and problem situations.	4 seminars
2. Examples and exercises related to Picard and weakly Picard operator theory for multi-valued operators	the same as before	4 seminars
3. Examples and exercises related to some applications of the fixed point theory	the same as before	4 seminars

Bibliography

1) I.A. Rus, A. Petrusel, G. Petrusel, Fixed Point Theory, Presa Universitară Clujeană, 2008.
2) A. Granas, J. Dugundji, Fixed Point Theory, Springer, 2003.
3) W.A. Kirk, N. Shahzad, Fixed Point Theory in Distance Spaces, Springer, 2014.
4) P.H. Kumar, An Itroduction to Nonlinear Analysis and Fixed Point Theory, Springer, 2018.
5) J. Andres, L. Gorniewicz, Topological Fixed Point Principles for Boundary Value Problems, Springer, 2003.

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 syllabus of this course is focused on the theory of Picard and weakly Picard operator theory, as a basis for a good research activity through the Doctoral School in Mathematics.
Moreover, the course propose the following three important directions:

1. the understanding of the main concepts in nonlinear analysis theory in metric and topological structures;
2. to understand the role and the applications of the (weakly) Picard operator theory;
3. applications of the Picard and WPO theory to various related fields.

The content of this discipline is in accordance with the curricula of other important universities, where nonlinear functional analysis and fixed point theory plays an essential role. This discipline is useful for young researchers in pure and applied mathematics.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Knowledge of basic concepts and results and to understand the proofs	Final Written Test	50%
10.5 Seminar	Ability to solve examples and exercises	Middle term written test	40%
10.6 Minimum performance standards			
Successful passing of the exam is conditioned by the final grade that has to be at least 5.			

Date 30.06.2021 | Signature of course coordinator | Signature of seminar coordinator Prof. Adrian Petruşel

Date of approval	Signature of the head of doctoral school
07.07.2021	Prof. dr. Gabriela Czibula