COURSE DESCRIPTION

Fixed Point Theory and Applications

Academic year 2025-2026

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University Cluj-Napoca
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Doctoral School	Doctoral School of Mathematics and Computer Science
1.4. Field of study	Mathematics
1.5. Level of study	Doctoral Studies

2. Course-related data

2.1. Course title	**Fixed Point Theory and Applications**			Course code	**MDE3147**
2.2. Course coordinator	Prof. Adrian PETRUSEL				
2.3. Seminar coordinator	Prof. Adrian PETRUSEL				
2.4. Year of study	1	2.5. Semester	1	2.6. Type of assessment	Progress check
2.7. Course status	Optional	2.8. Course type			Specialisation subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**3**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**1**
3.4. Total of hours in the curriculum	36	of which: 3.5. course	24	3.6. seminar/ laboratory	**12**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					48
Additional research in the library, on subject-specific electronic platforms, and on-site					48
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					48
Tutoring (professional guidance)					24
Examinations					9
Other activities					37
3.7. Total hours of individual study (IS) and self-taught activities (ST)				214	
3.8. Total hours per semester				250	
3.9. Number of credits				**10**	

4. Prerequisites (where applicable)

4.1. curriculum-related	Mathematical Analysis, Topology, Functional Analysis, Nonlinear Analysis
4.2 skills-related	Skills related to notions and results from Mathematical Analysis, Functional Analysis, Nonlinear Analysis

5. Specific conditions (where applicable)

5.1. course-related	Computer, Video projector
5.2. seminar/laboratory-related	Computer, Video projector

6. Subject-specific learning outcomes

Knowledge
1. New concepts to develop new theories
2. New results and original approaches
3. New applications and relevant examples, consistent open questions
4. Ethical and deontological norms and rules in scientific research
Skills
1. The student can formulate new concepts and can give relevant examples
2. The student can propose new results and methods with adequate proofs
3. The student can give illustrative applications or examples of the main theoretical results
Responsibility and autonomy
1. The student can understand and formulate critical thinking concerning different research studies
2. The student can describe a new method or theory in comparison with old approaches
3. The student can work independently and write short research papers on a subject of his own choice or the coordinator's choice

7. Contents

7.1. Course	Teaching and learning methods	Remarks[1]
Contraction Principle and Applications	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.	
Generalized Contractions and Applications	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.	

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[1] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

Coincidence Point Theory for Single-Valued Operators	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.	
Coupled Fixed Point Theory for Single-Valued Operators	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.	
Multi-Valued Contraction Principle and Applications	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.	
Multi-Valued Generalized Contractions and Applications	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.	
Coincidence Point Theory for Multi-Valued Operators	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.	
Coupled Fixed Point Theory for Multi-Valued Operators	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.	
Best Proximity Point Theory	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.	
Open Problems in Fixed Point Theory	Use of problems: use of problem questions, problems and problem situations.	

Bibliography:
I.A. Rus, **A. Petrusel**, G. Petrusel, Fixed Point Theory, Presa Universitara Clujeana, 2008.
A. Granas, J. Dugundji, Fixed Point Theory, Springer, 2003.
A. Petrusel: Operator Inclusions, House of the Book of Science Cluj-Napoca, 2002, 165 pp., ISBN 973-686-312-3.
V. Berinde, **A. Petrusel**, I.A. Rus, M.A. Serban: The retraction-displacement condition in the theory of fixed point equation with a convergent iterative algorithm, in Mathematical Analysis, Approximation Theory and their Applications (Th.M. Rassias, V. Gupta-Eds.), Springer 2016, pp. 75-106.
A. Petrusel, G. Petrusel: Coupled fixed points and coupled coincidence points via fixed point theory, in: Mathematical Analysis and Applications, Book Editors: M. Ruzhansky, H. Dutta, R.P. Agarwal, Wiley, 2018, pp. 661-717.
A. Petrusel, I.A. Rus: Ulam Stability of Zero Point Equations, in: Ulam type Stability, J. Brzdek, D. Popa, Th.M. Rassias - Editors, Springer Cham, 2019, pp. 345-364.
A. Petrusel, I.A. Rus: Graphic contraction principle and applications, Mathematical Analysis and Applications (Th.M. Rassias, P.M. Pardalos - Eds.), Springer Cham, 2019, 411-432.
A. Petrusel, G. Petrusel, J.-C. Yao: Fixed point theory for multi-valued Feng-Liu operators in vector-valued metric spaces. Recent developments in fixed-point theory-theoretical foundations and real-world applications, 43-63. Ind. Appl. Math. Springer, Singapore, 2024.

7.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
Examples and Exercises concerning Fixed Point Theory for Single-Valued Operators	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.	
Examples and Exercises concerning Fixed Point Theory for Multi-Valued Operators	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.	
Examples and Exercises concerning Coincidence Point Theory and Coupled Fixed Point Theory	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.	
Examples and Exercises concerning Best Proximity Point Theorems	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.	

Bibliography:

I.A. Rus, A. Petrusel, G. Petrusel, Fixed Point Theory, Presa Universitara Clujeana, 2008.
A. Granas, J. Dugundji, Fixed Point Theory, Springer, 2003.
A. Petrusel: Operator Inclusions, House of the Book of Science Cluj-Napoca, 2002, 165 pp., ISBN 973-686-312-3.

8. Evaluation

Type of activity	8.1 Evaluation criteria[2]	8.2 Evaluation methods[3]	8.3 Percentage in the final grade
8.4. Course	Knowledge of concepts and basic results	Middle Term Written Test	40%
	Knowledge to give new results and independent and original proofs	Final Written Test	40%
8.5. Seminar/ laboratory	Ability to justify by proofs theoretical results	Written and Oral Reports	10%
	Ability to apply concepts and results acquired in fixed point theory and related fields	Written and Oral Reports	10%
8.6 Minimum standard for passing			
Successful passing of the exam is conditioned by the final grade that has to be at least 5. All university official rules with respect to the student attendance of academic activities, as well as to cheating and plagiarism, are valid and enforced.			

9. SDG labels (Sustainable Development Goals)[4]

		Sustainable Development Generic Label

1 FĂRĂ SĂRĂCIE	2 FOAMETE „ZERO"	3 SĂNĂTATE SI BUNĂSTARE	4 EDUCATIE DE CALITATE	5 EGALITATE DE GEN	6 APĂ CURATĂ SI SANITATIE	7 ENERGIE CURATĂ SI LA PRETURI ACCESIBILE	8 MUNCĂ DECENTĂ SI CRESTERE ECONOMICĂ	9 INDUSTRIE, INOVATIE SI INFRASTRUCTURĂ
O	O	O	X	O	O	O	O	O

10 INEGALITĂTI REDUSE	11 ORASE SI COMUNITĂTI DURABILE	12 CONSUM SI PRODUCTIE RESPONSABILE	13 ACTIUNE CLIMATICĂ	14 VIATA ACVATICĂ	15 VIATA TERESTRĂ	16 PACE, JUSTITIE SI INSTITUTII EFICIENTE	17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR	No label applies
O	O	O	O	O	O	O	O	O

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[2] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[3] Both final evaluation methods and ongoing evaluation strategies should be established.

[4] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*

Date of entry: Signature of course coordinator   Signature of seminar coordinator
10,02.2026

                                         Adrian PETRUSEL   Adrian PETRUSEL

Date of approval in the department: Signature of the head of department
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