SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babes-Bolyai University 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	Advanced Mathematics

2. Information regarding the discipline

2.1 Name of the discipline	Morse theory and applications						
2.2 Course coordinator	Prof.dr. Varga Csaba						
2.3 Seminar coordinator	Prof.dr. Varga Csaba						
2.4. Year of study	**I**	2.5 Semester	**4**	2.6. Type of evaluation	**C**	2.7 Type of discipline	**Optional/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
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					42
Additional documentation (in libraries, on electronic platforms, field documentation)					40
Preparation for seminars/labs, homework, papers, portfolios and essays					60
Tutorship					12
Evaluations					10
Other activities:					

3.7 Total individual study hours	164
3.8 Total hours per semester	200
3.9 Number of ECTS credits	8

4. Prerequisites (if necessary)

4.1. curriculum	• Differential and Algebraic topology, PDE's
4.2. competencies	• Functional Analysis, Critical points theory • Maximum principle

5. Conditions (if necessary)

5.1. for the course	• videoprojector
5.2. for the seminar /lab activities	• videoprojector

6. Specific competencies acquired

Professional competencies	• The ability to understand and manipulate concepts, results and theories advanced in mathematics • Ability to use the knowledge gained and complementary in achieving a PhD in Mathematics
Transversal competencies	• Ability to self-improvement and to train continuously

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 critical points and Morse theory and applicationin PDE's.
7.2 Specific objective of the discipline	• basic concepts and tools of critical points theory • main concepts and results concerning critical groups and Morse inequalities • basic concepts of algebraic topology • homotopical and homological linking • applications to nonlinear PDE's.

8. Content

8.1 Course	Teaching methods	Remarks
1. Sobolev spaces	**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.	
2. Critical points and Principle of Symmetric Criticality	the same as before	
3. Abstract formulation of the problems and example	the same as before	

4. Homotopy and Alexander-Spanier cohomology	the same as before	
5. Compactness conditions and deformations lemmas	the same as before	
6. Critical groups, homotopical and homological linking	the same as before	
7. Nontrivial critical and mountain pass points	the same as before	
8. p-linear eigenvalue problem	the same as before	
9. Mountain pass solutions and cohomological local splitting	the same as before	
10. Jumping nonlinearity and Dancer-Fucik spectrum	the same as before	
11. Indefinite eigenvalue problem	the same as before	
12. Anisotropic systems	the same as before	

Bibliography

1. K. Perera, R.P. Agarwal, Donal O'Regan, Morse theoretic Aspects of p-Laplaccian Operators, AMS, 2010.
2. K. Perera, M. Schecter, Topics in critical point theory, Cambridge University Press, 2013.
3. K.-C. Chang, Infinite Dimensional Morse Theory and Multiple Solution Problems, Birkhauser Boston 1993.
4. R. A. Adams, Sobolev Space. Academic Press, 1975.
5. E. Spanier, Algebraic Topology, McGraw-Hill Book, 1966.
6. A. Kristaly, V. Radulescu, Cs. Varga, Variational Principles in Mathematical Physics, Geometry, and Economics, 2010.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Compact embeddings of Sobolev spaces	**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	
2. Applications of the Principle of Symmetric Criticality	the same as before	
3. Examples and exercises concerning p-Laplacian problems	the same as before	
4. Examples and exercises concerning homotopy and Alexander-Spanier cohomology	the same as before	
5. Compactness conditions and deformations lemmas	the same as before	
6. Examples and exercises homotopical and homological linking sets	the same as before	
7. Calculation of the critical groups in some concrete examples	the same as before	
8. Examples and exercises concerning p-linear eigenvalue problem	the same as before	
9. Dancer-Fucik spectrum	the same as before	
10. Jumping nonlinearity	the same as before	
11. Indefinite eigenvalue problem	the same as before	
12. Examples and exercises concerning anisotropic problems	the same as before	

Bibliography
1. K. Perera, R.P. Agarwal, Donal O'Regan, Morse theoretic Aspects of p-Laplaccian Operators, AMS, 2010.
2. K. Perera, M. Schecter, Topics in critical point theory, Cambridge University Press, 2013.
3. K.-C. Chang, Infinite Dimensional Morse Theory and Multiple Solution Problems, Birkhauser Boston 1993.
4. R. A. Adams, Sobolev Space. Academic Press, 1975.
5. E. Spanier, Algebraic Topology, McGraw-Hill Book, 1966.
6. A. Kristaly, V. Radulescu, Cs. Varga, Variational Principles in Mathematical Physics, Geometry, and Economics, 2010.

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 multivalued 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 critical points theory;
2. the use of the most important linking, mountain pass theorem;
3. the applications of critical points and Morse theory to PDE's.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course		Middle term written test	25%
		Final Written Test	50%
10.5 Seminar/lab activities		Written and Oral Report	25%
10.6 Minimum performance standards			
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 students attendance of academic activities, as well as to cheating and plagiarism, are valid and enforced.			

Date	Signature of course coordinator	Signature of seminar coordinator
April 25th, 2016	Prof.dr. Varga Csaba	Prof.dr. Varga Csaba

Date of approval	Signature of the head of department
April 25th, 2016	Prof.dr. Octavian Agratini