SYLLABUS

1. Information regarding the programme

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

2. Information regarding the discipline

2.1 Name of the discipline	**Aspects of critical point theory**						
2.2 Course coordinator	**Prof.PhD. Dorin Andrica**						
2.3 Seminar coordinator	**Prof.PhD. Dorin Andrica**						
2.4. Year of study	**2**	2.5 Semester	**1**	2.6. Type of evaluation	**C**	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	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					33
Additional documentation (in libraries, on electronic platforms, field documentation)					33
Preparation for seminars/labs, homework, papers, portfolios and essays					33
Tutorship					29
Evaluations					4
Other activities:					-

3.7 Total individual study hours	133
3.8 Total hours per semester	175
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1. curriculum	• General topology • Multivariable mathematical analysis • Differential geometry
4.2. competencies	• Logical thinking, notions and results from the above mentioned fields

5. Conditions (if necessary)

5.1. for the course	•

5.2. for the seminar /~~lab activities~~	•

6. Specific competencies acquired

Professional competencies	• Description of concepts, theories and models used in the application field • Identification of adequate models and methods for solving real problems
Transversal competencies	• Efficient fulfillment of organized activities in an inter-disciplinary group and development of empathic abilities of inter-personal communication, relationship and collaboration with various groups

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

7.1 General objective of the discipline	• To introduce the basic notions and results of Critical Point Theory as well as some of its applications
7.2 Specific objective of the discipline	• To present some applications of Critical Point Theory to various fields of Mathematics

8. Content

8.1 Course	Teaching methods	Remarks
1. The rank of a differentiable mapping	interactive exposure, explanation, didactical demonstration	
2. The critical set and the bifurcation set for a differentiable mapping	interactive exposure, explanation, didactical demonstration	
3. Submanifolds and the pre-image theorem. Applications	interactive exposure, explanation, didactical demonstration	
4. The Lagrange multipliers rule	interactive exposure, explanation, didactical demonstration	
5. Critical points of a real mapping	interactive exposure, explanation, didactical demonstration	
6. Nondegenerate critical points and the Morse lemma	interactive exposure, explanation, didactical demonstration	
7. Critical points and the gradient field	interactive exposure, explanation, didactical demonstration	
8. The first deformation lemma and the mini-max principle	interactive exposure, explanation, didactical demonstration	
9. The second deformation lemma	interactive exposure, explanation, didactical demonstration	
10. The existence of critical points	interactive exposure, explanation, didactical demonstration	
11. Lusternik-Schnirelman category and the	interactive exposure, explanation,	

multiplicity theorem	didactical demonstration	
12. Morse inequalities and some applications	interactive exposure, explanation, didactical demonstration	
13. Critical groups	interactive exposure, explanation, didactical demonstration	
14. Methods of computations	interactive exposure, explanation, didactical demonstration	

Bibliography

1. D.Andrica, C.Pintea, *Elemente de teoria omotopiei cu aplicatii la studiul punctelor critice*, Editura MIRTON, Timisoara, 2002.
2. D.Andrica, *Critical Point Theory and Some Applications*, Cluj University Press, 2005.
3. T.Bartsch, *Topological Methods for Variational Problems with Symmetries*, Springer Verlag, 1993.
4. D.Burghelea,s.a., *Introducere in topologia diferentiala*, Editura Stiintifica, Bucuresti, 1973.
5. K.C.Chang, *Infinite Dimensional Morse Theory and Multiple Solution Problems*, Birkhauser, Boston-Basel-Berlin, 1993.
6. Y.Matsumoto, *An Introduction to Morse Theory*, AMS, Providence, RI, 2002.
7. R.S.Palais, C-L.Terng, *Critical Point Theory and Submanifold Geometry*, Springer Verlag, 1988.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Review on manifolds and smooth mappings	interactive exposure, conversation	
2. Immersions, submersions, and embeddings	interactive exposure, conversation	
3. Sard's theorem	interactive exposure, conversation	
4. Applications of Sard's theorem	interactive exposure, conversation	
5. Whitney's embedding theorem	interactive exposure, conversation	
6. Applications of the pre-image theorem	interactive exposure, conversation	
7. Some basic constructions of Morse functions	interactive exposure, conversation	
8. The distance function and the height function	interactive exposure, conversation	
9. Topological properties of the Lusternik-Schnirelman category	interactive exposure, conversation	
10. The Morse–Smale characteristic of a manifold	interactive exposure, conversation	
11. Computation of the Morse-Smale characteristic(1)	interactive exposure, conversation	
12. Computation of the Morse-Smale characteristic(2)	interactive exposure, conversation	
13. Applications to some curvature problems	interactive exposure, conversation	
14. The "phi"-category of a pair of manifolds	interactive exposure, conversation	

Bibliography

1. D.Andrica, C.Pintea, *Elemente de teoria omotopiei cu aplicatii la studiul punctelor critice*, Editura MIRTON, Timisoara, 2002.
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3. D.Burghelea,s.a., *Introducere in topologia diferentiala*, Editura Stiintifica, Bucuresti, 1973.
4. Y.Matsumoto, *An Introduction to Morse Theory*, AMS, Providence, RI, 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 is directed towards applications of Critical Point Theory to mathematical research
- The content of this discipline is synchronized with the curriculum of most of the important universities from our country and from abroad where the study of mathematics plays an important role.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	To understand the notions and the results by typical examples or counterexamples. To be able to present the main ideas in the proof of the theoretical results.	Two ongoing tests (week 6 and week 12)	50%
	To develop a specific subject by reading the bibliography.	Report	30%
10.5 Seminar/~~lab activities~~	Solving problems skills	Evaluation of the homeworks	20%
	Active participation in the classroom		
10.6 Minimum performance standards			
➢ At least grade 5 (from a scale of 1 to 10)			

Date	Signature of course coordinator	Signature of seminar coordinator
08.01.2015	Prof.dr.Dorin Andrica	Prof.dr.Dorin Andrica

Date of approval	Signature of the head of department
15.01.2015	Prof.dr.Octavian Agratini