SYLLABUS

1. Information regarding the programme

1.1 I Higher education institution	BABES-BOLYAI UNIVERSITY
1.2 Faculty	MATHEMATICS AND COMPUTER SCIENCE
1.3 Departamentul	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	HOMOTOPICAL ALGEBRA						
2.2 Course coordinator	Conf. Dr. George Ciprian Modoi						
2.3 Seminar coordinator	Conf. Dr. George Ciprian Modoi						
2.4 Year of study	2	2.5 Semester	4	2.6. Type of evaluation	E	2.7 Type of discipline	DS

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	3.2 Of which: course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	36	Of which: course	24	3.6 seminar/laboratory	12
Learning using manual, course support, bibliography, course notes					45
Additional documentation (in libraries, on electronic platforms, field documentation)					45
Preparation for seminars/labs, homework, papers, portfolios and essays					45
Tutorship					34
Evaluations					20
Other activities:					
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	Homological Algebra (MME3112) and Category Theory (MME3123)
4.2 competencies	Basic knowlege of categories, functors, complexes and their homology.

5. Conditions (if necessary)

5.1 for the course	N/A
5.2 for the seminar /lab activities	N/A

6. Specific competencies acquired

Professional competencies	• Knowledge, understanding and use of main concepts and results in Homotopical Algebra (simplicial sets, homotopy theory of categories, model categories) • Ability to use fundamental theoretical concepts and to apply them in various fields of mathematics fields of mathematics (Algebra, Topology, Geometry etc.) • Ability to use scientific language and to write scientific reports and papers
Transversal competencies	• Ability to inform themselves, to work independently or in a team; • Ability to identify and use advanced techniques and methods in order to realize a specific research. • Ability for continuous self-perfecting and study.

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

7.1 General objective of the discipline	The understanding the homotopical point of view about Mathematics. Ability to use fundamental theoretical concepts and to apply them in various fields of mathematics fields of mathematics
7.2 Specific objective of the discipline	Knowledge, understanding and use of main concepts and results in Homological Algebra Use the machinery of model categories in order to deal with their homotopy category and with derived functors

8. Content

8.1 Course	Teaching methods	Remarks
1. Presheaves	Lectures, didactical demonstration, conversation	
2. Simplicial sets: basics and examples	Lectures, didactical demonstration, conversation	
3. Geometric realization	Lectures, didactical demonstration, conversation	
4. Cellular filtrations	Lectures, didactical demonstration, conversation	
5. The nerve of a category	Lectures, didactical demonstration, conversation	
6. Kan extensions and adjointness	Lectures, didactical demonstration,	

	conversation	
7. Homotopy theory of categories	Lectures, didactical demonstration, conversation	
8. Model categories	Lectures, didactical demonstration, conversation	
9. Derived functors	Lectures, didactical demonstration, conversation	
10. Examples of model categories	Lectures, didactical demonstration, conversation	
11. The model category of simplicial sets	Lectures, didactical demonstration, conversation	
12. Stable model categories	Lectures, didactical demonstration, conversation	

Bibliography

1. Yuri Berest, Sasha Patotski – *Homotopical Algebra*, lecture notes of the graduate course MATH 7400, Cornell University, http://pi.math.cornell.edu/~apatotski/7400-notes-2015.pdf
2. D.-C. Cisinski – *Higher Categories and Homotopical Algebra*, Cambridge Studies in Advanced Mathematics 180, Cambridge University Press, 2019.
3. M. Hovey – *Model Categories*, Mathematical Surveys and Monographs 63, American Mathematical Society, 1999.
4. S. Mac Lane – *Categories for the Working Mathematician*, Graduate Text in Mathematics, Second Edition, Springer Verlag, 1998.

8.2 Seminar / laboratory	Teaching methods	Remarks
1. Preasheves and Yoneda Lemma	problematization, exercises, problem solving	
2. Simplicial sets and triangulations	problematization, exercises, problem solving	
3. Simplicial sets and topological spaces	problematization, exercises, problem solving	
4. CW Complexes	problematization, exercises, problem solving	
5. The nerve of various categories	problematization, exercises, problem solving	
6. Examples of adjoints	problematization, exercises, problem solving	
7. Bar resolution	problematization, exercises, problem solving	
8. Examples of model categories	problematization, exercises, problem	

	solving	
9. Examples of derived functors	problematization, exercises, problem solving	
10. Stable module categories, homotopy category of (co)chain complexes	problematization, exercises, problem solving	
11. The model category of simplicial sets	problematization, exercises, problem solving	
12. Triangulation of the homotopy category of a model category	problematization, exercises, problem solving	

Bibliography

1. S. Gelfand, Y. Manin – *Methods of Homological Algebra*, Springer Monographs in Mathematics, Second Edition, Springer Verlag, 2003.
2. B. Richter – *From Categories to Homotopy Theory*, Cambridge Studies in Advanced Mathematics 188, Cambridge University Press, 2020.

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 content of this discipline is in accordance with the curricula of many important universities.

Lying between Algebra and Topology, Homotopical Algebra is useful since it realizes connections between various mathematical domains, its methods can be used in order to appoach important problems in mathematics.

The methods and tools presented here are often used in specifical PhD research activities.

10. Evaluare

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Concepts and basic results	Final exam	20%
	Examples	Final exam	20%
10.5 Seminar / lab activities	Ability to use the concepts in order to solve standard problems	Final exam	20%
	Ability to solve advanced problems	Homeworks	40%
10.6 Minimum performance standards			
At least grade 5 out 10.			

Date	Signature of course coordinator	Signature of seminar coordinator
29.04.2021	Conf. Dr. George Ciprian Modoi	Conf. Dr. George Ciprian Modoi

Date of approval

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Signature of the head of department

Prof. Dr. Octavian Agratini