1. Information regarding the programme

1.1 Higher education institution	Babeş Bolyai University
1.2 Faculty	Faculty of Mathematics and Computer Science
1.3 Department	Department 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	Algebraic topology						
2.2 Course coordinator	Assoc.Prof.PhD. Cornel Pintea						
2.3 Seminar coordinator	Assoc.Prof.PhD. Cornel Pintea						
2.4. Year of study	**1**	2.5 Semester	**1**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Compulsory**

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

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar	1
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					40
Additional documentation (in libraries, on electronic platforms, field documentation)					44
Preparation for seminars/labs, homework, papers, portfolios and essays					50
Tutorship					10
Evaluations					14
Other activities:					-
3.7 Total individual study hours	158				
3.8 Total hours per semester	200				
3.9 Number of ECTS credits	8				

4. Prerequisites (if necessary)

4.1. curriculum	● Elementary abstract algebra
4.2. competencies	● Competencies of logic reasonings and in using the knowledges of the above mentioned curricula.

5. Conditions (if necessary)

5.1. for the course	● The classroom should be gifted with a board and video projector. The attendance is strongly recommended.
5.2. for the seminar /lab activities	● The classroom should be gifted with a board and . The attendance is strongly recommended.

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 Algebraic Topology as well as some of its applications
7.2 Specific objective of the discipline	● To present some applications of Algebraic Topology to various fields of Mathematic s

8. Content

8.1 Course	Teaching methods	Remarks
1. Elementary homotopy theory 1.1 Homotopy of paths 1.2 The fundamental group	Exposure: description, explanation, examples	
1.3 The fundamental group of the circle and applications 1.4 *The Fundamental Theorem of Algebra (seminar)* *1.5 Brower fixed point Theorem (seminar)*	Exposure: description, explanation, examples	
1.6 The fundamental group of higher dimensional spheres *1.7* The Borsuk-Ulam Theorem *1.8 The Seifert-VanKampen theorem (seminar)*	Exposure: description, explanation, examples	
1.9 Homotopy of maps 1.10 Covering spaces 1.11 A lifting criterion 1.12 Fibrations. Examples 1.11.1 Serre/Weak fibrations	Exposure: description, explanation, examples	1

1.11.2 Hurewicz fibrations 1.11.3 Locally trivial fibrations		
1.12 Higher order homotopy groups 1.13 Higher order relative homotopy groups 1.14 The boundary operator 1.15 The induced group homomorphisms 1.16 The exact sequence of a triplet 1.17 The exact sequence of a fibration	Exposure: description, explanation, examples, proofs, debate, dialogue	
2. Singular homology theory 2.1 Affine preliminaries 2.2 Singular theory 2.3 Chain complexes 2.4 Homotopy invariance of Homology	Exposure: description, explanation, examples, proofs, debate, dialogue	
2.5 The Relation between π_1 and H_1 2.6 Relative homology 2.7 The exact homology sequence	Exposure: description, explanation, examples.	
2.8 The excision Theorem 2.9 The Mayer-Vietoris exact sequence 2.10 The Jordan-Brower separation Theorem	Exposure: description, explanation, examples, proofs	
3. Orientation and duality of manifolds 3.1 Orientation on manifolds 3.2 Singular cohomology	Exposure: description, explanation, examples, proofs	
3.3 Cup and Cap products	Exposure: description, explanation, examples, proofs	
3.4 Algebraic limits	Exposure: description, explanation, examples, proofs	
3.5 Poincare duality	Exposure: description, explanation, examples, proofs	
4 The homology and cohomology of products of spaces 4.1 The Kuneth formula	Exposure: description, explanation, examples, proofs	
4.1 The universal coefficient Theorem	Exposure: description, explanation, examples, proofs	
Bibliography		

1. D.Andrica, C.Pintea, Elemente de teoria omotopiei cu aplicatii la studiul punctelor critice, Editura MIRTON, Timisoara, 2002.
2. 2. D.Andrica, I.N.Casu, Grupuri Lie, aplicatia exponentiala si mecanica geometrica, Presa Universitara Clujeana, 2008.
2. A.Dold, Lectures on Algebraic Topology, Springer-Verlag, Berlin-Heidelberg-New York, 1972.
3. M.J.Greenberg, J.R.Harper, Algebraic Topology.A first course, Addison-Wesley, 1981.
4. C.Godbillon, Elements de topologie algebrique, Hermann, Paris, 1971.
5. A. Hatcher, Algebraic topology, Cambridge University Press, 2002.
6. S-T. Hu, Homotopy Theory, Academic Press, New York and London, 1959.
7. D. Husemoller , Fibre Bundles (Third Edition), 1994 Springer-Verlag .
8. W.S.Massey, Algebraic Topology: An Introduction, Harcourt, Brace&World, 1967.
9. I.Pop, Topologie algebrica, Editura Stiintifica, Bucuresti, 1990.
10. E.Spanier, Algebraic Topology, McGraw Hill, 1966.

8.2 Seminar	Teaching methods	Remarks
The Fundamental Theorem of Algebra The Brower fixed point Theorem	Explation, dialogue, solving problems	One tutorial
The fundamental group of higher dimensional spheres The Borsuk-Ulam Theorem	Dialogue, debate, examples, solving problems	Two tutorials
The fundamental groups of surfaces	Dialogue, debate, case studies, examples, solving problems	Two tutorials
The fundamental groups of classical Lie groups	Dialogue, debate, case studies, examples, solving problems	Two tutorials
Higher order homotopy grouops of classical Lie groups	Dialogue, debate, examples, solving problems	Two tutorials
Differential manifolds	Dialogue, debate, examples, solving problems	Two tutorials
Differential forms	Dialogue, debate, examples, solving problems	One tutorial
The DeRham cohomology	Dialogue, debate, examples, solving problems	Two tutorials

Bibliography

1. D.Andrica, C.Pintea, Elemente de teoria omotopiei cu aplicatii la studiul punctelor critice, Editura MIRTON, Timisoara, 2002.

2. D.Andrica, I.N.Casu, Grupuri Lie, aplicatia exponentiala si mecanica geometrica, Presa Universitara Clujeana, 2008.

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5. A. Hatcher, Algebraic Toology, https://pi.math.cornell.edu/~hatcher/AT/AT+.pdf

6. W.S.Massey, Algebraic Topology: An Introduction, Harcourt, Brace&World, 1967.

7. Pintea C., Geometrie. Geometrie diferenţialăGeometrie riemanniană. Grupuri şi algebra Lie, Presa Universitară Clujeană, 2006.

8. Pintea, C.,The size of critical and tangency sets, Presa Universitară Clujeană , 2021 .

9. I.Pop, Topologie algebrica, Editura Stiintifica, Bucuresti, 1990.

10. E.H. Spanier, Algebraic Topology, McGraw-Hill Education (1981)

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 oriented towards applications of Algebraic Topology to mathematical research.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	The students are expected 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.	Written final exam consisting in theoretical questions alongside applications and problems.	50%
	To develop a specific subject by reading the bibliography.	Reports	35%
10.5 Seminar	Solving problems skills the classroom	Quiz versus active participation in the classroom	15%
10.6 Minimum performance standards			
At least grade 5 (from a scale of 1 to 10) at the final exam and the grade for tutorial component.			

Date | Signature of course coordinator | Signature of seminar coordinator

28.09.2025 | Prof. Cornel PINTEA | Prof. Cornel PINTEA

Date of approval | Signature of the head of department

..... | Prof. Andrei MĂRCUS