SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babeş-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	Bachelor of Science
1.6 Study programme / Qualification	Mathematics and Computer Science

2. Information regarding the discipline

2.1 Name of the discipline	Real Analysis						
2.2 Course coordinator	Lect. dr. Adriana Nicolae						
2.3 Seminar coordinator	Lect. dr. Adriana Nicolae						
2.4. Year of study	2	2.5 Semester	4	2.6. Type of evaluation	C	2.7 Type of discipline	Compulsory

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

3.1 Hours per week	4	Of which: 3.2 course	2	3.3 seminar/laboratory	2
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					30
Additional documentation (in libraries, on electronic platforms, field documentation)					10
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					4
Evaluations					5
Other activities					-
3.7 Total individual study hours	69				
3.8 Total hours per semester	125				
3.9 Number of ECTS credits	5				

4. Prerequisites (if necessary)

4.1. curriculum	• Calculus 1, 2
4.2. competencies	• Analytic thinking

5. Conditions (if necessary)

5.1. for the course	• Lecture hall equipped with blackboard
5.2. for the seminar /lab activities	• Classroom equipped with blackboard

6. Specific competencies acquired

Professional competencies	• C1.1 Identification of notions, description of theories and use of specific language. • C1.4 Recognition of main classes/types of mathematical problems and of appropriate techniques for solving them. • C5.2 Use of mathematical arguments to prove mathematical results.
Transversal competencies	• CT1 Application of efficient and rigorous working rules by adopting responsible attitudes towards the scientific and didactic fields for the development of the own creative potential respecting professional and ethical principles.

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

7.1 General objective of the discipline	• To acquire fundamental knowledge about general topology, general measure theory and integration, and to apply it in solving problems.
7.2 Specific objective of the discipline	• To acquire knowledge about the two main parts of the course: elements of general topology (e.g., topological spaces, separation axioms, continuity, metric spaces, compactness, connectedness) and elements of general measure theory and integration (e.g., σ-algebras, measures, outer measures, Lebesgue measure, integration of measurable functions, limit theorems).

8. Content

8.1 Course	Teaching methods	Remarks
1. Topological spaces and related definitions	Lecture, discussion, didactical demonstration, problematisation	
2. Interior, closure and boundary of a set. Bases of topologies	Lecture, discussion, didactical demonstration, problematisation	
3. Continuous functions. Homeomorphisms. Separation axioms.	Lecture, discussion, didactical demonstration, problematisation	
4. Metric spaces	Lecture, discussion, didactical demonstration, problematisation	
5. Compactness in topological spaces and in metric spaces. Compactness and continuous functions	Lecture, discussion, didactical demonstration, problematisation	
6. Connectedness in topological spaces	Lecture, discussion, didactical demonstration, problematisation	
7. Algebras and σ-algebras. Measures	Lecture, discussion, didactical demonstration, problematisation	
8. Outer measures	Lecture, discussion, didactical demonstration, problematisation	
9. The Lebesgue measure	Lecture, discussion, didactical demonstration, problematisation	
10. Measurable functions	Lecture, discussion, didactical demonstration, problematisation	
11. Integration of measurable functions (I)	Lecture, discussion, didactical demonstration, problematisation	
12. Integration of measurable functions (II)	Lecture, discussion, didactical demonstration, problematisation	
13. Limit theorems and applications (I)	Lecture, discussion, didactical demonstration, problematisation	
14. Limit theorems and applications (II). The relation between the Riemann and Lebesgue integrals	Lecture, discussion, didactical demonstration, problematisation	

Bibliography

1. V. Anisiu, Topologie şi teoria măsurii, Universitatea "Babeş-Bolyai", Cluj-Napoca, 1993.
2. J.J. Benedetto, W. Czaja, Integration and modern analysis, Birkhäuser, Boston, MA, 2009.
3. D.L. Cohn, Measure theory, 2nd ed., Birkhäuser/Springer, New York, 2013.
4. R. Engelking, General topology, 2nd ed., Heldermann Verlag, Berlin, 1989.
5. G.B. Folland, Real analysis. Modern techniques and their applications, 2nd ed., John Wiley & Sons, Inc., New York, 1999.
6. J.L. Kelley, General topology. Reprint of the 1955 edition [Van Nostrand, Toronto, Ont.], Springer, New York-Berlin, 1975.
7. J.R. Munkres, Topology, 2nd ed., Prentice Hall, Inc., Upper Saddle River, NJ, 2000.
8. W. Rudin, Real and complex analysis, 3rd ed., McGraw-Hill Book Co., New York, 1987.

9. B. Simon, A comprehensive course in analysis. Part 1: Real analysis, American Mathematical Society, Providence, RI, 2015. 10. E. Stein, R. Shakarchi, Real analysis. Measure theory, integration, and Hilbert spaces, Princeton University Press, Princeton, NJ, 2005.

8.2 Seminar	Teaching methods	Remarks
1. Topological spaces and related definitions	Discussion, problem solving, didactical demonstration	
2. Interior, closure and boundary of a set. Bases of topologies	Discussion, problem solving, didactical demonstration	
3. Continuous functions. Homeomorphisms. Separation axioms.	Discussion, problem solving, didactical demonstration	
4. Compactness	Discussion, problem solving, didactical demonstration	
5. Compactness in topological spaces and in metric spaces. Compactness and continuous functions	Discussion, problem solving, didactical demonstration	
6. Connectedness in topological spaces	Discussion, problem solving, didactical demonstration.	
7. Algebras and σ-algebras. Measures	Discussion, problem solving, didactical demonstration	
8. Outer measures	Discussion, problem solving, didactical demonstration	
9. The Lebesgue measure	Discussion, problem solving, didactical demonstration	
10. Measurable functions	Discussion, problem solving, didactical demonstration	
11. Integration of measurable functions (I)	Discussion, problem solving, didactical demonstration	
12. Integration of measurable functions (II)	Discussion, problem solving, didactical demonstration	
13. Limit theorems and applications (I)	Discussion, problem solving, didactical demonstration	
14. Limit theorems and applications (II). The relation between the Riemann and Lebesgue integrals.	Discussion, problem solving, didactical demonstration	

Bibliography (in addition to the books mentioned before which also contain exercises)
1. A.V. Arkhangelʹskiĭ, V.I. Ponomarev, Fundamentals of general topology: Problems and exercises, D. Reidel Publishing Co., Dordrecht, 1984.
2. R.L. Schilling, Measures, integrals and martingales, Cambridge University Press, New York, 2005.
3. W.J. Kaczor, M.T. Nowak, Problems in Mathematical Analysis III. Integration, American Mathematical Society, Providence, RI, 2003.

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 course ensures a solid theoretical background, according to national and international standards. This discipline is useful in preparing future teachers and researchers in mathematics, but is also addressed to those who use various modern mathematical methods and techniques in other areas.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade
10.4 Course	- Knowledge of basic	- Test, exam	- Test: 30%

	notions, examples and results - Ability to prove theoretical results	- Lecture and seminar activity	- Exam: 70% - Lecture and seminar activity: bonus max. 5%
10.5 Seminar/lab activities	- Problem solving using concepts and results acquired during the lecture classes - Attendance according to the rules of the faculty		
10.6 Minimum performance standards			
Both the grade at the exam and the final average should be at least 5.			

Date
4.05.2020

Signature of course coordinator
Lect. dr. Adriana Nicolae

Signature of seminar coordinator
Lect. dr. Adriana Nicolae

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