SYLLABUS

1. Information regarding the programme

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

2. Information regarding the discipline

2.1 Name of the discipline	**Calculus**						
2.2 Course coordinator	**Conf. dr. Breckner Brigitte**						
2.3 Seminar coordinator	**Conf. dr. Breckner Brigitte**						
2.4. Year of study	**1**	2.5 Semester	**1**	2.6. Type of evaluation	**Written Exam**	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	4	Of which: 3.5 course	2	3.6 seminar/laboratory	2
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					34
Additional documentation (in libraries, on electronic platforms, field documentation)					20
Preparation for seminars/labs, homework, papers, portfolios and essays					20
Tutorship					10
Evaluations					10
Other activities:					-

3.7 Total individual study hours	94
3.8 Total hours per semester	150
3.9 Number of ECTS credits	6

4. Prerequisites (if necessary)

4.1. curriculum	• High-school calculus
4.2. competencies	• Logical thinking abilities

5. Conditions (if necessary)

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

6. Specific competencies acquired

Professional competencies	C4.1 Defining basic concepts, theory and mathematical models C4.2 Interpretation of mathematical models C4.3 Identifying the appropriate models and methods for solving real-life problems C4.5 Embedding formal models in applications from various areas
Transversal competencies	CT1 Application of efficient and rigorous working rules, manifest responsible attitudes towards the scientific and didactic fields, respecting the professional and ethical principles. CT3 Use of efficient methods and techniques for learning, information, research and development of abilities for knowledge acquiring, for adapting to the needs of a dynamic society and for communication in Romanian as well as in a widely used foreign language.

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

7.1 General objective of the discipline	• Acquiring knowledge about the algebraic and topological structure of the Euclidean space IR^n and the basic notions and results concerning the differential and integral calculus of real-valued functions of several real variables.
7.2 Specific objective of the discipline	• Representation of the algebraic and topological structure of the Euclidian space R^n. • Study of sequences of reals and of infinitely series of reals. • Sequences in R^n. • Differential and integral calculus in R and R^n.

8. Content

8.1 Course	Teaching methods	Remarks
1. The system of real numbers (upper and lower bound of a set; minimum and maximum of a set; infimum and supremum of a set; the infimum principle, the supremum principle and its consequences; the sets of natural numbers, the set integer numbers, the set of rational numbers, and the set of irrational numbers; the extended set of real numbers).	Lecture, discussion, problematisation.	
2. The set of real numbers (absolute value and distance; neighborhood of a point). Sequences of real numbers (definition of the limit and its characterizations; uniqueness of the limit; subsequence of a sequence; sandwich theorem; the connection between the existence of the limit of a sequence and the boundedness of the sequence).	Lecture, discussion, problematisation.	
3. Sequences of real numbers (existence of the limit for monotone sequences; applications: the irrational number e; fundamental sequences; Cauchy's convergence criterion). Series of real	Lecture, discussion, problematisation.	

numbers (the sum of a series; operations with convergent series; properties of convergent series).		
4. Series of real numbers (convergence/divergence criteria for series: Cauchy's general criterion, Cauchy's condensation criterion, comparison criteria, the root criterion, Kummer's criterion and its consequences, D'Alembert's and Raabe-Duhamel's criteria; absolutely convergent series; the Leibniz criterion for alternant series).	Lecture, discussion, problematisation.	
5. Real-valued functions of a single real variable (limits; continuous functions; differentiable functions).	Lecture, discussion, problematisation.	
6. Real-valued functions of a single real variable (primitives and indefinite integrals; Riemann integrability).	Lecture, discussion, problematisation.	
7. Real-valued functions of a single real variable (improper integrals: convergence criteria for improper integrals).	Lecture, discussion, problematisation.	
8. The euclidean space R^n (algebraic structure; inner product and norm; topological structure).	Lecture, discussion, problematisation.	
9. Sequences in R^n (limit of a sequence; operations with convergent sequences). Real-valued functions of several real variables (limits; operations with functions which have a limit; continuity; operations with continuous functions; Weierstrass' theorem).	Lecture, discussion, problematisation.	
10. Vector-valued functions of several real variables (limits; continuity). Differential calculus in R^n (the derivative of a vector-valued function of a single real variable; the mean value theorem for vector-valued functions of a single real variable).	Lecture, discussion, problematisation.	
11. Differential calculus in R^n (first order and higher order partial derivatives of real-valued functions of several real variables; C^1-functions; the Schwarz theorem).	Lecture, discussion, problematisation.	
12. Differential calculus in R^n (differentiability of real-valued functions of several real variables; the mean value theorem; operations with differentiable functions; second order differentiability).	Lecture, discussion, problematisation.	
13. Differential calculus in R^n (local optima of real-valued functions of several real variables; necessary and sufficient conditions for local optima).	Lecture, discussion, problematisation.	
14. Integral calculus in R^n (Riemann integrability of real-valued functions of several real variables over compact intervals in R^n).	Lecture, discussion, problematisation.	
Bibliography 1. BRECKNER W. W.: Analiza matematica. Topologia spatiului R^n, Universitatea din Cluj-Napoca, Cluj-		

Napoca, 1985.

2. COBZAS S.: Analiza matematica (Calcul diferential), Presa Universitara Clujeana, Cluj-Napoca, 1998.

3. MEGAN M.: Analiza matematica, vol. 1,2. Editura Mirton, Timisoara, 1999.

4. MURESAN, M.: A Concret Approach to Classical Analysis, Springer, New York, 2008.

5. OBERGUGGENBERGER M. And OSTERMANN A.: Analysis for Computer Scientists, Foundations, Methods, and Algorithms, Springer, 2011.

6. sites.google.com/site/brigittebreckner

8.2 Seminar / laboratory	Teaching methods	Remarks
1. The system of real numbers (upper and lower bound of a set; minimum and maximum of a set; infimum and supremum of a set) and the induction principle.	Discussion, problem solving, self-study, team work.	
2. Sequences of reals (operations with convergent sequences; typical examples for convergent/divergent sequences; computation of limits).	Discussion, problem solving, self-study, team work.	
3. Series of reals (the irrational number e as the sum of some remarkable series; telescopical series; computation of the sum of concrete series of reals).	Discussion, problem solving, self-study, team work.	
4. Series of reals (application of the presented convergence/divergence criteria to check the convergence/divergence of some series).	Discussion, problem solving, self-study, team work.	
5. Real-valued functions of a single real variable (limits; continuous functions; differentiable functions).	Discussion, problem solving, self-study, team work.	
6. Real-valued functions of a single real variable (primitives and indefinite integrals; Riemann integrability).	Discussion, problem solving, self-study, team work.	
7. Real-valued functions of a single real variable (improper integrals: convergence criteria for improper integrals).	Discussion, problem solving, self-study, team work.	
8. Exercises and problems related to the algebraic and topological structure of R^n.	Discussion, problem solving, self-study, team work.	
9. Limits of sequences in R^n. Real-valued functions of several real variables (limits, continuity).	Discussion, problem solving, self-study, team work.	
10. Vector-valued functions of several real variables (limits; continuity). Differential calculus in R^n (the derivative of a vector-valued function of a single real variable).	Discussion, problem solving, self-study, team work.	
11. Differential calculus in R^n (first order and higher order partial derivates of real-valued functions of several real variables).	Discussion, problem solving, self-study, team work.	
12. Differential calculus in R^n (the chain rule).	Discussion, problem solving, self-study, team work.	
13. Computing local optima of real-valued	Discussion, problem	

functions of several real variables.	solving, self-study, team work.	
14. Computing double and triple integrals over compact intervals.	Discussion, problem solving, self-study, team work.	

Bibliography

1. DUCA D. I. si E. DUCA: Exercitii si probleme de analiza matematica, vol. I si II, Casa Cartii de Stiinta, Cluj-Napoca, 2007, 2009.

2. TRIF T.: Probleme de calcul diferential si integral in R^n, Casa Cartii de Stiinta, Cluj-Napoca, 2003.

3. sites.google.com/site/brigittebreckner

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 course is designed to satisfy the expectations of several networks of professionals of recognised expertise. The results of our students validate this statement.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Exam	Written exam	60%
10.5 Seminar/lab activities	Continuous evaluation	Evaluation of the weekly activity	20%
	Midterm test (compulsory)	Midterm test	20%
10.6 Minimum performance standards 5			
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Date	Signature of course coordinator	Signature of seminar coordinator
28.04.2015	Conf. dr. Brigitte Breckner	Conf. dr. Brigitte Breckner

Date of approval ..... Signature of the head of department

Prof. dr. Octavian Agratini