COURSE DESCRIPTION

Complex Analysis

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeş-Bolyai University
1.2. Faculty	Mathematics and Computer Science
1.3. Department	Mathematics
1.4. Field	Mathematics
1.5. Level of study	Bachelor
1.6. Degree programme / Qualification	Mathematics and Computer Science
1.7. Form of education	Full-time

2. Course-related data

2.1. Course title	Complex Analysis			Course code	MLE0008
2.2. Course coordinator	Lecturer PhD Mihai IANCU				
2.3. Seminar coordinator	Lecturer PhD Mihai IANCU				
2.4. Year of study	2	2.5. Semester	3	2.6. Type of assessment	Exam
2.7. Course status		Compulsory		2.8. Course type	Core subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	**4**	of which: 3.2. course	**2**	3.3. seminar/ laboratory/ project	**2**
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. seminar/ laboratory	**28**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					20
Additional research in the library, on subject-specific electronic platforms, and on-site					12
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					20
Tutoring (professional guidance)					9
Examinations					8
Other activities					
3.7. Total hours of individual study (IS) and self-taught activities (ST)			**69**		
3.8. Total hours per semester			**125**		
3.9. Number of credits			**5**		

4. Prerequisites (where applicable)

4.1. curriculum-related	• Calculus 1 (Analysis on **R**); Calculus 2 (Differential and integral calculus in $\mathbf{R}^n$); Analytical geometry
4.2 skills-related	• useful logical thinking and mathematical notions and results from the above mentioned fields

5. Specific conditions (where applicable)

5.1. course-related	• Classroom with blackboard/whiteboard
5.2. seminar/laboratory-related	• Classroom with blackboard/whiteboard

6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

Professional competencies

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes. If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

Competency code	Competency
PC2	perform analytical mathematical calculations
PC6	think abstractly
PC8	study relationships between quantities
Transversal competencies	
Competency code	**Competency**
TC4	Solve problems
TC5	Think analytically

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
PC2	7. The student/graduates selects, explains, and specifies the mathematical foundations applied in computer science, including formal logic, algebra, probability, and statistics.	7. The student/graduates applies, evaluates, and proposes mathematical methods for modeling, simulating, and solving computer science problems.
PC6	4. The student/graduate defines the basic concepts from advanced mathematics disciplines in the curriculum.	4. The student/graduate answers questions and correctly and rigorously formulates the statements of mathematical assertions (lemmas, propositions, theorems) from the disciplines in the curriculum.
PC8	3. The student/graduate formulates observations and differentiates notions, properties, and assertions from the core disciplines of mathematics through examples and counterexamples.	3. The student/graduate identifies and describes the essential elements in the construction of proofs of mathematical assertions (lemmas, propositions, theorems), recognizes errors in reasoning, and corrects them.
TC4	2. The student/graduate compares and distinguishes related notions and their properties from the core disciplines of mathematics.	2. The student/graduate recognizes and analyzes the necessary and/or sufficient conditions in the statements of mathematical assertions and specifies their role in the proof.
TC5	2. The student/graduate compares and distinguishes related notions and their properties from the core disciplines of mathematics.	2. The student/graduate recognizes and analyzes the necessary and/or sufficient conditions in the statements of mathematical assertions and specifies their role in the proof.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Define and correctly use the fundamental concepts of Complex Analysis, including complex numbers, limits, differentiability, holomorphy, Moebius transformations, complex integration, power series and Laurent series.
2. State and explain the main theorems and results of complex analysis, such as the Cauchy-Riemann theorem, Cauchy's Integral Formula, Liouville's Theorem, Maximum Modulus Theorem and the Residue Theorem.
Specific academic skills
1. Apply complex analytic methods to compute contour integrals, using residues.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

2. Analyse and solve problems involving holomorphic functions and conformal mappings, while constructing rigorous mathematical proofs and identifying key hypotheses in theorem statements.

8. Content

8.1. Course	**Teaching and learning methods**	**Remarks**[3]
1. Complex numbers. The complex plane. The stereographic projection. The extended complex plane.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
2. The derivative of complex functions of one complex variable. Paths in **C**. Fundamental notions and results.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
3. The Cauchy-Riemann theorem. Holomorphic functions. General properties. Applications.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
4. Elementary functions. Harmonic functions. Examples. Linear fractional transformations (Möbius transformations). General properties. Applications.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
5. Integration of complex functions. General properties of the complex integral.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
6. Primitives (anti-derivatives) of complex functions of one complex variable. Fundamental results.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
7. Cauchy's theorem. Applications.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
8. Cauchy's formulas. Cauchy's inequalities. Morera's and Liouville's theorems. Applications.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
9. Sequences of holomorphic functions. Weierstrass' theorem. Series of holomorphic functions. Fundamental results.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	

[3] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

10. Power series. The Cauchy-Hadamard theorem. The equivalence between analyticity and holomorphy.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
11. Zeros of holomorphic functions. The identity theorem of holomorphic functions. The maximum modulus theorem. Schwarz's lemma.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
12. Laurent series. Singular points. Classification of isolated singularities. Meromorphic functions.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
13. The residue theorem. Applications to calculus of complex integrals.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
14. Applications of residue theorem to the evaluation of real integrals.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	

Bibliography

1. Hamburg, P., Mocanu, P.T., Negoescu, N., *Mathematical Analysis* (*Complex Functions*), Editura Didacticã şi Pedagogică, Bucureşti, 1982 (in Romanian).
2. Kohr, G., *Complex Analysis*, lecture notes (in Romanian), 2020.
3. Kohr, G., Mocanu, P.T., *Special Topics of Complex Analysis*, Cluj University Press, Cluj-Napoca, 2005 (in Romanian).
4. Ahlfors, L.V., *Complex Analysis*, 3rd ed., McGraw-Hill Book Co., New York, 1979.
5. Bulboacă, T., Joshi, S.B., Goswami, P., *Complex Analysis. Theory and Applications*, de Gruyter, Berlin, Boston, 2019.
6. Conway, J.B., *Functions of One Complex Variable,* vol. I, Graduate Texts in Mathematics, Springer Verlag, New York, 1978 (Second Edition).
7. Gaşpar, D., Suciu, N., *Complex Analysis*, Publishing House of the Romanian Academy, Bucharest, 1999 (in Romanian).
8. Krantz, S., *Handbook of Complex Variables*, Birkhäuser Verlag, Boston, Basel, Berlin, 1999.
9. Narasimhan, R., Nievergelt, Y., *Complex Analysis in One Variable*, Second Edition, Birkhäuser, 1985.
10. Popa, E., *Introduction in the Theory of Functions of One Complex Variable*, A.I. Cuza Univ. Press , Iaşi, 2001 (in Romanian)
11. Rudin, W., *Real and Complex Analysis*, 3rd ed., Mc. Graw-Hill, 1987.
12. Stein, E.M., Shakarchi, R., *Complex Analysis,* Princeton University Press, 2003.
13. Zakeri, S., *A Course in Complex Analysis*, Princeton University Press, 2021.

8.2 **Seminar**	Teaching methods	Remarks

1. Properties of complex numbers. Applications.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
2. The stereographic projection. The extended complex plane. Sequences of complex numbers.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
3. Complex functions of one complex variable. Examples and applications.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
4. The derivative of functions of one complex variable. Applications of the Cauchy-Riemann theorem. The geometric interpretation of the complex derivative.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
5. Linear fractional transformations (Möbius transformations). Applications (I).	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
6. Linear fractional transformations (Möbius transformations). Applications (II).	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
7. Entire functions. Harmonic functions. Examples and applications.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
8. The complex integral. Computation of elementary complex integrals. Applications of Cauchy's theorem.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
9. Cauchy's formulas. Applications.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
10. Taylor series expansions.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
11. Applications of Liouville's and maximum modulus theorems for holomorphic functions.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
12. Laurent series expansions. Isolated singular points. Examples and applications.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
13. Applications of Residue theorem to calculus of complex integrals.	Description of arguments and proofs for solving problems. Direct answers to students. Homework assignments.	
14. Applications of Residue theorem to calculus of real integrals.	Description of arguments and proofs for solving problems. Direct answers to students.	

	Homework assignments.	

Bibliography

1. Hamburg, P., Mocanu, P.T., Negoescu, N., *Mathematical Analysis* (*Complex Functions*), Editura Didacticã şi Pedagogicã, Bucureşti, 1982 (in Romanian).
2. Kohr, G., *Complex Analysis*, seminar notes (in Romanian), 2020.
3. Kohr, G., Mocanu, P.T., *Special Topics of Complex Analysis*, Cluj University Press, Cluj-Napoca, 2005 (in Romanian).
4. Berenstein, C.A., Gay, R., *Complex Variables: An Introduction*, Springer-Verlag New York Inc., 1991.
5. Bulboacă, T., Joshi, S.B., Goswami, P., *Complex Analysis. Theory and Applications*, de Gruyter, Berlin, Boston, 2019.
6. Conway, J.B., *Functions of One Complex Variable,* vol. I, Graduate Texts in Mathematics, Springer Verlag, New York, 1978 (Second Edition).
7. Krzyz, J., *Problems In Complex Variable Theory*, American Elsevier Publishing Company, 1971.
8. Popa, E., *Introduction in the Theory of Functions of One Complex Variable*, A.I. Cuza Univ. Press , Iaşi, 2001 (in Romanian)
9. Volkovysky, L., Lunts, G., Aramanovich, I., *Problems in the Theory of Functions of a Complex Variable*, Moscow: MIR Publishers, 1972.
10. Evgrafov, M., Bejanov, K., Sidorov, Y., Fedoruk, M., Chabounine, M., *Recueil de Problèmes sur la Théorie des Fonctions Analytiques*, Moscou: Editions Mir, 1974.
11. Mocanu, G., Stoian, G., Vişinescu, E., *Function Theory of One Complex Variable* (*Textbook of Problems*), Editura Didacticã şi Pedagogicã, Bucureşti, 1970 (in Romanian).
12. Sălăgean, G.S., *Geometria Planului Complex*, Promedia-Plus, Cluj-Napoca, 1997.

9. Evaluation

Type of activity	9.1 Evaluation criteria[4]	9.2 Evaluation methods[5]	9.3 Percentage in the final grade
9.4. Course	Knowledge of concepts and basic results.	Written exam.	60%
	Ability to justify by proofs theoretical results.		
9.5. Seminar/ laboratory	Ability to apply concepts and results acquired at the course in solving concrete problems of complex analysis.	Evaluation of student activity during the semester, and active participation in the seminar activity. A midterm written test.	10% 30%
	There are valid the official rules of the faculty concerning the attendance of students to teaching activities.		

[4] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[5] Both final evaluation methods and ongoing evaluation strategies should be established.

9.6 Minimum standard for passing
The final grade should be at least 5 (from a scale of 1 to 10).

10. SDG labels (Sustainable Development Goals)[6]

	○	Sustainable Development Generic Label

1 FĂRĂ SĂRĂCIE	2 FOAMETE „ZERO”	3 SĂNĂTATE ȘI BUNĂSTARE	4 EDUCAȚIE DE CALITATE	5 EGALITATE DE GEN	6 APĂ CURATĂ ȘI SANITAȚIE	7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE	8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ	9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ
○	○	○	○	○	○	○	○	X
10 INEGALITĂȚI REDUSE	11 ORAȘE ȘI COMUNITĂȚI DURABILE	12 CONSUM ȘI PRODUCȚIE RESPONSABILE	13 ACȚIUNE CLIMATICĂ	14 VIAȚA ACVATICĂ	15 VIAȚA TERESTRĂ	16 PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE	17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR	No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
14.04.2026

Signature of course coordinator

Lecturer PhD Mihai IANCU

Digitally signed by
MIHAI IANCU
Date: 2026.04.14 23:58:20
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Signature of seminar coordinator

Lecturer PhD Mihai IANCU

Date of approval in the department:
24.04.2026

Signature of the head of department

Prof. dr. Andrei Mărcuș

[6] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *“No label applies.”*