

**MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATION OF
THE REPUBLIC OF UZBEKISTAN
CHIRCHIQ STATE PEDAGOGICAL UNIVERSITY**



Approved by”

Acting vice-rector for
educational affairs

D.B.Akhmadjanov

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**SYLLABUS FOR
MATHEMATICAL ANALYSIS
(Form of education: full-time 2-course)**

Field of knowledge	500 000 – Natural Sciences, Mathematics and Statistics
Field of education:	540 000 – Mathematics and Statistics
Direction of education:	60540200-Applied Mathematics

CHIRCHIQ – 2025



SYLLABUS OF SUBJECT

Academic year:	2025/2026		
Course name:	Mathematical Analysis		
Course type:	Compulsory		
Course code:	MA112316		
Year:	4 years		
Form of education:	Full-time		
Type of education:	Bachelor's degree		
Distribution of hours per semester:	Total	3-semester	4-semester
	150	150	—
Lectures	30	30	—
Practical classes	30	30	—
Laboratory classes	—	—	—
Seminars	—	—	—
Self-study	90	90	—
Credit units:	5	5	—
Assessment form:	Midterm examination	written	—
	Final control	written	—
Department responsible for the course:	Algebra and mathematical analysis		

Information about the course instructor

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1. Course Objectives (CO)

CO 1	The main objective of the Mathematical Analysis course is to familiarize students with a necessary set of mathematical information (concepts, theorems and their proofs, methods for solving practical problems, etc.). At the same time, it serves to teach students logical thinking, correct reasoning, improving mathematical culture, and also to acquaint students with the foundations of modern mathematics, to explain the essence of mathematical analysis capabilities in consciously researching professional problems, finding solutions to problems, and teaching them to apply these capabilities.
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2. Prerequisite knowledge required for the course

1.	Mathematics
2.	Algebra
3.	Geometry

3. Learning Outcomes (LO)

	In terms of knowledge:
LO1	Demonstrate a deep understanding of mathematical analysis concepts and principles;
LO2	Deeply analyze the essence of mathematical analysis methods;
LO3	Possess knowledge, skills and competencies in mathematical analysis, algebra and number theory, geometry, differential equations, probability theory to solve problems in professional activities, and participate in scientific research work.
LO4	Problems (examples and exercises) of the mathematical analysis course are presented, and students are given the opportunity to practice applying the necessary mathematical techniques and methods to solve them.
	In terms of skills:
LO5	Students perform given practical examples or problems both in teams and individually.
LO6	The student understands the goals, objectives, and essence of the given example or problem, studies the problem, and conducts research.
LO7	The student analyzes the results obtained, prepares presentations with solutions, and defends them.

4. Course content		
Lecture format (L)		Hours
1st half-year		
L1	Power series.	2
L2	Taylor series.	2
L3	Fourier series.	2
L4	Functions of several variables.	2
L5	Limit of functions of several variables.	2
L6	Continuous functions of several variables.	2
L7	Uniform continuity of functions of several variables.	2
L8	Differentiation of functions of several variables.	2
Midterm examination		
L9	Applications of the differential of functions of several variables to approximate calculations.	2
L10	Higher-order derivatives and differentials of functions of several variables.	2
L11	Differentiation of implicit functions.	2
L12	Extrema of functions of several variables.	2
L13	Maximum and minimum values of functions of several variables. Directional derivative.	2
L14	Double integrals.	2
L15	Applications of double integrals.	2
Total		30
Practical classes (P)		
1st half-year		
P1	Power series.	2
P2	Taylor series.	2
P3	Fourier series.	2
P4	Functions of several variables.	2
P5	Limit of functions of several variables.	2
P6	Continuous functions of several variables.	2
P7	Uniform continuity of functions of several variables.	2
P8	Differentiation of functions of several variables.	2
P9	Applications of the differential of functions of several variables to approximate calculations.	2
P10	Higher-order derivatives and differentials of functions of several variables.	2
P11	Differentiation of implicit functions.	2
P12	Extrema of functions of several variables.	2
P13	Maximum and minimum values of functions of several variables. Directional derivative.	2

P14	Double integrals.	2
P15	Applications of double integrals.	2
Total		30
5. Independent Study (IS)		
1st half-year		
IS1	Taylor and Maclaurin series.	2
IS2	Expansion of elementary functions into power series.	2
IS3	Mean value of a function.	2
IS4	Mean value theorem and its application.	2
IS5	Improper integrals of the first kind and their convergence.	2
IS6	Convergence of improper integrals with infinite limits.	2
IS7	Convergence of improper integrals of arbitrary functions.	2
IS8	Cauchy criterion for integrals.	2
IS9	Dirichlet test. Abel test.	2
IS10	Concepts of improper integrals of the second kind.	2
IS11	Concepts of improper integrals of the second kind.	2
IS12	Improper integrals of the second kind and their convergence.	2
IS13	Absolute and conditional convergence of improper integrals.	2
IS14	Tests for convergence of improper integrals.	2
IS15	R^n space and its important sets. Sequences in R^n space and their limits.	2
IS16	Functions of several variables and their limits.	4
IS17	Continuity of functions of several variables.	4
IS18	Properties of continuous functions.	4
IS19	Uniform continuity of functions of several variables.	4
IS20	Cantor's theorem.	4
IS21	Derivatives of functions of several variables. Differentials of functions of several variables.	4
IS22	Directional derivative.	4
IS23	Higher-order derivatives of functions of several variables. Higher-order differentials of functions of several variables.	4
IS24	Mean value theorem.	4
IS25	Continuity of functions of several variables.	4
IS26	Taylor's formula for functions of several variables.	4
IS27	Existence of implicit functions. Continuity of implicit functions. Differentiability of implicit functions.	4
IS28	Theorems on implicit mapping and inverse mapping.	4
IS29	Dependence and independence of systems of functions.	4
IS30	Dependence and independence of systems of functions of several variables. Extremum values of functions of several variables.	4
	Total:	90
Course topics		
1.	Mathematical induction method	

2.	Set. Operations on sets. Numerical sets and their properties. Bounds of numerical sets.
3.	Mappings. Types of mappings.
4.	Limit of numerical sequences. Properties of convergent sequences and operations on them.
5.	Indeterminate forms. Monotone sequences and their limits.
6.	Subsequences. Cauchy theorem.
7.	Concept of function. Elementary functions. Limit of a function.
8.	Drawing function graphs in various coordinate systems.
9.	Limit of a monotone function. Cauchy theorem.
10.	Comparison of functions.
11.	Continuity of functions
12.	Discontinuity of functions. Types of discontinuities.
13.	Arithmetic operations on continuous functions. Continuity of composite functions.
14.	Using function continuity in calculating limits. Properties of continuous functions.
15.	Uniform continuity of functions. Cantor's theorem.
16.	Properties of functions continuous on compact sets.
17.	Space of continuous functions.
18.	Derivative of a function, its geometric and mechanical meanings
19.	Differential of a function.
20.	Higher-order derivatives and differentials of functions
21.	Fundamental theorems of differential calculus
22.	Taylor's formula
23.	Some applications of differential calculus.
24.	Convexity, concavity, inflection points, and asymptotes of functions

25.	Complete investigation of functions. Drawing graphs.
26.	Resolving indeterminate forms. L'hôpital's rules.
27.	Concepts of antiderivative and indefinite integral
28.	Integration methods.
29.	Integration of rational functions.
30.	Integration of some irrational functions. Integration of trigonometric functions
31.	Problems leading to definite integrals. Definition of definite integral.
32.	Darboux sums. Alternative definition of definite integral.
33.	Existence of definite integral. Class of integrable functions.
34.	Properties of definite integral. Calculation of definite integral. Approximate calculation of definite integral.
35.	Concept of functional.
36.	Arc length and its calculation using definite integral (in various coordinate systems).
37.	Calculating the area of a plane figure (in various coordinate systems).
38.	Work done by a variable force and its calculation using definite integral.
39.	Solving some problems of mechanics and physics using integrals
40.	Improper integrals with infinite limits
41.	Improper integral of an unbounded function
42.	Absolute and conditional convergence of improper integrals. Convergence tests for improper integrals. Applications of improper integrals
43.	Numerical series and their convergence.
44.	Convergence tests for series. Theorems on convergent numerical series.
45.	Positive series and their convergence
46.	Series with arbitrary terms and their convergence
47.	Properties of convergent series
48.	R^n space and its important subsets. Sequence in R^n space and its limit
49.	Functions of several variables and their limits
50.	Continuity of functions of several variables

51.	Uniform continuity of functions of several variables. Cantor's theorem
52.	Partial derivatives of functions of several variables
53.	Differentiability of functions of several variables. Directional derivative
54.	Differentiability of composite functions of several variables
55.	Higher-order derivatives and differentials of functions of several variables
56.	Taylor's formula for functions of several variables
57.	Extreme values of functions of several variables. Necessary condition for extremum. Sufficient condition for function extremum.
58.	Implicit functions. Theorem on the existence of implicit functions.
59.	Functional sequences and series, their convergence
60.	Uniform convergence of functional sequences and series
61.	Continuity of the sum of a functional series and the limit function of a functional sequence
62.	Term-by-term limit transition, integration, and differentiation in functional series and sequences.
63.	Power series. Properties of power series.
64.	Taylor series. Maclaurin series. Approximation of functions by polynomials. Expansion of elementary functions into power series
65.	Parameter-dependent integrals
66.	Beta function. Gamma function
67.	Connection between beta and gamma functions
68.	Double integral. Existence of double integral.
69.	Class of integrable functions. Properties of double integrals
70.	Calculation of double integrals. Change of variables in double integrals
71.	Some applications of double integrals
72.	Triple integrals. Properties of triple integrals and their calculation
73.	Some applications of triple integrals.
74.	Line integrals of the first kind. Calculation of line integrals of the first kind

75.	Applications of line integrals of the first kind.
76.	Line integrals of the second kind. Calculation of line integrals of the second kind
77.	Applications of line integrals of the second kind.
78.	Green's formula and its applications.
79.	Connection between line integrals of the first and second kind
80.	Surface integrals of the first kind
81.	Surface integrals of the second kind
82.	Stokes' formula. Ostrogradsky's formula.
83.	Periodic functions. Periodic extension of functions
84.	Fourier series. Definition of fourier series.
85.	Lemmas. Dirichlet integral
86.	Convergence of fourier series.
87.	An extremal property of partial sums. Bessel's inequality
88.	Functional properties of the sum of a convergent fourier series
89.	Approximation of functions by trigonometric polynomials
90.	Mean convergence. Mean convergence of fourier series
91.	Orthogonal system of functions. Generalized fourier series

6. Educational technologies and methods:

Lectures - interactive case studies; seminars (logical thinking, quick Q&A); group work; presentations; individual projects; teamwork and defense of projects.

In practical classes - solving problems related to topics, practical observation, measurement, operations with astronomical tables are performed.

Independent work - the following types are recommended:

- Preparing reports;
- Preparing presentations;
- Solving problems;
- Individual and group educational projects;
- Working with information-analytical materials;
- Working with sources;
- Creating illustrative models (intellect maps, frames, logical graphs, etc.);
- Creating multimedia presentations;
- Preparing methodological developments for lessons;

- Preparing developments for extracurricular activities.

Requirements for obtaining credits:

Complete mastery of theoretical and methodological concepts related to the subject, correct reflection of analysis results, independent reasoning about the processes and concepts being studied, completion of tasks assigned in current and midterm assessment forms, completion of written assignments for final assessment based on variants.

Criteria for assessing and monitoring students' knowledge of the subject

Students' learning outcomes are assessed on a 100-point rating system. The conversion of points for learning outcomes by students is carried out on the basis of the ECTS (European Credit Transfer System).

Points for assessing learning outcomes are determined as follows:

Midterm Assessment	Final Assessment
During midterm assessment for answering - midterm assessment grade (MAG); For completing independent study tasks - independent work assessment (IWA); The student's performance of practical, seminar, laboratory classes and independent study tasks, as well as their activity in these classes, is assessed by the subject teacher. When assessing a student by the type of midterm assessment, the grades received during the educational classes are taken into account.	During final assessment for answering - final assessment grade (FAG)
Maximum score for midterm assessment 5 grade: $\Sigma MA = MAG + IWA$	Maximum score for final assessment (FAG) 5 grade

A student with $\Sigma MA \geq 3$ grade is allowed to take the final assessment. Module (subject) mastery indicator (MI): $\Sigma MI = FAG$. The module (subject) is considered mastered when $\Sigma MI \geq 3$ grade.

Criteria for assessing students' learning outcomes:

"5"	4,5 – 5	"A"	90 — 100	Excellent
"4"	3,5 – 4,49	"B+"	80 — 89,9	Good
		"B"	70 – 79,9	
"3"	3 – 3,49	"C+"	65 — 69,9	Satisfactory
		"C"	60 — 64,9	
"2"	0 – 2,99	"F"	0 — 59,9	Unsatisfactory

Main and additional educational literature and information sources

Main literature	
1.	Azlarov T., Mansurov H. Mathematical Analysis, volumes 1,2, Tashkent, "Uzbekistan", 1994,1995.
2.	Khudoyberganov G., Vorisov A. K., Mansurov H.T., Shoimkulov B. A. Mathematical Analysis, volumes 1,2, Tashkent, "Uzbekistan", 2010.

3.	A.Sadullayev, H.Mansurov, G.Khudayberganov, A.Vorisov, R.Gulomov "Collection of examples and problems from the course of Mathematical Analysis", parts 1-3. Tashkent "Uzbekistan"1993
4.	A.Gaziyev, I. Israilov, M. Yakhshiboyev. "Examples and problems from Mathematical Analysis". "Yangi asr avlodi" publishing house, 2006
5.	G.Kh.Djumabayev. Mathematical Analysis 1. Chirchiq 2023
6.	F.S.Aktamov, E.M.Makhkamov, G.B.Kuzmanova. "Mathematical Analysis". Chirchiq-2023, "Yangi chirchiq prints"

Additional literature

1.	Ilin V., Sadovnichiy V., Sendov B. Mathematical Analysis, Moscow "Nauka", 1979.
2.	Khudoyberganov G., Vorisov A., Mansurov H. Complex Analysis lecture. Tashkent "University" 1998.
3.	Kudryavtsev L. Course of Mathematical Analysis TT, 1, 1973.
4.	Demidovich B. Collection of problems and exercises on Mathematical Analysis, Moscow, "Nauka", 1990.
5.	A.G.Abdurakhmonov. Definite and indefinite integrals (mathematical analysis) BookTrade 2022. ChSPU.

Internet sites

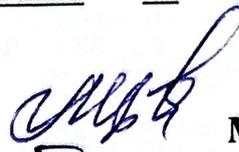
1.	http://www.edu.uz – Website of the Ministry of Higher Education, Science and Innovation of the Republic of Uzbekistan.
2.	www.ziyounet.uz – Educational network of the Republic of Uzbekistan
3.	www.cspi.uz – Website of Chirchiq State Pedagogical University
4.	https://mathnet.uz - National Mathematics Platform
5.	www.natlib.uz - (A.Navoi National Library of Uzbekistan)
6.	www.unilibrary.uz – Unified electronic library information system of higher education and research institutions of the Republic of Uzbekistan
7.	http://www.gov.uz – Portal of the Government of the Republic of Uzbekistan.
8.	www.pedagog.uz – Database system on professional certification of pedagogical staff of state general education organizations and periodicity of awarding positions and qualification categories to pedagogical staff.

This syllabus was approved at meeting protocol No. 23 of the Department of "Algebra and Mathematical Analysis" on 18 june 2025.

This syllabus was approved at meeting protocol No. 11 of the Faculty of "Mathematics and Informatics" on 25 june 2025

This syllabus was approved at meeting protocol No. 15 of the Council of Chirchiq State Pedagogical University on 2 jule 2025.

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