Документ подписан простой электронной подписью
Информация о владельце:
ФИО: Максимов Алексей Борисович
Должность: директор департамента по образовательной политике
Дата подписания: 03.09.2025 12:44:55
Уникальный программный ключ:
8db180d1a3f02ac9e60521a5672742735c18b1d6

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION

FEDERAL STATE AUTONOMOUS EDUCATIONAL INSTITUTION OF HIGHER EDUCATION

"MOSCOW POLYTECHNIC UNIVERSITY"

(MOSCOW POLYTECHNIC UNIVERSITY)

Faculty of Economics and Management

APPROVED BY

FEU Dean

/A. V. Nazarenko/

«27» February 2025

WORKING PROGRAM OF THE DISCIPLINE

« Mathematical analysis»

Direction of training/specialty

38.03.01 Economy

Profile/specialization

International business and foreign economic

Qualification

bachelor

Forms of study

full-time

Moscow, 2025

Разработчик:

Канд. физ.-мат. наук, доцент _____ /Е.А. Коган/

И.о. зав. кафедрой «Математика»,
канд. физ.-мат. наук _____ /Н.В. Васильева/

Agreed:

Head of Department"Economics and Organization"

PhD in Economics, Associate Professor _____ /A.V. Tenishchev/

Content

1. Objectives, tasks and planned learning outcomes in the discipline....4
2. The place of the discipline in the structure of the educational program... 5
3. Structure and content of the discipline 5
3.1. Types of academic work and labor intensity....5
3.2. Thematic plan for studying the discipline....6
3.3. Contents of the discipline 6
3.4. Topics of seminars/practical and laboratory classes....7
4. Educational, methodological and informational support....9
4.1. Normative literature 9
4.2. Main literature 9
4.3. Further reading....9
4.4. Electronic educational resources.... 10
4.5. Licensed and freely distributed software... 10
4.6. Modern professional databases and information reference systems....11
5. Logistics and technical support 12
6. Methodological recommendations 12
6.1. Methodological recommendations for the teacher on organizing training.....12
6.2. Methodological instructions for students on mastering the discipline... 13
7. Evaluation Fund....14
Appendix 1. Thematic plan of the discipline content 15
Appendix 2. Fund of assessment tools....25
1. Methods of monitoring and assessing learning outcomes.... 25
2. Scale and criteria for assessing learning outcomes.... 25
3. Evaluation tools.... 26
3.1. Current control.... 27
3.2. Interim certification.... 32

1. Objectives, tasks and planned learning outcomes discipline

To the main ones*goals*mastering the discipline "Mathematical Analysis" should be attributed to sty:

- developing a general mathematical culture in students;
- acquisition by students of a wide range of mathematical knowledge, skills and abilities kov;
- development of students' ability for inductive and deductive thinking along with the development of mathematical intuition;
- the ability of students to develop skills for independent study of educational and scientific literature containing mathematical information and results;
- preparation of students for activities in accordance with the qualification characteristics bachelor's degree in this field, including the development of skills to use mastered mathematical methods in professional activities.
- training of highly qualified personnel in demand in the digital environment turbulence and high technological risks of the modern digital economy.

To the main ones*tasks*mastering the discipline "Mathematical Analysis" should be attributed to sty:

- students master the basic concepts and methods that form general mathematical technical training necessary for the successful solution of applied problems;
- the formation of the required set of competencies in the student that correspond to his direction of training and ensuring its competitiveness in the labor market.

Training in the discipline "Mathematical Analysis" is aimed at developing the following competencies in students in accordance with Federal State Educational Standard 38.03.01 (bachelor's degree level) in the field of training 38.03.01 Economics, approved by order of the Ministry of Education and Science of Russia dated 12.08.2020 No. 954 (as amended and supplemented on November 26, 2020):

Code and name of competencies	**Indicators of achievement of comp-Tensions**
UK-1. Capable of searching, critically analyzing and synthesizing information, applying a systematic approach to solving assigned tasks	IUK-1.1. Analyzes the task, identifying its basic components IUK-1.2. Searches, critically evaluates, generalizes, systematizes and ranks the information required to solve the assigned task IUK-1.3. Considers and proposes rational options for solving a given problem using a systems approach, critically evaluates their advantages and disadvantages

2. The place of the discipline in the structure of the educational program

The discipline belongs to the compulsory part of block B1: Module “Mathematical and natural science disciplines”.

The discipline is based on the following completed discipline:

- linear algebra.

The discipline "Mathematical Analysis" is logically connected with the following disciplines: *In the mandatory part:*

- econometrics;
- economic theory;
- economic statistics;
- risk assessment and analysis.

In the part formed by the participants of educational relations:

- financial analysis;
- business planning.

3. Structure and content of the discipline

The total workload of the course is 4 credit units - 144 hours.

3.1. Types of academic work and labor intensity

3.1.1. Full-time education

p/p	Type of academic work	Quantity hours	Semester 2
	Classroom lessons	72	72
	Including:		
1.	Lectures	18	18
2.	Seminars/practical classes	54	54
	Laboratory exercises	-	-
	Independent work	72	72
	Interim assessment		
	exam	E	E
	Total	144	144

3.1.2. Part-time and part-time education

p/p	Type of academic work	Quantity hours	Semester 2
	Classroom lessons	36	36
	Including:		

1.	Lectures	8	8
2.	Seminars/practical classes	28	28
3.	Laboratory exercises	-	-
	Independent work	108	108
	Interim assessment		
	exam	E	E
	Total	144	144

3.2. Thematic plan for studying the discipline

Placed in Appendix 1 to the work program.

3.3. Contents of discipline sections

Introduction

Subject, objectives and content of the discipline. Main stages of development of the discipline. Structure of the course, its place and role in the preparation of a bachelor, connection with other disciplines.

Section 1. Differential calculus of functions of one variable

Topic 1. Numerical sequence. Limit of a numerical sequence and its properties. Function. Plotting function graphs. Limit of a function. Basic theorems on function limits. The first and second remarkable limits. Comparison of infinitely small and infinitely large quantities. Equivalent infinitely small quantities.

Topic 2. Continuity of functions at a point and on an interval, Points of discontinuity of a function, their classification. Asymptotes of the function graph, their classification.

Topic 3. Derivative of a function. Geometric and physical meaning of the derivative. Rules of differentiation and formulas for calculating derivatives. Table of derivatives of basic elementary functions. Calculation of derivatives of functions defined in different ways.

Differential. Derivatives and differentials of higher orders. Approximate calculations using differentials.

Topic 4.L'Hôpital's rule. Taylor's formula. Uncertainty disclosure. personal type. Expansion of the basic elementary functions using the Taylor formula. Approximate calculations using the Taylor formula.

Topic 5. Fundamental theorems of differential calculus. Monotonicity of functions tions, extrema Necessary and sufficient conditions for monotonicity, local extremum. Study of convexity of the graph of a function. Inflection points of the graph of a function.

General scheme of studying a function and constructing its graph. Properties of functions continuous on a segment. The greatest and least values of a function on a segment.

Section 2. Differential calculus of functions of several variables

Topic 1. Functions of several variables. Level lines and surfaces. Particular derivatives. water. Total differential. Derivatives of a complex function of several variables.

nykh. Partial derivatives and differentials of higher orders. Schwartz's theorem.

Topic 2. Directional derivative. Gradient. Tangent to curve. Tangent plane and normal to the surface. Taylor formula. Extremum of a function of several variables. Necessary and sufficient conditions for an extremum.

Section 3. Integral calculus

Topic 1. Antiderivative. Theorem of existence of the indefinite integral. Non-definite integral and its properties. Table of integrals of basic elementary functions. Direct integration method.

Methods of integration using variable replacement, bringing under the differential sign. Method of integration by parts.

Integration of rational fractions, integration of some types of irrational and trigonometric functions.

Topic 2. Problems leading to the concept of a definite integral. Definite integral, its properties. Integrability conditions. Integral with variable integration limit. Newton-Leibniz formula. Change of variable in a definite integral.

Applications of the definite integral in geometry and mechanics (calculation of areas of plane figures, length of curves, volumes.

Topic 3. Improper integrals of the first and second kind (over infinite space) horror, from unbounded functions on a finite interval), their properties.

Topic 4. Problems leading to multiple integrals. Double and triple integrals, their properties. Rules for calculating double integrals.

3.4. Topics of practical classes in the discipline "Mathematical Analysis"

3.4.1. Full-time education

No. p/p	Topic of the lesson
1	**Section 1. Elements of mathematical analysis.** Numerical sequence. Limit of a numerical sequence and its properties. Rules for limit transition. Function. Limit of a function. Theorems on limits of a function. The first and second remarkable limits.
2	Comparison of infinitely small and infinitely large quantities. Equivalent infinitely small quantities.
3	Disclosure of uncertainties of various types
4	Continuity of functions at a point and on an interval. One-sided limits. Points of discontinuity of a function. Examples of problem solving
5	Derivative of a function. Rules of differentiation and formulas for calculating derivatives. Differentiation technique
6	Differentiation of inverse functions, functions given implicitly, parametrically, logarithmic differentiation
7	Differential. Geometrical meaning of differential. Derivatives and differentials of higher orders. Approximate calculations using differentials.
8	L'Hôpital's rule. Taylor's formula. Expansions of the basic elementary functions according to the Maclaurin formula.
9	Approximate calculations using Taylor's formula.
10	Complete exploration of functions and plotting.

11	Complete Study of Functions and Plotting Graphs (continued) Test #1 at the Seminar on Functions of One Variable
12	**Section 2. Functions of several variables.**Level lines and surfaces. Part-derivatives and first-order differential.
13	Total differential. Derivatives of a composite function. Derivative of a function given implicitly. Partial derivatives and differentials of higher orders. Schwartz's theorem.
14	Directional derivative. Gradient.
15	Extremum of a function of several variables. Necessary and sufficient conditions for an extremum.
16	Test #2 at the Seminar on Functions of Several Variables
17	**Section 3. Integral calculus** Antiderivative. Indefinite integral and its properties. Method of direct integration.
18	Integration by means of variable substitution, bringing under the differential sign. Method of integration by parts
19	Integration of rational fractions, integration of some types of irrational functions
20	Integration of trigonometric functions.
21	Calculation of definite integrals using the Newton-Leibniz formula. Change of variable and integration by parts in a definite integral.
22	Applications of the definite integral in geometry and mechanics (calculation of areas of plane figures, length of a curve).
23	Applications of the definite integral in geometry and mechanics (calculation of volumes, surface areas).
24	Improper integrals of the first and second kind, their calculation.
25	Problems leading to multiple integrals. Calculation of double integrals by reducing them to repeated ones. Problems on changing the order of integration in a double integral
26	Geometrical and physical applications of multiple integrals, calculation examples.
27	Control testing for the course.

3.4.2. Full-time and part-time education

Item No.	**Topic of the lesson**
1	**Section 1. Elements of mathematical analysis.** Problems on calculating the limits of numerical sequences and functions.
2	Disclosure of uncertainties of various types
3	Continuity of functions at a point and on an interval. One-sided limits. Points of discontinuity of a function.
4	Derivative of a function. Rules of differentiation and formulas for calculating derivatives. Differentiation technique
5	Differential. Geometrical meaning of differential. Derivatives and differentials of higher orders. Approximate calculations using differentials.
6	L'Hôpital's rule. Taylor's formula. Expansions of the basic elementary functions by Maclaurin's formula.
7	Complete exploration of functions and plotting.

8	**Functions of several variables.**Partial derivatives. Derivative with respect to direction. Gradient.
9	Extremum of a function of several variables. Necessary and sufficient conditions for an extremum.
10	**Integral calculus.**Antiderivative. Indefinite integral and its tva. Direct integration method.
11	Various integration methods.
12	Applications of the definite integral in geometry and mechanics.
13	Improper integrals of the first and second kind, their calculation.
14	Calculation of double integrals by reduction to iterated ones. Geometrical and physical applications of multiple integrals. Control testing

4. Educational, methodological and informational support

4.1. Regulatory documents and GOSTs

1. Federal State Educational Standard 38.03.01. 38.03.01 Economics. Approved by the order of the Ministry of Education and Science of Russia dated 12.08.2020 No. 954.
2. Academic curriculum for the field of study: 38.03.01 Economics. Profile: Economics of organizations and enterprises. Form of study – full-time. 2023.
3. Academic curriculum for the field of study: 38.03.01 Economics. Profile: Economics of organizations and enterprises. Form of study – full-time and part-time. 2023.
4. Decree of the President of the Russian Federation of 01.12.2016 No. 642 “Strategies for scientific and technological development of the Russian Federation”.
5. Order of the Ministry of Education and Science of the Russian Federation dated August 23, 2017 No. 816 “On approval of the Procedure for the application by organizations carrying out educational activities of electronic learning, distance educational technologies in the implementation of educational programs.”

4.2. Main literature

1. Fichtenholz G.M. Fundamentals of Mathematical Analysis: textbook for universities, 15th ed., reprinted. St. Petersburg, Lan. 2023. Part 1. 444 p.
2. Fichtenholz G.M. Fundamentals of Mathematical Analysis: textbook for universities, 14th ed., reprinted. St. Petersburg, Lan. 2023. Part 2. 464 p.
3. Kudryavtsev L.D. Brief course of mathematical analysis. V.1. Differential and integral calculus of functions of one variable. Series: Textbook [Electronic resource]: textbook. - Electronic data. - Moscow: Fizmatlit, 2015. - 444 p. [Access mode: URL: https:// e.lanbook.com/book/71994 - Title from the screen.]

4.3. Further reading

1. Piskunov N. S. Differential and integral calculus for technical universities. In 2 volumes. Moscow: Integral Press, 2009 – 416, 544 p. 180 copies.
2. Zubkov V.G., Lyakhovsky V.A., Martynenko A.I., Minostsev V.B., Pushkar E.A. Course of Mathematics for technical higher educational institutions. Parts 1-4. Moscow: MGIMO, 2012. 400 copies.

3. A Brief Course in Higher Mathematics [Electronic resource]: textbook. - Electronic data. - Moscow: Dashkov i K, 2017. - 510 p. [Access mode: URL: https://e.lanbook.com/book/93522. - Title from the screen.]
4. Bugrov Ya.S., Nikolsky S.M. Higher Mathematics: textbook for universities in 3 volumes. Moscow: Drofa, 2009.
5. Integral calculus of functions of one and several variables. Field theory: methodological instructions and variants of calculation and graphic works // Bodunov M.A., Borodina S.I., Pokazeev V.V., Teush B.L., Tkachenko O.I. M.: MSTU "MAMI", 2009.
6. Mathematical analysis. Limit theory and differential calculus: basic principles of the theory, guidelines and variants of calculation and graphic works // Bodunov M.A., Borodina S.I., Korotkova N.N., Tkachenko O.I. Moscow: Moscow State Technical University "MAMI", 2009.

7.

4.4. Electronic educational resources

Conducting classes and assessments is possible in a remote format using the university's distance learning system (LMS) based on electronic educational resources (EER) developed by the Department of Mathematics for all sections of the program:.

Elements of Mathematical Analysis	https://online.mospolytech.ru/local/crw/course.php?id=313
Integral calculus of functions of one variable	https://online.mospolytech.ru/local/crw/course.php?id=3781
Differential calculus of functions of several variables	https://online.mospolytech.ru/local/crw/course.php?id=3362
Additional Chapters in Mathematical Analysis	https://online.mospolytech.ru/course/view.php?id=3592

The developed electronic educational resources include training and final tests.
The procedure for carrying out work in a remote format is established by separate orders of the Vice-Rector for Academic Affairs and/or the Center for Educational and Methodological Work.

Each student is provided with individual unlimited access to the electronic library of Moscow Polytechnic University
https://online.mospolytech.ru/course/view.php?id=7621§ion=1 .
Internet resources include educational and methodological materials in electronic form, presented on the website mospolytech.ru in the section: “Center for Mathematical Education” (http://mospolytech.ru/index.php?id=4486 , http://mospolytech.ru/index.php?id=5822);
Useful educational, methodological and informational materials are presented on the websites: *http://exponenta.ru* , *http://eqworld.ipmnet.ru/ru/info/mathwebs.htm* .
List of resources of the information and telecommunications network "Internet" for mastering the discipline: www.matematikalegko.ru>studentu,www.i-exam.ru .

4.5. Licensed and freely distributed software security

No.	Name	Software Developer (copyright holder-body)	Availability (li-licensed, free freely distributed wandering)	Link to the Unified Register of Russian Computer Programs and Databases (if available)
1	Astra Linux Common Edition	OOO "RUSBITEKH-ASTER"	Licensed	https://reestr.digital.gov.ru/reestr/305783/?sphrase_id=9540 36
2	MyOffice	OOO "NEW CLOUD TECHNOLOGIES"	Licensed	https://reestr.digital.gov.ru/reestr/301558/?sphrase_id=9433 75

4.6. Modern professional databases and information references external systems

List of Internet resources available for mastering the discipline:

	Name	Link to resource	Availability
Information and reference systems			
	Stack Overflow	https://stackoverflow.com/	Available on the Internet without restrictions ny
	Information resources of the ConsultantPlus Network	http://www.consultant.ru	Available
	Portal of Federal State Educational Standards of Higher Education	http://www.fgosvo.ru.	Available
Electronic library systems			
	Doe	https://e.lanbook.com/	Available on the Internet without restrictions ny
	IPR Books	https:// www.iprbookshop.ru/	Available on the Internet without restrictions ny
Professional databases			
	Database of scientific electronic library	http://www.elibrary.ru	Available

	(eLIBRARY.RU)		
	Web of Science Core Collection is a polythematic reference and bibliographic collection scientometric (bibliometric) database	http://webofscience.com	Available

5. Material and technical support of discipline

The university's material and technical base ensures the implementation of all types of classes provided for by the curriculum and complies with current sanitary and fire safety rules and regulations.

The Department of Mathematics does not have its own classrooms and uses classrooms from the general university fund.

If necessary, the university's computer labs are used to conduct interactive practical classes.

6. Methodological recommendations

6.1. Methodological recommendations for the teacher

on the organization of training

First of all, it is necessary to draw the students' attention to the fact that practically all the material they study does not require any special (additional) preparation and can be successfully studied if the students attend classes, do their homework on time and use (if necessary) the system of scheduled consultations during each semester. The sections included in the course of mathematical analysis are classical, at the same time they are practically oriented, as they are widely used for solving various kinds of problems within mathematics itself and applied problems. Their mastery will help students to construct oral and written speech logically, reasonably and clearly, and successfully apply the accumulated knowledge in their professional activities.

It is necessary to recommend basic and additional literature to students from the very beginning of classes, and at the end of the semester to provide a list of questions to prepare for the exam.

At the first lesson on the subject, it is necessary to inform students about the type and forms of current and intermediate assessments on the subject, the timing of their implementation, the conditions for admission to intermediate assessment, and the types of intermediate control used.

The presentation of theoretical material should be accompanied by illustrative examples, carefully selected by the teacher so that technical difficulties and calculations in solving the problem do not distract from the main thing: understanding the idea and essence of the methods used. Examples of the practical application of the equations and formulas considered in class should always be given.

Practical classes should be organized by the teacher in such a way that there is time for students to periodically complete a short independent work in the classroom to check their assimilation of the material presented.

The teacher conducting practical classes must coordinate the educational and thematic plan of classes with the lecturer and use a unified system of notations.

The teacher should strive for systematic, continuous work of students throughout the semester; it is necessary to identify strong students and involve them in scientific work, in participation in various kinds of Olympiads and competitions.

The student must feel the teacher's interest in achieving the final result: in the acquisition by students of solid knowledge, skills and mastery of accumulated information to solve problems in professional activities.

6.1.1. Educational technologies

Conducting classes and assessments is possible in a remote format using the university's distance learning system (LMS) based on the developed

the Department of Mathematics of electronic educational resources (EER) for all sections of the program (see section 4.4).

The procedure for conducting work in a remote format is established by separate orders of the Vice-Rector for Academic Affairs and/or the Center for Educational and Methodological Work.

6.2. Methodological instructions for students on mastering disciplines

Section 1: Differential calculus of functions of one variable

When studying differential calculus of functions of one variable, pay attention to the concept of the limit of a function at a point and the methods for calculating it. The limit is one of the basic concepts of mathematical analysis. When calculating and the limits of the function must be, First of all, to clarify the nature of the uncertainty , , 0 - -, - - -, 1.- . To

-0 -- --

To master the technique of solving problems on calculating limits, one must know two remarkable limits, the table of equivalent infinitesimals, L'Hôpital's rule, various methods of disclosing uncertainties depending on the type of function, and solve a fairly large number of problems.

When studying topics devoted to the derivative and differential of a function, it is necessary to comprehend their geometric meaning, to understand the difference between them (the differential is the main linear part of the increment of a function). Know firmly (like the multiplication table) the formulas for differentiating the basic elementary functions and the rules of differentiation (all of them, of course, but especially the rule for differentiating a complex function).

Pay attention also to the peculiarities of differentiation of functions specified in implicit form, parametrically, and to the method of logarithmic differentiation.

It is necessary to clearly know and be able to apply the algorithm for studying functions and constructing graphs: determining break points (and their classification), graph asymptotes (vertical, oblique, horizontal), necessary and sufficient conditions for the monotonicity of a function, the existence of a local extremum, intervals of convexity and concavity of a function, and inflection points.

Section 2: Differential Calculus of Functions of Several Variables

When studying this section, pay attention to the fact that a function of two variables has a clear geometric meaning - it is a surface in three-dimensional space.

It is necessary to understand the concepts of partial derivatives and total differentials and the peculiarities of their calculation, to master the technique of calculating derivatives of a complex function several variables. It should be noted that for the function z-$z(x,y)$

mixed partial derivatives of the second order are equal to each other: $\frac{-2z}{-x-y} - \frac{-2z}{-y-x}$ (Theo-Schwartz's remnant), that is, the order of differentiation does not matter.

For a function of several variables, the rate of change of the function in an arbitrary direction is characterized by the directional derivative, and the greatest rate of change of the function will be in the direction of the gradient vector.

In this topic, attention should be paid to the necessary and sufficient conditions for the existence of an extremum of a function of several variables.

Section 3: Integral Calculus

In integral calculus, the problem solved is the inverse of the one considered in differential calculus: it is necessary to find for a given function $f(x)$ such function, the derivative of which would be equal to the given one. Integration of functions is a rather complex section of mathematics, which can only be mastered if the student “takes” a sufficiently large number of integrals of different types.

It is necessary to have a firm knowledge of the table of integrals of the basic elementary functions, the basic methods of integration (change of variable, bringing under the differential sign, integration by parts, methods for calculating integrals of rational fractions, of different types of trigonometric functions).

It is necessary to understand the unity of the approach to constructing definite, multiple integrals – constructing a certain integral sum and passing to the limit.

Know the geometric meaning and the basic formula for calculating definite integrals – the Newton-Leibniz formula, geometric and physical applications of definite and multiple integrals, be able to find the area of a flat figure, the length of a curve, the volume and surface area of bodies of revolution.

7. Evaluation Fund

The fund of assessment tools is presented in Appendix 2 to the work program and includes the following sections:

1. Methods of monitoring and assessing learning results.
2. Scale and criteria for assessing learning outcomes.
3. Evaluation tools.
3.1. Current control.
3.2. Interim certification.

Appendix 1

1. Subject plan of the discipline "Mathematical analysis" in the field of training 38.03.01 Economy

Profile

Economy of enterprises and organizations

(bachelor)

Full-time education

Recruitment year 2023/2024

No. n/n	Chapter	Semester	Week Semester	Types of educational work, including independent students' work, and labor intensity in hours					Types of independent work Students					Forms certificate-tions	
				L	P/C	Lab	SRS	KSR	K.R.	K.P.	RGR	Re-fe-rat	K/p	E	Z
Second semester															
1.1	**Section 1. Differential calculus of functions of one variable.** Numerical sequence ity. Limit of a numerical sequence and its properties. Rules for limit transition. Function.	2	1	2	2		4				+				

	Limit of a function. Theorems on limits of a function. **Issuance of tasks by RGR No. 1 on the ma- thematic analysis.**														
1.2	The first and second remarkable limits. Infinitely small and infinitely large quantities. Equivalent infinitely small quantities. Disclosure of indefinitely- of different types.	2	2		4		4								
1.3	Continuity of functions at a point and on an interval. One-sided limits. Points of discontinuity of a function, their classification.	2	3	2	2		4								
1.4	Derivative of a function. Geometrical and mechanical meaning of the derivative. Rules of differentiation and formulas for calculating derivatives. Table of derivatives of basic elementary functions. Differentiation technique	2	4		4		4								
1.5	Differential. Derivatives and differentials of higher orders. Approximate calculations using differentials.	2	5	2	2		4								
1.6	L'Hôpital's rule. Taylor's formula. Expansions of basic elementary functions using Taylor's formula. Approximate calculations using Taylor's formula.	2	6		4		4								

1.7	Fundamental theorems of differential calculus. Monotonicity of a function, extrema. Necessary and sufficient conditions for monotonicity, local extremum. Study of convexity of the graph of a function. Inflection points.	2	7	2	2		4								
1.8	General scheme for studying a function and constructing its graph. Properties of functions that are continuous on a segment. The largest and smallest values of a function on a segment. **Test #1 at the seminar on functions of one variable**	2	8		2		4					+			
1.9	**Section 2. Function of several variables.**Limit and continuous ity. Basic properties of continuous functions. Partial derivatives. Total differential. **Issuance of tasks RGR No. 2 for functions of several variables nyh**	2	9	2	2		4				+				
1.10	Derivatives of a complex function are not how many variables. Partial derivatives and differentials of higher orders. Schwartz's theorem. Directional derivative. Gradient.	2	10		4		4								

1.11	Extremum of a function of several variables. Necessary and sufficient conditions for an extremum. **Test #2 at the Seminar on Functions of Several Variables**	2	11	2	2		4					+		
1.12	**Section 3. Integral calculus** Antiderivative. Uncertain integral and its properties. Table of integrals of basic elementary functions. Method of direct integration. **Issuance of tasks by RGR No. 3 on information tegral calculus**	2	12		4		4				+				
1.13	Integration by means of variable substitution, bringing under the differential sign. Method of integration by parts	2	13	2	2		4								
1.14	Integration rational fractions integration of some types of irrational and trigonometric functions.	2	14		4		4								
1.15	Problems leading to the concept of a definite integral. Properties of a definite integral. Newton-Leibniz formula. Change of variable and integration by parts in a definite integral	2	15	2	2		4								
1.16	Applications of the definite integral in geometry and mechanics (calculation of areas of plane figures,	2	16		4		4								

	curve lengths, volumes, surface areas).														
1.17	Improper integrals of the first and second kind, their properties.	2	17	2	2		4								
1.18	Problems leading to multiple integrals. Double and triple integrals, their properties. Calculation of double integrals by reducing to repeated integrals. Geometric and physical applications of multiple integrals **Control testing**	2	18		6		4						+		
	Certification form		**19-21**											**E**	
	Total hours per discipline			**18**	**54**		**72**				**3 RGR**		**3** **counter. slave.**		

2. Subject plan of the discipline "Mathematical analysis" in the field of training 38.03.01 Economy

Profile

Economy of enterprises and organizations

(bachelor)

Part-time and part-time education

Recruitment year 2023/2024

No. n/n	Chapter	Semester	Week Semester	Types of educational work, including independent students' work, and labor intensity in hours					Types of independent work Students					Forms certificate-tions	
				L	P/C	Lab	SRS	KSR	K.R.	K.P.	RGR	Re-fe-rat	K/p	E	Z
Second semester															
1.1	**Section 1. Differential calculus of functions of one variable.** Numerical sequence ity. Limit of a numerical sequence and its properties. Rules	2	1	2			6				+				

	limit transition. Function. Limit of a function. Theorems on limits of a function. **Issuance of tasks by RGR No. 1 on the ma- thematic analysis.**														
1.2	The First and Second Remarkable Limits. Infinitely Small and Infinitely Large Quantities. Equivalent Infinitely Small Quantities. Disclosure of indefinitely- of different types.	2	2		2		6								
1.3	Continuity of functions at a point and on an interval. One-sided limits. Points of discontinuity of a function, their classification.	2	3		2		6								
1.4	Derivative of a function. Geometrical and mechanical meaning of the derivative. Rules of differentiation and formulas for calculating derivatives. Table of derivatives of basic elementary functions. Differentiation technique	2	4		2		6								
1.5	Differential. Derivatives and differentials of higher orders. Approximate calculations using differentials.	2	5		2		6								
1.6	L'Hôpital's rule. Taylor's formula. Decomposition of the basic elements.	2	6		2		6								

	tare functions using the Taylor formula. Approximate calculations using the Taylor formula.														
1.7	Fundamental theorems of differential calculus. Monotonicity of a function, extrema. Necessary and sufficient conditions for monotonicity, local extremum. Study of convexity of the graph of a function. Inflection points.	2	7		2		6								
1.8	General scheme of studying a function and constructing its graph. Properties of functions continuous on a segment. The greatest and least values of a function on a segment. **Test #1 at the seminar on functions of one variable**	2	8		2		6						+		
1.9	**Section 2. Function of several variables.**Limit and continuous ity. Basic properties of continuous functions. Partial derivatives. Total differential. **Issuance of tasks to RGR No. 2 on the func- tions of several variables**	2	9	2			6				+				
1.10	Derivatives of a complex function of several variables. Partial derivatives and differentials of higher orders. Schwartz's theorem. Directional derivative. Gradient.	2	10		2		6								

1.11	Extremum of a function of several variables. Necessary and sufficient conditions for an extremum. **Test #2 at the Seminar on Functions of Several Variables**	2	11		2		6					+		
1.12	**Section 3. Integral calculus** Antiderivative. Uncertain integral and its properties. Table of integrals of basic elementary functions. Method of direct integration. **Issuance of tasks of RGR No. 3 on inte- gral calculus**	2	12	2			6				+				
1.13	Integration by means of variable substitution, bringing under the differential sign. Method of integration by parts	2	13		2		6								
1.14	Integration of rational fractions, integration of some types of irrational and trigonometric functions.	2	14		2		6								
1.15	Problems leading to the concept of a definite integral. Properties of a definite integral. Newton-Leibniz formula. Change of variable and integration by parts in a definite integral	2	15		2		6								
1.16	Applications of the definite integral in geometry and mechanics (calculation of areas of plane figures,	2	16	2			6								

	curve lengths, volumes, surface areas).														
1.17	Improper integrals of the first and second kind, their properties.	2	17		2		6								
1.18	Problems leading to multiple integrals. Double and triple integrals, their properties. Calculation of double integrals by reducing to iterated ones. Geometric and physical applications of multiple integrals **Control testing**	2	18		2		6						+		
	Certification form	2	**19-21**											**E**	
	Total hours per discipline			**8**	**28**		**108**				**3 RGR**		**3** **counter. slave.**		

Appendix 2

ASSESSMENT TOOLS FUND

BY DISCIPLINE

"Mathematical Analysis"

Field of study: 38.03.01 "Economics". Profile
"Economics of enterprises and organizations".
Forms of study: full-time, part-time.

Department: "Mathematics"

1. Methods of monitoring and assessing learning outcomes

To monitor academic performance and the quality of mastering the discipline, this program provides for the following types of monitoring:

- monitoring of current academic performance (current monitoring);
- midterm assessment (exam).

2. Scale and criteria for assessing learning outcomes

Form of midterm assessment: exam

Midterm assessment of students in the form of an exam is carried out based on the results of completing all types of academic work stipulated by the curriculum for a given discipline, taking into account the results of current monitoring of academic performance during the semester. The assessment of the degree to which students have achieved the planned learning outcomes for a discipline is carried out by the teacher conducting classes in the discipline using the expert assessment method. Based on the results of midterm assessment for a discipline, a grade of “excellent,” “good,” “satisfactory,” or “unsatisfactory” is given.

Rating scale	**Description**
Great	All completed**mandatory conditions for the preparation of students denta for intermediate certification**, provided by the discipline program.The student demonstrates the appropriate the combination of knowledge, skills, and abilities with the indicators given in the tables, operates with the acquired knowledge, skills, and abilities, and applies them in situations of increased complexity. At the same time, minor errors, inaccuracies, and difficulties in transferring knowledge and skills to new, non-standard tasks may be allowed.

Fine	All completed**mandatory conditions for the preparation of students denta for intermediate certification**, provided by the program of the discipline. The student demonstrates the correspondence of knowledge, abilities, and skills to the indicators given in the tables, operates with the acquired knowledge, abilities, and skills. At the same time, when answering, he allows for insignificant errors, solves problems with shortcomings that do not affect the overall course of the solution.
Satisfactorily	All completed**mandatory conditions for the preparation of students denta for intermediate certification**, provided by the program of the discipline. The student demonstrates the correspondence of knowledge, abilities, and skills to the indicators given in the tables, operates with the acquired knowledge, abilities, and skills. But he shows shallow knowledge, does not allow gross errors or contradictions when answering, however, in the formulation of the answer there is no proper connection between the analysis, argumentation, and conclusions, and the solution of problems may contain gross errors. To obtain the correct answer, clarifying questions are required.
Unsatisfactory	Not fulfilled**mandatory conditions for the preparation of students denta for intermediate certification**, provided by the discipline program, OR the student demonstrates incomplete compliance of knowledge, skills, and abilities with those given in the tables, significant errors are made, a lack of knowledge, skills, and abilities is demonstrated in a number of indicators, the student experiences significant difficulties in operating knowledge and skills.

3. Evaluation tools

No. p/p	Name evaluation average sva	Brief description of the evaluation means	Presentation of the assessment night remedy in FOS
1	Control (sa-independent) Job (KR)	A means of testing the ability to apply acquired knowledge to solve problems of a certain type on a topic or section	Control tasks nia

2	Calculation and graphic Czech work (RGR)	A means of testing the ability to apply acquired knowledge using a predetermined methodology to solve problems or assignments for a module or discipline as a whole.	Set of tasks to perform the dis-even-graphic works
3	Oral survey with-conversation, (UO)	A means of control organized as a special conversation between a teaching staff member and a student on topics related to the discipline being studied, and designed to determine the extent of the student's knowledge on a specific section, topic, problem, etc.	Questions about topics/sections of the dis-ciplins
4	Test (T)	A system of standardized tasks that allows automated implement a procedure for measuring the level of knowledge and skills of a student.	Test option
5	Examination tickets (EB)	A means of testing knowledge, skills, and abilities. May include a set of theoretical questions, tasks, and practical assignments.	Examination tickets

3.1. Current control

Assessment tools for ongoing monitoring of academic performance include test questions and assignments in the form of form testing to monitor students' mastery of sections of the discipline, and the use of RGR.

Contents of calculation and graphic works.

Calculation and graphic work No. 1 on differential calculus of functions of one variable

Brief summary and stages of the calculation and graphic work: Limit of a numerical sequence, limit of a function. Study of a function for continuity. Calculating derivatives of a function. Studying a function, constructing graphs.

Calculation and graphic work No. 2 on functions of several variables.

Brief summary of the calculation and graphic work:
Functions of several variables. Partial derivatives. Derivatives of complex functions. Directional derivative and gradient. Extremum of a function of two variables.

Calculation and graphic work No. 3 on integral calculus.

Brief summary and stages of the calculation and graphic work:
First stage:
Methods of integration. Calculation of indefinite integrals.
Second stage:

Applications of definite integrals. Study of convergence of improper integrals.

Set of tasks
to perform calculation and graphic works (CGR)
by discipline**"Mathematical Analysis"**

Limit theory and differentiation of a function of one variable

1. Find the limits:

$$\lim_{n\to\infty}\frac{(2n^2-1)^2-(n-1)^2}{(n-2)^2-(2n-3)^2},\qquad \lim_{n\to\infty}\frac{\sqrt{n^2-8}+\sqrt[3]{n^3-3}}{\sqrt{n^5-n}}$$

$$\lim_{n\to\infty}\frac{2n^2-1}{2n^2-3},\qquad \lim_{n\to\infty}\left(n-\sqrt{n^2-1}\right)n,\qquad \lim_{n\to\infty}\left(\frac{n+1}{n-1}\right)^{3n-1}.$$

$$\lim_{x\to 3}\frac{2x^2-11x+15}{x^2-3x},\qquad \lim_{x\to 0}\frac{4x^2}{3x^2+3x}.$$

$$\lim_{n\to\infty}\frac{2^{n-1}-5^{n-1}}{3^{n-2}-5^n},\qquad \lim_{x\to 0}\frac{\sin 3x}{1-e^{x^2}},\qquad \lim_{x\to 0}(1-3x)^{\operatorname{ctg} 7x}$$

2. Examine for continuity and make a drawing: $y=\begin{cases}\sin x, & x<0\\ x, & 0\le x\le 1\\ 1, & x>1\end{cases}$

---

3. Find the derivative of the function:

$$y=\frac{(2x^3-4x^2-x-2)^2}{15\sqrt{1-x}},\qquad y=\ln\arcsin\sqrt{1-e^{2x}}.$$

$$y=\operatorname{arctg}\frac{\operatorname{tg}x-\operatorname{ctg}x}{\sqrt{2}},\qquad \begin{cases}x=\dfrac{3t^2}{1+t^3},\\ y=\dfrac{3t-t^3}{1+t^3}.\end{cases}$$

$$y=\frac{\cos 6x}{3\sin 12x},\qquad y=\operatorname{arctg}^2\frac{1}{\sqrt{1+2x^2}}+\sin\ln 2x$$

$$y=\operatorname{arctg}^3\ln\frac{\sqrt{x}}{x+2},\qquad y=\sqrt{x}^{\sqrt{x}}$$

$$\sin(x^2y)=\frac{x^3}{y}+7x,\qquad \begin{cases}x=e^t\cos t,\\ y=e^t\sin t.\end{cases}$$

4. Write the equations of the tangent and normal to the given curve at the point with the abscissa x_0: $y=\sqrt{x^2+8x+32},\ x_0=4$.

5. Conduct a full study and plot a graph $f(x)=x^2+\frac{1}{x^2}$

Functions of several variables

1. Find the second-order partial derivatives, make sure that $z_{xy} = z_{yx}$: $z = \frac{x^2 - 3y^2}{xy}$

2. Find the gradient of the function $z = f(x,y)$ at the point $M_0(x_0,y_0)$: $z = \frac{y^2}{\sqrt{x}}$, $M_0(4,6)$.

3. Investigate the function for extremum $z = x^2 - xy - 2y$.

Integration

Calculate indefinite integrals

$\int \frac{dx}{2(x - \sqrt{x})}$, $\int x 2^{-x} dx$, $\int x 1 - e^x dx$, $\int x \cos 3x dx$, $\int e^x \cos x dx$,

$\int \frac{dx}{x^2 - 6x - 18}$, $\int \frac{dx}{x^2 - 6x - 5}$, $\int \frac{x - 18}{(x-6)(x-2)} dx$, $\int \frac{x-1}{x^2 - 3} dx$, $\int \frac{\sin^3 x}{\cos^2 x} dx$,

Calculate definite integrals dx

$\int_0^{-.6} -3\sin^2 x \cos x dx$, $\int_0^1 \frac{}{\sqrt{1 - 3x}}$, $\int_0^1 (x-1) e^x dx$, $\int_1^{e^3} \frac{dx}{x\sqrt{7 - \ln x}}$,

$\int_{-1}^{6} \frac{dx}{1 - \sqrt{3x-2}}$, $\int_{-2}^{2} 1 - x^2 dx$, $\int_1^{-4} \frac{dx}{(3x-5)^2}$, $\int_0^1 \frac{x^2 - 2x}{x^2 - 1} dx$,

$\int_0^{\sqrt{3}} \frac{x^3}{\sqrt{1-x^2}} dx$, $\int_0^2 4\sqrt{-x^2} dx$, $\int_0^{-.6} -3\sin^2 x \cos x dx$, $\int_0^1 \frac{dx}{\sqrt{1 - 3x}}$,

$\int_0^1 -(x-1) e^x dx$, $\int_1^{e^3} \frac{dx}{x\sqrt{7 - \ln x}}$.

Improper integrals

1. Indicate which of the improper integrals is convergent.

$\int_1^{\infty} \sqrt{x} dx$, $\int_1^{\infty} x^{-3} dx$, $\int_1^{\infty} \sqrt{x^5} dx$.

2. Calculate the integral, establish its convergence or divergence $\int_{-\infty}^{\infty} \frac{dx}{1 - x^2}$

*3.*Calculate the integral, establish its convergence or divergence $\int_1^{\infty} \ln x dx$

4. Calculate the improper integral $\int_0^a \frac{dx}{\sqrt{x}}$, establish its convergence or divergence.

5. Calculate the improper integral $\int_{-1}^{1} \frac{dx}{x^2}$, establish its convergence or divergence.

Multiple integrals

1. Change the order of integration in the double integral

a. $\int_0^2 dx \int_{2x}^{6-x} f(x,y)\,dy$, b. $\int_0^1 dy \int_{\sqrt{y}}^{2-y} f(x,y)\,dx$.

2. Calculate $\iint_{(D)} (10 - x^2 - y^2)\,dxdy$, $D = \{(x,y) : |x| \le 2,\ 0 \le y \le 2\}$.

3. Calculate

$\iint_D 12x^2y^2 - 16x^3y^3\,dxdy$;

$D: x = 1, y = x^2, y = -x$. $\sqrt{\ }$

4. Calculate

$\iint_{(D)} (x^2 - y)\,dxdy$, D is a set of points on a plane bounded by lines

$y = x/2, y = 2x$, $y = 2/x\ (x > 0)$.

---

5. Find the area of the figure bounded by the given lines

$y = 3x, y = 4e^x, y = 3, y = 4$.

6. Find the area of the figure bounded by lines $y = x^2$, $y = -x + 2$

8. Find the volume of a body obtained by rotation around an axis OY figure bounded by a line yami $y = x^3, y = 1, x = 0$.

9. Find the volume of a body obtained by rotation around an axis OX figure bounded by a line yami $y = x^2, y^2 = x$.

Tests (examples)

Option

1. Plot a graph: $y = 3\cos 2x$
2. Find the limits:

1) $\lim_{n\to\infty} \frac{5 - n - 2^2}{5 - n} - \frac{5 - n - 2^2}{5 - n}$ 2) $\lim_{x\to 0} \frac{1 - \cos 2x}{e^{2x^2} - 1}$ 3) $\lim_{x\to 2} \frac{x^3 - x^2 - x - 2}{x^3 - 2x^2 - x + 2}$

4) $\lim_{x\to 2} \frac{\sqrt{x^2 - x - 1}}{\ln x - 1}$ 5) $\lim_{x\to 0} \frac{1 - x\cos 2x}{1 - x\cos x}$ 6) $\lim_{x\to\infty} \left(x - \sqrt{x^2 - x + 1}\right)$

-

3. Examine for continuity and make a drawing: $y=\begin{cases} x, & x\le 0 \\ x^2, & 0<x\le 2 \\ 3, & x>2 \end{cases}$

Option

1. Find the derivative y'_x:

A) $y=\operatorname{arctg}^3\ln\dfrac{\sqrt{x}}{x-2}$ b) $y=x^{\sqrt{x}}$

c) $\sin(x-2y)=\dfrac{x^3}{y}-7x$ G) $x=e^t\cos t, y=e^{\cos t}$

2. Find $\lim\limits_{x\to}\left(\dfrac{1}{x}-\operatorname{arctg}x\right)$

3. Conduct a full study and plot a graph $f(x)=x^2-\dfrac{1}{x^2}$.

Option.

№1. Calculate the derivative in direction $\dfrac{\partial u}{\partial s}$ and find the modulus of the gradient vector for functions $u=2xy-\dfrac{x}{\sqrt{y}}-z^3$ at the point $A(6;9;1)$ in the direction constituting the coordinate axes dinat angles $\cos\alpha=\dfrac{3}{7}, \cos\beta=\dfrac{6}{7}, \cos\gamma=\dfrac{2}{7}$.

№2. Investigate the function for extremum $z=xy(1-4x^2-4y)-5$.

№3. $z=\ln(y-x^4)$, $x=\sin\sqrt{t}, y=\cos t$. Find $\dfrac{dz}{dt}$.

Option

C a l c o l u t:

1. $\int_9^{16}\dfrac{dx}{\sqrt{x}-2}$.

2. $\int_1^2(2x-1)\ln x\,dx$.

3. $\int\dfrac{3x^2-4}{x^2-4x}dx$. **4.** $\int\sin^3 3x\,dx$. **5.** $\int\dfrac{2x-1}{\sqrt{4-2x-x^2}}dx$.

1. Calculate the integrals:

$\int_1 he^{h-x^2}dx$.

$\int_e\dfrac{dx}{x\ln\sqrt{x}}$.

Draw the integration domain and change the order of integration in the repeated integral

$$\int_{-4}^{0}dx\int_{0}^{\sqrt{25-x^2}}f(x;y)dy.$$

Calculate the area of a figure bounded by lines

$$y=2-x^2, y=x.$$

Variant of training test tasks.

Tasks -

Part 1 1. y-sin ln$x$,y-,y--? 2.y-- $\frac{\text{arcctg}\sqrt{x}}{x}$, dy- ? 3.

y-3x^2-xe^x,x_0=2,x-0,1,4. y-?

Find the derivative$y$- $_x$:

A)y- $\sqrt[5]{\sin^4 x\text{-}\frac{3}{x}}$ b)y-$x^{\text{arctg}7x}$

V)e^{xy} - $\frac{y}{x}$cos3x G)x-cos$t$-sin$t$,y-sin$t$-$t$cos$t$

5. Explore for extremum f-x--x-3- $_2$-x-5-.

6. Find intervals of monotonicity$y$- $\frac{e^{2x}}{x}$.

7. Find the largest, smallest value of the function f-x-- $\frac{x^3}{3}$-16$x$on the segment--5;1-.

8. Construct a tangent to the graph of a function f-x--3arccosx^2 at the point$x$-$\frac{1}{2}$.

Part 2 9. Find the limits:

1) lim-3-n--$\frac{2}{2}$ -n- ^{2} $_2$ $_{n\text{--}}$-2 -n---1-n-- 2) lim $\frac{\text{tg}2x}{3^x}$ $_{x\text{-}0}e$-1 3) lim $\frac{x^2\text{-}2x\text{-}3}{x^3\text{-}5x^2\text{–}6x\text{-}}$ $_{x\text{--}3}$ 4) lim $\frac{\text{tg}5x}{\text{tg}3x}$ $_{x\text{-}\frac{\pi}{2}}$

Part 3

10. Examine for continuity and make a drawing: y---sin$x$, -- -x-0 . -0,x- ---- --- ,x-0

11. Conduct a full study and plot a graph f-x-- $\frac{x^3}{x^2\text{-}4}$.

Evaluation criteria:

- the grade “passed” is given to a student if he regularly submitted solutions to problems during the semester, completed all assignments in full and defended them, answering the teacher’s questions;

- the grade “fail” is given to a student if he/she has not regularly submitted solutions to problems during the semester, has not completed assignments completely or has not submitted work for checking at all, or makes significant inaccuracies in his/her answers to the teacher’s questions.

To conduct ongoing monitoring of students’ knowledge in a remote format, the online courses developed by the Department of Mathematics include intermediate (trial) tests.

3.2. Interim assessment

Intermediate assessment - (exam) is conducted orally using tickets. Time for preparing answers to questions is no more than 45 minutes.

The ticket includes a theoretical question and tasks.

Sets of examination tickets are stored in the Department of Mathematics.

Standard ticket options are attached..

Set of questions

by discipline**"Mathematical Analysis"**

Differential calculus of functions of one variable

1. The concept of a variable and the area of its change.
2. the concept of functional dependence, classification of functions.
3. Definition and types of numerical sequence.
4. Limit of a numerical sequence. Arithmetic operations on sequences.
5. Conditions for the existence of a finite limit of a numerical sequence (Cauchy and Weierstrass theorems).
6. The second remarkable limit.
7. Limit of a function. Definitions. Geometric interpretation of the concept of limit of a function. Properties of limits.
8. Infinitely small, infinitely large functions.
9. The first remarkable limit.
10. Infinitesimal quantities. Equivalent infinitesimals and their use in calculating limits. Table of equivalent infinitesimals.
11. Continuity of a function at a point and on an interval. One-sided limits. Classification of graph discontinuity points.
12. Properties of functions continuous on a segment (Weierstrass, Bolzano-Cauchy theorems).
13. Derivative. Geometrical and physical meaning of the derivative. Tangent and normal to a plane curve.
14. Table of derivatives of basic elementary functions.
15. The relationship between the existence of the derivative of a function at a point and the continuity of the function at the same point.
16. Derivative of a sum, product, quotient. Derivative of complex and inverse functions.
17. Derivative of a parametrically defined function.
18. Derivative of a function defined implicitly.
19. Differentiation of a complex exponential function.
20. Differentiability. Differential. Geometric meaning of differential.
21. Derivatives and differentials of higher orders.
22. Fundamental theorems of differential calculus (Fermat's theorem, Rohl's theorem, Lagrange's theorem, Cauchy's theorem).
23. L'Hôpital's rule.
24. Taylor polynomial and its properties. Taylor formula. The remainder term of the Taylor formula in Lagrange and Peano form.
25. Asymptotes of the graph of a function.
26. Extremum. Necessary condition of extremum.
27. Sufficient conditions for an extremum.
28. Sufficient condition for an increase (decrease) in a function.
29. The largest and smallest values of a function on a segment.
30. Convexity, concavity, inflection point. Sufficient condition for concavity (convexity).
31. Necessary condition for the inflection point. Sufficient condition for the inflection point.
32. General scheme for constructing and studying the graph of a function.

Functions of several variables

1. Definition and geometric meaning of a function of two variables.

2. Level lines of a function of two variables.
3. Partial derivatives of a function of several variables, their geometric meaning
4. Functions of several variables, the concept of total differential.
5. Differentiation of complex functions of several variables.
6. Higher-order derivatives of functions of several variables. Mixed derivatives. Schwartz's theorem.
7. Derivative of a function of several variables in direction.
8. Directional derivative and gradient of a scalar field.
9. Extremum of a function of several variables.
10. Necessary and sufficient conditions for the extremum of a function of two variables.

Integral calculus

1. Antiderivative, indefinite integral. Table of basic integrals.
2. Change of variable and integration by parts in an indefinite integral.
3. Integration by bringing under the differential sign.
4. Integration of rational fractions.
5. Integration by parts and change of variable in a definite integral.
6. Integration of trigonometric functions, basic techniques.
7. Integration of irrational functions.
8. Universal trigonometric substitution.
9. Definite integral and its properties. Newton-Leibniz formula.
10. Applications of the definite integral to solving geometric and physical problems.
11. Calculating areas using a definite integral.
12. Calculation of the area and length of a curve given by equations in parametric form.
13. Calculating the area of a curvilinear sector in polar coordinates.
14. Calculation of areas in rectangular and polar coordinates using a definite integral.
15. Calculating the arc length using a definite integral.
16. Calculating the arc length of a curve specified parametrically.
17. Calculating the volume of a body of revolution using a definite integral.
18. Calculation of the surface area of a body of revolution.
19. Improper integrals of the first and second types. Concepts of convergence and divergence of an improper integral.
20. Improper integrals of discontinuous functions.

Standard ticket options

by discipline**"Mathematical Analysis"**

MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
FEDERAL STATE AUTONOMOUS EDUCATIONAL
HIGHER EDUCATION INSTITUTION **"MOSCOW POLYTECHNIC UNIVERSITY"**
(MOSCOW POLYTECHNIC)

Faculty of Basic Competencies, Department of Mathematics
Discipline "Mathematical Analysis"
Course 1, Semester 2

EXAM TICKET

1. Antiderivative, indefinite integral. Table of basic integrals.
2. Calculate the indefinite integral $\int \frac{dx}{\sqrt{5-x}-5-x\sqrt{\text{at the}}}$.
3. Find the gradient of the function $z-y\sqrt{xy}$ point $M_0(1,4)$.
4. Indicate which of the improper integrals is convergent.

$$\int_1 \sqrt{x}dx, \quad \int_1 x^{-3}dx, \quad \int_1 \sqrt{x^5}dx.$$

5. Find the extrema and inflection points of the function $y-(x-1)e^{-x}$.

Approved at the meeting of the Department of Mathematics "03 »05 2023, protocol no.10 Acting Head of Department N.V. Vasilyeva / /

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
FEDERAL STATE AUTONOMOUS EDUCATIONAL
HIGHER EDUCATION INSTITUTION **"MOSCOW POLYTECHNIC UNIVERSITY"**
(MOSCOW POLYTECHNIC)

Faculty of Basic Competencies, Department of Mathematics
Educational program 15.03.03 "Applied Mechanics" Course 1, semester 2

Examination ticket No. 1

1. Improper integrals of the first and second types. Concepts of convergence and divergence of an improper integral.
2. Find the derivative of a function given parametrically $x-\frac{t}{1-t^3}$, $y-\frac{2t^2}{1-t^3}$.
3. Investigate the function for extremum $z-x^2-x-y^2-2y$.
4. **.**Calculate the definite integral $\int_0^{-.6} 3\sin^2 x\cos x dx$**.**
5. Find the volume of a body obtained by rotation around an axis OX figure bounded by a line yami $y-x^3, y-1, x-0$.

Approved at the meeting of the Department of Mathematics "03 »05 2023, protocol no.10

Acting Head of Department N.V. Vasilyeva / /

To conduct intermediate control of students' knowledge in a remote format, the online courses developed by the Department of Mathematics include final tests.