Federal State Autonomous Educational Institution of Higher Education
"Peoples' Friendship University of Russia named after Patrice Lumumba"

Academy of Engineering
(name of the main educational unit (MEU) that developed the educational program of higher education)

WORKING PROGRAM OF THE DISCIPLINE

MATHEMATICAL ANALYSIS
(name of discipline/module)

Recommended for the field of study/specialty:

27.03.04 CONTROL IN TECHNICAL SYSTEMS
(code and name of the training area/specialty)

The discipline is mastered within the framework of the implementation of the main professional educational program of higher education (EP HE):

DATA SCIENCE AND SPACE SYSTEMS
(name (profile/specialization) of the educational institution of higher education)

2025

1. THE GOAL OF MASTERING THE DISCIPLINE

The discipline "Mathematical Analysis" is included in the bachelor's program "Data Science and Space Systems" in the direction 27.03.04 "Control in Technical Systems" and is studied in semesters 1 and 2 of the 1st year. The discipline is implemented by the Department of Mechanics and Control Processes. The discipline consists of 8 sections and 151 topics and is aimed at studying basic knowledge in mathematical analysis, as well as the formation of general professional competencies necessary for solving scientific and industrial problems in the professional field.

The purpose of mastering the discipline is to develop the skills of setting and practically solving problems of mathematical analysis, the formation of modern mathematical thinking, including the ability to describe various phenomena using mathematical apparatus.

2. REQUIREMENTS TO THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Mathematical Analysis" is aimed at developing the following competencies (parts of competencies) in students:

Table 2.1. List of competencies developed in students while mastering the discipline (results of mastering the discipline)

Cipher	Competence	Indicators of Competence Achievement (within the framework of this discipline)
GPC-1	Able to analyze the tasks of professional activity based on provisions, laws and methods in the field of natural sciences and mathematics	GPC-1.1 Possesses basic knowledge obtained in the field of mathematical and (or) natural sciences; GPC-1.2 Knows how to use them in professional activities; GPC-1.3 Has the skills to select methods for solving problems of professional activity based on theoretical knowledge;
GPC-2	Able to formulate tasks of professional activity based on knowledge, specialized sections of mathematical and natural science disciplines (modules)	GPC-2.1 Has mastered mathematical methods, programming fundamentals and specialized programming systems for implementing algorithms for solving applied problems; GPC-2.2 Able to select and adapt mathematical methods and software to solve practical problems; GPC-2.3 Possesses skills in developing and implementing algorithms for solving applied problems in the field of professional activity;
GPC-3	Able to use fundamental knowledge to solve basic control problems in technical systems in order to improve in professional activities	GPC-3.1 Knows the theoretical foundations and principles of mathematical modeling; GPC-3.2 Able to develop and use methods of mathematical modeling, information technologies to solve problems of applied mathematics; GPC-3.3 Possesses practical skills in solving problems of applied mathematics, methods of mathematical modeling, information technologies and the basics of their use in professional activities, skills of professional thinking and an arsenal of methods and approaches necessary for the adequate use of methods of modern mathematics in theoretical and applied problems;

3. PLACE OF THE DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL EDUCATIONAL EDUCATION

Discipline "Mathematical Analysis" refers to the mandatory part of block 1 “Disciplines (modules)” of the educational program of higher education.

As part of the higher education program, students also master other disciplines and/or practices that contribute to the achievement of the planned results of mastering the discipline "Mathematical Analysis".

Table 3.1. List of components of the educational program of higher education that contribute to the achievement of the planned results of mastering the discipline

Cipher	Name of competence	Previous courses/modules, practices*	Subsequent disciplines/modules, practices*
GPC-1	Able to analyze the tasks of professional activity based on provisions, laws and methods in the field of natural sciences and mathematics		Research work / Scientific research work; Technological Training; Undergraduate Training; Research Work; Space Flight Mechanics; Complex analysis;
GPC-2	Able to formulate tasks of professional activity based on knowledge, specialized sections of mathematical and natural science disciplines (modules)		Space Flight Mechanics; Numerical Methods; Automatic Control Theory; Equations of mathematical physics; Analysis of Geoinformation Data; Research work / Scientific research work; Technological Training; Undergraduate Training; Research Work;
GPC-3	Able to use fundamental knowledge to solve basic control problems in technical systems in order to improve in professional activities		Research work / Scientific research work; Technological Training; Undergraduate Training; Space Flight Mechanics; Theoretical Mechanics; Numerical Methods; Automatic Control Theory; Theory of Probability and Mathematical Statistics; Differential equations; Complex analysis; Equations of mathematical physics; Optimal Control Methods; Analysis of Geoinformation Data;

* - filled in in accordance with the competency matrix and the SUP EP HE
** - elective disciplines/practices

4. SCOPE OF THE DISCIPLINE AND TYPES OF STUDY WORK

The total workload of the discipline "Mathematical Analysis" is "15" credit units.

Table 4.1. Types of educational work by periods of mastering the educational program of higher education for full-time education.

Type of academic work	**TOTAL,** ac.h.		**Semester(s)**	
			1	**2**
Contact work, academic hours	*157*		*72*	*85*
Lectures (LC)	70		36	34
Laboratory work (LW)	0		0	0
Practical/seminar classes (SC)	87		36	51
Independent work of students, academic hours	*320*		*117*	*203*
Control (exam/test with assessment), academic hours	*63*		*27*	*36*
General complexity of the discipline	**ac.h.**	***540***	*216*	*324*
	credit.ed.	***15***	*6*	*9*

5. CONTENT OF THE DISCIPLINE

*Table 5.1. Contents of the disc*iplines (modules) by types of academic work

Section number	**Name of the discipline section**	**Section Contents (Topics)**		**Type of academic work***
Section 1	Elementary functions and their graphs	1.1	Introduction to the course	LC, LW, SC
		1.2	Elements of logic	LC, LW, SC
		1.3	Statements and predicates, operations on them	LC, LW, SC
		1.4	Construction of the negation of a complex statement	LC, LW, SC
		1.5	Theorem as an implication	LC, LW, SC
		1.6	Necessity and sufficiency	LC, LW, SC
		1.7	Direct, inverse and opposite theorems, the relationship between them	LC, LW, SC
		1.8	Proof by contradiction	LC, LW, SC
		1.9	Method of mathematical induction	LC, LW, SC
		1.10	Bernoulli's inequality	LC, LW, SC
		1.11	Binomial theorem	LC, LW, SC
		1.12	Sets, operations on them, their properties	LC, LW, SC
		1.13	The set R of real numbers and its axiomatics	LC, LW, SC
		1.14	Completeness of the set R	LC, LW, SC
		1.15	Intervals	LC, LW, SC
		1.16	Neighborhoods of the end point and infinity	LC, LW, SC
		1.17	The principle of nested segments (Cauchy-Kantor)	LC, LW, SC
		1.18	Bounded and unbounded sets in R	LC, LW, SC
		1.19	The greatest upper and lower bounds of a set	LC, LW, SC
		1.20	Archimedes' principle and its consequences	LC, LW, SC
		1.21	Display and function	LC, LW, SC
		1.22	Graph of a function	LC, LW, SC
		1.23	Types of mappings: surjective, injective, bijective	LC, LW, SC
		1.24	Reverse mapping	LC, LW, SC
		1.25	The concept of the cardinality of a set	LC, LW, SC
		1.26	Countable sets	LC, LW, SC
		1.27	Uncountability of the set R	LC, LW, SC

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
		1.28	Composition of functions	LC, LW, SC
Section 2	Limit of a numerical sequence	2.1	Numerical sequence, its limitedness and monotony	
		2.2	Limit of a sequence	
		2.3	Infinitely small and infinitely large sequences	
		2.4	Properties of convergent sequences	
		2.5	Weierstrass's theorem	
		2.6	Theorem on arithmetic operations under the limit sign	
		2.7	The number e as the limit of a numerical sequence	
		2.8	Hyperbolic functions	
		2.9	Limit points of a set	
		2.10	Bolzano-Weierstrass principle	
		2.11	Limit points of the sequence	
		2.12	Fundamental number sequence	
		2.13	Cauchy criterion for convergence of a numerical sequence	
Section 3	Limit of a function	3.1	Definition of the limit of a function according to Cauchy	
		3.2	Theorem on the relationship between two-sided limits and one-sided ones	
		3.3	Definition of the limit of a function according to Heine	
		3.4	Equivalence of the Heine and Cauchy definitions of the limit	
		3.5	Theorem on the uniqueness of the limit of a function	
		3.6	Theorem on local boundedness of a function having a finite limit	
		3.7	Infinitesimal functions	
		3.8	Theorem on the relationship between a function, its limit and infinitesimal	
		3.9	Properties of infinitesimal functions	
		3.10	Theorem on arithmetic operations on functions having a limit	
		3.11	Theorem on the limit of a composite function (change of variable in the limit)	
		3.12	Theorem on the constancy of sign of a function having a non-zero limit	
		3.13	Passage to the limit in inequality	
		3.14	Theorem on the limit of an intermediate function	
		3.15	Infinitely large functions	
		3.16	Theorem on the relationship between infinitely large and infinitely small functions	
		3.17	The first and second remarkable limits and their consequences	
		3.18	Weierstrass's theorem on the limit of a monotone and bounded function	
		3.19	Comparison of infinitesimals	
		3.20	Order of smallness, equivalent infinitesimals, incomparable infinitesimals	
		3.21	Table of equivalent infinitesimals	
		3.22	Properties of equivalent infinitesimals	
		3.23	Rules for working with "o maloe"	
		3.24	Comparison of infinitely large	
		3.25	Theorems on equivalent infinitesimals	
Section 4	Continuity of function	4.1	Continuity of a function at a point	

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
		4.2	Various definitions of continuity and their equivalence	
		4.3	Continuity of a function in an interval	
		4.4	One-sided continuity at a point	
		4.5	Continuity of a function on a segment	
		4.6	Properties of functions continuous at a point (connection of continuity with one-sided continuity, local boundedness, constancy of sign, arithmetic operations with continuous functions, limit transition, continuity of a complex function)	
		4.7	Breakpoints and their classification	
		4.8	Properties of functions continuous on a segment (theorems on zeros, on intermediate values, on boundedness, on reaching exact boundaries of a function continuous on a segment)	
		4.9	Continuity on a segment of a monotone function, the relationship between continuity, injectivity and strict monotonicity	
		4.10	Inverse Function Existence Theorem	
		4.11	Points of discontinuity of a monotone function	
		4.12	Continuity criterion for a monotone function	
		4.13	Continuity theorem of the inverse function	
		4.14	Continuity of the basic elementary functions	
		4.15	Uniform continuity of functions	
		4.16	The relationship between uniform continuity on a set and continuity at a point in that set	
		4.17	Cantor's theorem on the uniform continuity of a function on a segment	
Section 5	Differential calculus of a function of one variable	5.1	Differential of a function	
		5.2	Theorem on the relationship between derivative and differential	
		5.3	Geometrical meaning of differential	
		5.4	Rules for working with differentials (differential of sum, difference, product, quotient)	
		5.5	Invariance of the form of writing the first differential	
		5.6	Approximate calculations using differentials	
		5.7	Higher order differentials, lack of invariance	
		5.8	Fundamental theorems of differential calculus (Fermat, Rolle, Cauchy, Lagrange) and their geometric meaning	
		5.9	Bernoulli-L'Hôpital theorem and the disclosure of [0/0] type uncertainty	
		5.10	Bernoulli-L'Hôpital theorem and the disclosure of indeterminacy of type [infin. / infin.] (without proof)	
		5.11	Comparison of the orders of growth of logarithmic, power and exponential functions at infinity	
		5.12	Disclosure of uncertainties of the type [0, infin.], [infin., -infin.], [0 in step 0], [1 in step infin.], [infin. in step 0]	
		5.13	Taylor's formula for polynomials	
		5.14	Taylor polynomial for arbitrary functions	
		5.15	Taylor formula with remainder term in Peano form	
		5.16	Theorem on the uniqueness of the expansion of a function by the Taylor formula with a remainder term in Peano form	

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
		5.17	Taylor's formula with remainder term in general form	
		5.18	Consequences: the remainder term in Cauchy form and in Lagrange form	
		5.19	Maclaurin formula	
		5.20	Decomposition of the basic elementary functions according to the Maclaurin formula	
		5.21	Using decompositions to reveal uncertainties	
		5.22	Approximate calculations using Taylor's formula	
		5.23	Application of differential calculus to the study of functions and the construction of their graphs	
		5.24	Relationship between derivative and monotonicity	
		5.25	Necessary and sufficient conditions for monotonicity. Local extremum of a function	
		5.26	A necessary condition for the existence of a local extremum of a differentiable function	
		5.27	Sufficient conditions for the existence of an extremum for the first derivative, for the second derivative, for the n-th derivative	
		5.28	The concept of upward (downward) convexity of a function	
		5.29	The geometric meaning of the definition of convexity of a function is the relative position of the graph of the function and the chord	
		5.30	Lemma on convexity of a function and its geometric meaning	
		5.31	Necessary and sufficient condition for convexity with respect to the first derivative	
		5.32	Consequences: a necessary and sufficient condition for the convexity of a twice-differentiable function, a sufficient condition for the strict convexity of a twice-differentiable function	
		5.33	The relationship between the direction of convexity of the graph of a function and the position of the tangent	
		5.34	Inflection points of the function graph	
		5.35	Necessary and sufficient conditions for the existence of an inflection point of a twice differentiable function	
		5.36	Asymptotes of the graph of a function: vertical, horizontal, oblique	
		5.37	Oblique Asymptote Theorem	
		5.38	General scheme of studying functions and constructing their graphs	
Section 6	Indefinite integral	6.1	The concept of a primitive	
		6.2	Theorem on Antiderivatives	
		6.3	Indefinite integral and its properties	
		6.4	Table of basic indefinite integrals	
		6.5	General methods of integration: substitution of the differential sign (change of variable), substitution, integration by parts	
		6.6	Integration of rational functions by expansion into simple fractions	
		6.7	Integration of expressions containing trigonometric functions and irrational functions	
		6.8	Examples of integrals that cannot be expressed through elementary functions	

Section number	Name of the discipline section	Section Contents (Topics)		Type of academic work*
Section 7	Definite integral	7.1	Examples of problems leading to a definite integral	
		7.2	Definite integral as a limit of integral sums	
		7.3	Darboux sums and integrals	
		7.4	Criterion for the existence of a definite integral	
		7.5	Basic properties of the definite integral	
		7.6	Theorems on the estimation of a definite integral and on the mean value of an integrand	
		7.7	Derivative of the integral with respect to the upper limit	
		7.8	Newton-Leibniz formula	
		7.9	Calculation of a definite integral by integration by parts and by changing the variable (substitution)	
		7.10	Integration of even and odd functions on a segment symmetrical with respect to the origin	
		7.11	Improper integrals of continuous functions over an infinite interval	
		7.12	Improper integrals of unbounded functions on a segment	
		7.13	Tests for convergence and divergence of an improper integral	
		7.14	Absolute and conditional convergence of improper integrals	
		7.15	Area of a flat figure	
		7.16	Calculating the area of a flat figure in rectangular and polar coordinates	
		7.17		
		7.18		
		7.19		
		7.20		
		7.21		
		7.22		
Section 8	Functions of several variables			

* - filled in only for FULL-TIME education: LC – lectures; LW – laboratory work; SC – practical/seminar classes.

6. LOGISTIC AND TECHNICAL SUPPORT OF DISCIPLINE

Table 6.1. Material and technical support of the discipline

Audience type	Equipping the auditorium	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; a board (screen) and technical means for multimedia presentations.	
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with a set of	

Audience type	Equipping the auditorium	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
	specialized furniture and technical means for multimedia presentations.	
For independent work	A classroom for independent work of students (can be used for conducting seminars and consultations), equipped with a set of specialized furniture and computers with access to the Electronic Information System.	

* - the audience for independent work of students MUST be indicated!

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Main literature:

1. Kudryavtsev L.D. Course of mathematical analysis.T.1, 2 -M., 2006
2. Demidovich B.P. Collection of problems and exercises in mathematical analysis.M., 2002
3. Kudryavtsev L.D. et al. Collection of problems in mathematical analysis: Textbook: In 2 parts. Moscow, 2010
4. Ilyin V.A., Poznyak E.G. Fundamentals of Mathematical Analysis: Textbook: In 2 parts: M., Nauka, 2002
5. Zorich V.M. Mathematical Analysis: Textbook for Universities: In 2 Parts. 2002. 787 p. Irodov Igor Evgenievich. Problems in General Physics: Textbook for Universities. - 8th ed.; Electronic text data. - M.: BINOM.Laboratory of knowledge, 2010.

Further reading:

1. Fichtenholz G.M. Course of differential and integral calculus: Textbook.In 3 volumes. 2003,2006
2. Kolmogorov Andrey Nikolaevich. Elements of the theory of functions and functional analysis [Text]. - 7th ed. - M.: Fizmatlit, 2004, 2006. - 572 p.
3. Ilyin V.A., Sadovnichy V.A., Sendov B.Kh. Mathematical analysis: Textbook: M., Nauka, 1979.719 pp.

Resources of the information and telecommunications network "Internet":

1. RUDN University EBS and third-party EBSs to which university students have access on the basis of concluded agreements
   - Electronic library system of RUDN - ELS RUDNhttp://lib.rudn.ru/MegaPro/Web
   - Electronic library system "University library online"http://www.biblioclub.ru
   - EBS Yuraithttp://www.biblio-online.ru
   - Electronic Library System "Student Consultant" www.studentlibrary.ru
   - Electronic library system "Troitsky Bridge"
2. Databases and search engines
   - electronic fund of legal and normative-technical documentationhttp://docs.cntd.ru/
   - Yandex search enginehttps://www.yandex.ru/
   - search engineGoogle https://www.google.ru/
   - abstract databaseSCOPUS http://www.elsevierscience.ru/products/scopus/

Educational and methodological materials for independent work of students in mastering a discipline/module:*

1. Lecture course on the subject "Mathematical Analysis".

* - all educational and methodological materials for independent work of students are posted in accordance with the current procedure on the discipline page in TUIS!

DEVELOPER:

Associate Professor		Saltykova Olga Alexandrovna
Position, Department	*Signature*	*Surname I.O.*

HEAD OF THE DEPARTMENT:

Head of Department		Razumny Yuri Nikolaevich
Position of the Department	*Signature*	*Surname I.O.*

HEAD OF THE EP HE:

Head of Department		Razumny Yuri Nikolaevich
Position, Department	*Signature*	*Surname I.O.*