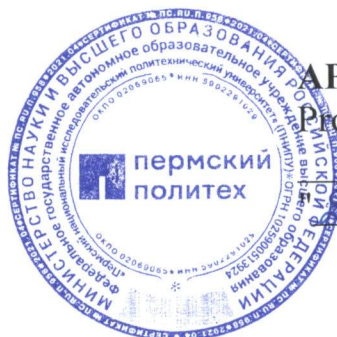


Ministry of Science and Higher Education of the Russian Federation  
Federal State Autonomous Educational Institution of Higher Education  
**Perm National Research Polytechnic University**



**APPROVED BY**

Pro-rector for Academic Affairs

N.V. Lobov

2021

**ACADEMIC COURSE WORKING PROGRAM**

**Academic course:** Mathematics  
(Name)

**Form of education:** Full-time studies  
(full-time / part-time / correspondence)

**Level of higher education:** Bachelor's program  
(Bachelor's program / Specialist program / Master's program)

**Workload in hours (in credits):** 756 (21)  
(Hours (CU))

**Training program (degree):** 15.03.06 Mechatronics and robotics technology  
(Code and denomination of degree)

**Direction:** Mechatronics and robotics technology  
(Title of curriculum)

Perm 2021

## 1. GENERAL PROVISIONS

### 1.1. GOALS AND OBJECTIVES OF THE COURSE

The main goal is to form students' knowledge of mathematics aimed at solution of professional problems using methods of mathematical analysis, theory of differential equations, probability theory and math statistics, to assimilate, deepen and expand their mathematical knowledge, to develop a sustainable interest in the subject, as well as to form the ability of analytical thinking (GPC-1).

### 1.2. PRESCRIBED OBJECTS OF THE COURSE

Linear algebra. Matrices. Determinants. Systems of linear algebraic equations. Vector algebra. Vector quantities. Linear operations on vectors. Non-linear operations on vectors. Analytical geometry. Equation of a line on a plane. Equations of a plane, a line in space. Curves of the second order. Surfaces of the second order. Differential calculus. Introduction to mathematical analysis. Limit of a numerical sequence. Limit, function continuity. Derivative. Differential. Fundamental theorems of differential calculus. Function study. Theory of functions of several variables. Functions of several variables. Partial derivatives of functions of several variables. Extrema of a function of several variables. Integral calculus of a function of one variable. Indefinite integral. Classes of integrable functions. Definite integral. Geometric and physical applications of a definite integral. Differential Equations. Differential equations of the first order. Linear differential equations of higher orders. Systems of differential equations. Series. Number series. Alternating series. Functional series. Power series. Integral calculus of a function of several variables. Double integral. Triple integral. Contour integrals. Fourier series. Expansion of a function in a trigonometric Fourier series. Probability theory and mathematical statistics. The subject of probability theory. Methods for calculating probabilities. Random variables. Problems of mathematical statistics. Statistical estimates of distribution parameters.

### 1.3. STARTING CONDITIONS

Unstipulated

## 2. PLANNED RESULTS OF THE COURSE TRAINING

Competence	Indicator's Index	Planned Results of the Course Training (to know, to be able, to master)	Indicator of Attaining Competence which the planned results of training are correlated with	Means of Assessment
1	2	3	4	5
GPC-1	IA-1 <sub>gpc-1</sub>	<b>To know</b> the readiness to identify the natural scientific essence of the problems arising in the course of professional activity and the ability to attract the appropriate physical and mathematical apparatus to solve them	<b>Knows</b> basic concepts and provisions of the sections of higher mathematics which will be used in professional activities; basic concepts and methods of linear and vector algebra, analytical geometry; basic concepts and methods of differential and integral calculus; fundamentals of the theory of ordinary differential equations; series and their convergence, expansion of elementary functions in a series; harmonic analysis; basic concepts, methods and techniques of probability theory and mathematical statistics.	Exam
GPC-1	IA-3 <sub>gpc-1</sub>	<b>To master the skills</b> to present a scientific picture of the world adequate to the modern level of knowledge based on knowledge of the basic provisions, laws and methods of natural sciences and mathematics	<b>Masters the tools</b> for solving mathematical problems in their subject area; methods of mathematical analysis in solving professional problems; methods for solving algebraic and ordinary differential equations of the first and second order; methods of analytical geometry, linear algebra; methods of differential and integral calculus.	Practice work
GPC-1	IA-2 <sub>gpc-1</sub>	<b>To be able to</b> use the physical and mathematical apparatus for solving computational and analytical problems arising in the course of professional activity.	<b>Is able to</b> navigate in reference mathematical literature; use the basic laws of natural science disciplines, mathematical methods in professional	Test



1	2	3	4	5
			activity; to acquire new mathematical knowledge using modern educational and information technologies; solve typical problems in the main sections of the course, using the methods of higher mathematics; apply methods of differential calculus to solve extreme problems, study the behavior of functions and solve nonlinear equations; use the apparatus of linear algebra and analytical geometry; solve differential equations; calculate the probabilities of random events, compose and investigate the distribution functions of random variables, determine the numerical characteristics of random variables.	

### 3. FULL TIME AND FORMS OF ACADEMIC WORK

Form of academic work	Hours in all	Distribution in hours according to semesters		
		Number of semester		
		2	3	4
1. Holding classes (including results monitoring) in the form:				
1.1. Contact classwork, including:				
– lectures (L)	112	32	32	48
– laboratory work (LW)				
– practice, seminars and/or other seminar-type work (PW)	186	44	54	88
– control of self-work (CSW)	12	4	4	8
– test				
1.2. Students' self-work (SSW)	370	100	90	180
2. Interim/midterm assessment				
Exam	72	36		36
Grading test				
Test (Credit)				
Course Project (CP)				
Course Work (CW)				
<b>Workload in hours</b>	<b>756</b>	<b>216</b>	<b>180</b>	<b>360</b>

## 4. COURSE CONTENTS

Course sections with brief contents	Full time of classroom activity in hours according to the forms			Full time of extracurricular work in hours according to the forms
	L	LW	PW	SSW
1	2	3	4	5
<b>Semester 2</b>				
I. Algebra and Geometry 1. Linear algebra. 2. Vector algebra. 3. Analytical geometry.	16		22	50
II. Introduction to math analysis 1. Differential calculus. Introduction to mathematical analysis.	16		22	50
<b>Total with regard to semester</b>	<b>32</b>		<b>44</b>	<b>100</b>
<b>Semester 3</b>				
I. Functions of several variables and integral calculus 1. Theory of functions of several variables. 2. Integral calculus of a function of one variable.	14		24	40
II. Differential equations and series 1. Differential equations. 2. Series.	18		30	50
<b>Total with regard to semester</b>	<b>32</b>		<b>54</b>	<b>90</b>
<b>Semester 4</b>				
I. Integral calculus of functions of several variables and harmonic analysis 1. Integral calculus of a function of several variables. 2. Fourier series.	12		22	36
II. Probability theory and math statistics 1. Probability theory and mathematical statistics.	12		22	36
<b>Total with regard to semester</b>	<b>24</b>		<b>44</b>	<b>72</b>
<b>Total with regard to the course</b>	<b>88</b>		<b>142</b>	<b>262</b>

## Topics of exemplary practical work

Sl.No	Topic of practical work (seminars)
1	Determinants. Cramer's method for solving systems of linear algebraic equations.
2	Matrices. Matrix operations. Inverse matrix method for solving LAES.
3	Gaussian method for solving LAES.
4	Control work.
5	Vector. Vector properties. Linear operations on vectors. The problem of finding the coordinates of a vector in a new basis.
6	Scalar and vector product of two vectors. The geometric meaning of the vector product.
7	Triple product of three vectors. The geometric meaning of the triple product.
8	Equation of a line on a plane.
9	Plane. Equations of a line in space.
10	Curves of the second order. Surfaces of the second order.
11	Control work.



Sl.№	Topic of practical work (seminars)
12	Limit of a numerical sequence.
13	Function limit.
14	Function limit, function continuity.
15	Control work.
16	Derivative. The geometric and physical meaning of the derivative.
17	Derivative of a complex function.
18	Logarithmic differentiation. Implicit function differentiation. Differentiation of the parametric function.
19	Differential and its geometric meaning.
20	Derivatives of high order.
21	Function study using a derivative.
22	Control work.
23	Functions of several variables. Partial derivatives of functions of several variables.
24	Extrema of a function of several variables.
25	Directional derivative. Gradient.
26	Control work.
27	Indefinite integral. Replacement method in indefinite integral.
28	Method of integration by parts.
29	Integration of rational fractions.
30	Integration of some classes of trigonometric functions.
31	Integration of irrational functions.
32	Definite integral.
33	Geometric and physical applications of a definite integral.
34	Control work.
35	Elementary differential equations.
36	Homogeneous differential equations of the first order.
37	Linear differential equations of the first order.
38	Bernoulli's equation.
39	Exact differential equation.
40	Second-order differential equations admitting a reduction in order.
41	Linear homogeneous differential equations of the second order.
42	Linear inhomogeneous differential equations of the second order.
43	Systems of differential equations.
44	Control work.
45	Number series. Convergence criteria for numerical series
46	Alternating series.
47	Functional series. Power series.
48	Taylor and Maclaurain's series.
49	Control work.
50	Calculation of the double integral. Replacement method in double integral.
51	Double integral in polar coordinates.
52	Calculating surface area using double integral.
53	Triple integral.
54	Triple integral in cylindrical and spherical coordinate system.
55	Calculating body volume using triple integral.
56	Contour integrals.
57	Contour integrals.
58	Control work.
59	Examples of expansion of functions in Fourier series.

Sl.№	Topic of practical work (seminars)
60	Fourier series for a function with a period $2l$ .
61	Combinatorial elements.
62	Classical definition of probability.
63	Addition and multiplication theorems for probabilities. Dependent and independent events.
64	Total probability and Bayes formulas.
65	Bernoulli's formula.
66	Local and integral Laplace theorems.
67	Discrete random variable.
68	Continuous random variable.
69	Statistical estimates of distribution parameters.
70	Statistical testing of statistical hypotheses.
71	Control work.

#### Topics of exemplary laboratory practice

Sl. №	Topic of laboratory work

## 5. ORGANIZATIONAL AND PEDAGOGICAL CONDITIONS

### 5.1. EDUCATIONAL TECHNOLOGIES USED FOR COMPETENCES FORMATION

Holding lectures in the discipline is based on the active method of training in the process of which students are not passive but active participants of the lesson answering questions of the teacher. Teacher's questions are aimed at activating the process of learning material as well as at the development of logical thinking. The questions stimulating associative thinking and connecting new material with the previous one are formulated by the teacher in advance.

Practical lessons are held by realization of the method based on active training: problem areas are determined, groups are formed. The following aims are pursued in the process of practical education: use of definite disciplines knowledge and creative methods in solving problems and decision-making; students' skill-building of teamwork, interpersonal communication and development of leadership skills; consolidation of the basic theoretical knowledge.

### 5.2. STUDENTS' MANUAL FOR THE COURSE STUDY

Learning the course students are recommended to fulfill the following positions:

1. Learning of the discipline should be done systematically.
2. After learning one of the course unit with the help of the text-book or lecture notes it is recommended to reproduce the basic terms, definitions, notions of the unit from memory.



3. Special attention should be paid to the reports on practical studies, laboratory works and individual complex tasks for self-work.

4. The topics list for individual study is given by the teacher at the lectures. The teacher also provides students with literary sources (first of all, new ones in the periodical scientific literature) for a more detailed understanding of the issues presented at the lectures.

## 6. LIST OF TEACHING MATERIALS AND INFORMATION SUPPLY FOR STUDENTS' SELF WORK IN THE DISCIPLINE

### 6.1. PAPER-BASED COURSEWARE

Sl.No	Bibliographic entry (author, title, mode of publication, place, publishing house, year of publication, number of pages )	Number of copies in the library
<b>1. Basic literature</b>		
1	Mathematical Analysis / Ed. by J. M. Rassias. – Leipzig: B.G. Teubner Verl.-Ges., 1985.	1
2	Rudin Walter. Principles of Mathematical Analysis (International Series in Pure and Applied Mathematics) 3 <sup>rd</sup> ed. – NY: McGraw-Hill, 1976.	1
3	Mattuck Arthur. Introduction to Analysis. – Pearson, 1998.	1
4	Durrett Rick. Probability: Theory and Examples. 4 <sup>th</sup> ed. – Cambridge University Press, 2010.	1
5	Dudley R. M. Real Analysis and Probability. – Cambridge University Press, 2002.	1
<b>2. Additional literature</b>		
<b>2.1. Educational and scientific literature</b>		
1	Rossberg H.-J. Analytic Methods of Probability Theory / H.-J. Rossberg, B. Jesiak, G. Siegel. – Berlin: Akademie-Verl., 1985.	1
2	Marek I. Matrix Analysis for Applied Sciences : in two vol. / I. Marek, K. Zitny. – Leipzig: BSB Teubner, 1986.	1
3	Vol. 2. – Leipzig: , BSB Teubner, 1986. – (Matrix Analysis for Applied Sciences : in 2 vol.; Vol. 2).	1
4	Conway J. B. A Course in Functional Analysis. New York : Springer-Verlag, 1985. 406 p.	1
<b>2.2. Standardized and Technical literature</b>		
	No provision	
<b>3. Students' manual in mastering discipline</b>		
	No provision	
<b>4. Teaching and learning materials for students' self work</b>		
	No provision	



## 6.2. ELECTRONIC COURSEWARE

Kind of literature	Name of training tool	Reference to information resource	Accessibility of EBN (Internet/local net; authorized free access)
Book	Azbelev N.V., Maksimov V.P., Rakhmatullina L.F. Introduction to the Theory of Functional Differential Equations : Methods and Applications. New York : Hindawi Publ. Corr., 2007. 314 p.	<a href="https://elib.pstu.ru/vufind/Record/RUPSTUbooks126449">https://elib.pstu.ru/vufind/Record/RUPSTUbooks126449</a>	authorized free access

## 6.3. LICENSE AND FREE DISTRIBUTED SOFTWARE USED IN THE COURSE EDUCATIONAL PROCESS

Type of Software	Software branding
<i>Operating system</i>	Windows 10 (Azure Dev Tools for Teaching)
<i>Office application</i>	Adobe Acrobat Reader DC
<i>Image processing software</i>	Corel CorelDRAW Suite X4
<i>General purpose application software</i>	Mathematica Professional Version (license L3263-7820*)
<i>General purpose application software</i>	Microsoft Office Visio Professional 2016 (Azure Dev Tools for Teaching)
<i>General purpose application software</i>	WinRAR (license №879261.1493674)
<i>Management systems for projects, research, development, design, modeling and implementation</i>	Autodesk AutoCAD 2019 Education Multi-seat Stand-alone

## 6.4. MODERN PROFESSIONAL DATA BASES AND INQUIRY SYSTEMS USED IN THE COURSE EDUCATIONAL PROCESS

Branding	Reference to information resource
<i>Scopus database</i>	<a href="https://www.scopus.com/">https://www.scopus.com/</a>
<i>Web of Science Database</i>	<a href="https://www.webofscience.com/">https://www.webofscience.com/</a>
<i>Scientific electronic library database (eLIBRARY.RU)</i>	<a href="https://elibrary.ru/">https://elibrary.ru/</a>
<i>Scientific Library of the Perm National Research Polytechnic University</i>	<a href="https://lib.pstu/">https://lib.pstu/</a>
<i>Lan Electronic Library System</i>	<a href="https://e.lanbook.com/">https://e.lanbook.com/</a>
<i>Electronic library system IPRbooks</i>	<a href="https://www.iprbookshop.ru/">https://www.iprbookshop.ru/</a>
<i>Information resources of the Network ConsultantPlus</i>	<a href="https://www.consultant.ru/">https://www.consultant.ru/</a>
<i>Company database EBSCO</i>	<a href="https://www.ebsco.com/">https://www.ebsco.com/</a>

## 7. LOGISTICS OF THE COURSE EDUCATIONAL PROCESS

Type of classes	Name of the necessary basic equipment	Number of units
Lecture	Projector	1

## 8. FUND OF THE COURSE EVALUATING TOOLS

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