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

THEORY OF PROBABILITY AND MATHEMATICAL STATISTICS

(name of discipline/module)

Recommended for the field of study/specialty:

27.03.04 CONTROL IN TECHNICAL SYSTEMS

(code and name of the field of study/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)

2026

1. THE GOAL OF MASTERING THE DISCIPLINE

The course "Theory of Probability and Mathematical Statistics" is part of the bachelor's degree program "Data Science"and Space Systems" in the direction 27.03.04 "Control in Technical Systems" and is studied in semesters 3 and 4 of the 2nd year. The course is implemented by the Department of Mechanics and Control Processes. The course consists of 13 sections and 30 topics and is aimed at studying and gaining an understanding of the goals and objectives of probability theory and their role and place in socio-economic research and engineering applications, modern trends in probability theory, methodological problems of probability theory; basic concepts of combinatorics, probability theory, fundamentals of the theory of random processes, basic concepts and problems of mathematical statistics, familiarization with the basic concepts of probability theory (event, probability, random variable, numerical characteristics of random variables, etc.), mastering the basic techniques for solving practical problems on the topics of the discipline, developing computer skills in scientific research, the possibilities of applying the mastered methods in solving specific engineering problems.

The goal of mastering the discipline is to study the basics of probability theory and mathematical statistics.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline "Theory of Probability and Mathematical Statistics" 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 Competency Achievement** (within this discipline)
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 INSTITUTION

Course "Theory of Probability and Mathematical Statistics" 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 "Theory of Probability and Mathematical Statistics".

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, practical training*	Subsequent disciplines/modules, practices*
GPC-3	Able to use fundamental knowledge to solve basic control problems in technical systems in order to improve in professional activities	Mathematical analysis; Algebra and Geometry;	Research work / Scientific research work; Technological Training; Undergraduate Training; Space Flight Mechanics; Numerical Methods; Automatic Control Theory; Equations of mathematical physics; Optimal Control Methods; Analysis of Geoinformation Data;

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

4. SCOPE OF THE DISCIPLINE AND TYPES OF EDUCATIONAL WORK

The total workload of the course “Theory of Probability and Mathematical Statistics” is 7 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,**academic hours		**Semester(s)**	
			3	**4**
Contact work, academic hours	*123*		*72*	*51*
Lectures (LC)	53		36	17
Laboratory work (LW)	0		0	0
Practical/seminar classes (SC)	70		36	34
Independent work of students, academic hours	*75*		*54*	*21*
Control (exam/test with assessment), academic hours	*54*		*18*	*36*
Total complexity of the discipline	**academic hours**	***252***	*144*	*108*
	credit	*7*	*4*	*3*

5. CONTENT OF THE DISCIPLINE

Table 5.1. Content of the discipline (module) by types of academic work

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
Section 1	Probability space	1.1	Space of elementary outcomes.	The space of elementary outcomes. Events and actions upon them. Certain and impossible events. Joint and incompatible events. The complete group of events.	LC, SC
		1.2	Probability space	Axiomatic definition of probability. Properties of probability. Probability space.	LC, SC
Section 2	Classical and geometric probabilities	2.1	Classical definition of probability	The concept of classical probability. Basic formulas of combinatorics: permutations, arrangements, and combinations. Hypergeometric distribution.	LC, SC
		2.2	Geometric definition of probability.	The concept of geometric probability. The meeting problem. Buffon's problem.	LC, SC
Section 3	Conditional Probability. Independence of Events. The Formula for Total Probability and Bayes's	3.1	Conditional probability	The concept of conditional probability. The formula for multiplying probabilities. Pairwise and joint independence of events. Bernstein's example.	LC, SC
		3.2	Formula of total probability.	Bayes' formula.	LC, SC
Section 4	Bernoulli diagram	4.1	Bernoulli's formula and its limit theorems	Bernoulli scheme. Bernoulli formula. Poisson theorem. Local Moivre-Laplace theorem. Integral Moivre-Laplace theorem. Bernoulli theorem. Polynomial scheme.	LC, SC
Section 5	Random variables and their distributions	5.1	Random variable.	The concept of a random variable. The distribution function and its properties.	LC, SC
		5.2	Discrete distributions	Discrete random variable. Distribution series. Binomial distribution. Poisson distribution. Geometric distribution.	LC, SC
		5.3	Continuous distributions	Continuous random variable. Distribution density and its properties. Uniform distribution. Exponential distribution. Normal distribution. Gamma distribution.	LC, SC
		5.4	Functions of random variables	Calculating the distributions of a function of a random variable for various cases.	LC, SC
Section 6	Multidimensional random variables and their properties	6.1	Two-dimensional random variables	The concept of a multivariate random variable using a two-dimensional one as an example. The joint distribution function and its properties. A discrete two-dimensional random variable. A continuous two-dimensional random variable. The joint probability density function and its properties.	LC, SC
		6.2	Multivariate normal law and conditional	Multivariate normal law. Conditional distributions of random	LC, SC

Section number	Name of the discipline section	Topic Title		Topic Contents	Type of academic work*
			distributions	variables. Independent random variables.	
		6.3	Functions of multivariate random variables	Functions of a two-dimensional random variable. Calculating distributions. Convolution formula.	LC, SC
Section 7	Numerical characteristics of random variables	7.1	Mathematical expectation and variance	The mathematical expectation of a random variable and its properties. The variance of a random variable and its properties.	LC, SC
		7.2	Covariance and correlation	Covariance and correlation coefficient of random variables, their properties. Covariance matrix.	LC, SC
		7.3	Moments and other characteristics	Higher-order moments. Median, quantile, mode, entropy.	LC, SC
Section 8	Convergence of random variables	8.1	Convergence and the law of large numbers	Types of convergence. Chebyshev's inequality. The law of large numbers for independent identically distributed random variables and its generalizations.	LC, SC
Section 9	Central Limit Theorem	9.1	The concept of the central limit theorem	Central limit theorem for independent identically distributed random variables.	LC, SC
Section 10	Introduction to Mathematical Statistics and Parameter Estimation Theory	10.1	Basic concepts of mathematical statistics	Sample, variation series, empirical distribution function, histogram.	LC, SC
		10.2	Point estimation	Consistency, unbiasedness, efficiency. Method of moments. Maximum likelihood method.	LC, SC
		10.3	Interval estimation.	Confidence interval. Confidence probability. Constructing confidence intervals for the parameters of a normal distribution.	LC, SC
Section 11	Testing statistical hypotheses	11.1	Basic concepts of hypothesis testing	Null and alternative hypotheses. Type I and II errors. Significance level. Criterion power. Hypothesis testing algorithm. Neyman-Pearson lemma.	LC, SC
		11.2	Parametric criteria	Chi-square test. Student's t-test. Fisher's exact test. Kolmogorov-Smirnov test. Test based on the sample correlation coefficient.	LC, SC
		11.3	Nonparametric tests	Rank tests. Wilcoxon test. Spearman's rank correlation coefficient. Tests for independence of random variables.	LC, SC
Section 12	Applications of mathematical statistics	12.1	Regression analysis.	Regression models. Ordinary least squares. Gauss-Markov scheme. Simple linear regression.	LC, SC
		12.2	Statistical modeling and experimental design	Method of statistical testing. Concept of experimental design.	LC, SC
Section 13	Random processes	13.1	Basic concepts of the theory of random processes	The concept of a random process. Classification of random processes. Basic characteristics of random processes.	LC, SC
		13.2	Stationary random processes	Linear and nonlinear transformations of random processes. Differentiation and integration of random processes. Stationary white noise.	LC, SC
		13.3	Markov processes	The concept of a Markov random process. Discrete and continuous Markov processes. Markov chain.	LC, SC

* - to be completed 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 for the discipline

Audience type	Equipment of the auditorium	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
Lecture	A lecture hall equipped with specialized furniture, a whiteboard (screen), and multimedia presentation equipment.	Projector
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and midterm assessment, equipped with a set of specialized furniture and technical means for multimedia presentations.	No
For independent work	A classroom for independent student work (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to the Electronic Information System.	No

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

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Main literature:

1. V.E. Gmurman. Guide to solving problems in probability theory and mathematical statistics: A textbook for applied bachelor's degree programs. - 11th ed., revised and enlarged. - Moscow: Yurait, 2014. - 404 p.

2. Zaryadov I.S., Kozyrev D.V., Milovanova T.A., Razumchik R.V. “Collection of problems in probability theory and mathematical statistics”: a textbook. - Moscow: RUDN, 2014. - 140 p.: ill.

3. Bocharov P.P., Pechinkin A.V. Probability Theory and Mathematical Statistics. Moscow: Fizmatlit. 2005.

4. Pismenny D.T. Lecture notes on probability theory, mathematical statistics and random processes. – 7th ed. – Moscow: Iris-press, 2015.

5. Kibzun A.I., Goryainova E.R., Naumov A.V. Probability Theory and Mathematical Statistics: Basic Course with Examples and Problems. Moscow: Fizmatlit, 2007.

6. Kochetkov E.S., Smerchinskaya S.O. Probability Theory in Problems and Exercises. – 2nd ed. – Moscow: FORUM, 2017

Further reading:

1. Bocharov P.P., Pechinkin A.V. Probability Theory and Mathematical Statistics. – Moscow: Fizmatlit. 2005

2. V. Feller, Introduction to Probability Theory and its Applications, vol. 1, 2. - M.: Librokom, 2010

3. Ventzel E.S., Ovcharov Probability Theory and its Engineering Applications. - M.: Knorus, 2010.

4. Ivchenko G.I., Medvedev Yu.I. Mathematical statistics. - M.: Higher school, 1992

5. Pugachev V.S. Probability Theory and Mathematical Statistics - Moscow: Nauka, 1979

Resources of the information and telecommunications network "Internet":

1. RUDN University Electronic Library System and third-party electronic library systems to which university students have access based on concluded agreements

- Electronic library system of RUDN - ELS RUDN http://lib.rudn.ru/MegaPro/Web
- Electronic Library System "University Library Online" http://www.biblioclub.ru
- EBS Yurayt http://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 regulatory documentation http://docs.cntd.ru/
- Yandex search engine https://www.yandex.ru/
- Google search engine https://www.google.ru/
- SCOPUS abstract database 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 "Probability Theory and Mathematical Statistics".

* - all teaching 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		Veligura Alexander Nikolaevich
Position, DEPARTMENT	*Signature*	*Surname I.O.*

HEAD OF THE DEPART-MENT:

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

HEAD OF THE EP HE:

Professor		Razumny Yuri Nikolaevich
Position, DEPARTMENT	*Signature*	*Surname I.O.*