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

Academy of Engineering
(name of the main educational unit (POU) - developer of the EP HE)

COURSE SYLLABUS

THEORY OF PROBABILITY AND MATHEMATICAL STATISTICS
(name of discipline/module)

Recommended by the Didactic Council for the Education Field of:

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

The course instruction is implemented within the professional education programme of higher education:

DATA ENGINEERING AND SPACE SYSTEMS CONTROL
(name (profile/specialization) EP HE)

2024

1. GOAL OF DISCIPLINE MASTERING

The discipline “Theory of Probability and Mathematical Statistics” is included in the bachelor’s program “Data Engineering and Space Systems Control” in the direction of 27.03.04 “Control in Technical Systems” and is studied in the 3rd and 4th semesters of the 2nd year. The discipline is implemented by the Department of Mechanics and Control Processes. The discipline consists of 13 sections and 43 topics and is aimed at 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, and 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, familiarity 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 subjects of the discipline, development of skills in using a computer in scientific research, possibilities of using mastered methods in solving specific engineering problems

The purpose of mastering the discipline is to study the fundamentals of probability theory and mathematical statistics

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

Mastering the discipline “Theory of Probability and Mathematical Statistics” is aimed at developing the following competencies (parts of competencies) in students:

Table 2.1. List of competencies formed in students when 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, professional thinking skills 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 DISCIPLINE IN THE STRUCTURE OF HE EP

Discipline “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 educational program of higher education, students also master other disciplines and/or practices that contribute to achieving the planned results of mastering the discipline “Theory of Probability and Mathematical Statistics”.

Table 3.1. List of components of EP HE that contribute to achieving the planned results of mastering the discipline

Cipher	Name of competency	Previous disciplines/modules, practices*	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 practice / Pre-graduate practice; Space Flight Mechanics; Numerical Methods; Automatic Control Theory; Equations of mathematical physics; Optimal Control Methods; Analysis of Geoinformation Data;

* - to be filled out in accordance with the competency matrix and SUP EP VO
** - elective disciplines/practices

4. SCOPE OF DISCIPLINE AND TYPES OF STUDY WORK

The total labor intensity of the discipline “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 study.

Type of educational work	**TOTAL,**ac.ch.		**Semester(s)**	
			3	**4**
Contact work, ac.ch.	*123*		*72*	*51*
Lectures (LK)	53		36	17
Laboratory work (LR)	0		0	0
Practical/seminar sessions (SZ)	70		36	34
Independent work of students, ac.ch.	*75*		*18*	*57*
Control (exam/test with assessment), academic degree.	*54*		*18*	*36*
Total labor intensity of the discipline	**ac.ch.**	***252***	*108*	*144*
	credit units	*7*	*3*	*4*

5. CONTENT OF DISCIPLINE

Table 5.1. Contents of the discipline (module) by type of academic work

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
Section 1	Probability space	1.1	Space of elementary outcomes.	LC, NW
		1.2	Events, actions on them.	LC, NW
		1.3	Axiomatic definition of probability.	LC, NW
		1.4	Probability space	LC, NW
Section 2	Classical and geometric probabilities	2.1	Classic definition of probability	LC, NW
		2.2	Elements of combinatorics	LC, NW
		2.3	Hypergeometric distribution	LC, NW
		2.4	Geometric definition of probability. Meeting problem. Buffon's problem (throwing a needle).	LC, NW
Section 3	Conditional probability. Independence of events. Total Probability and Bayes Formula	3.1	Conditional probability. Probability multiplication formula.	LC, NW
		3.2	Independence of events in pairs and in aggregate. Bernstein's example of events that are independent in pairs, but dependent in aggregate	LC, NW
		3.3	Total probability formula. Bayes' formula.	LC, NW
Section 4	Bernoulli scheme	4.1	Bernoulli scheme, Bernoulli formula.	LC, NW
		4.2	Poisson's theorem.	LC, NW
		4.3	Local theorem of Moivre-Laplace. Integral theorem of Moivre-Laplace.	LC, NW
		4.4	Bernoulli's theorem (law of large numbers in Bernoulli form). Polynomial circuit.	LC, NW
Section 5	Random variables and their distributions	5.1	Random value. Distribution function and its properties.	LC, NW
		5.2	Discrete random variable. Distribution series. Binomial, Poisson, geometric distributions.	LC, NW
		5.3	Continuous random variable. Distribution density and its properties. Uniform, exponential, normal, gamma distributions.	LC, NW
		5.4	Function of a random variable (calculation of distributions of a function of a random variable for various cases).	LC, NW
Section 6	Multidimensional random variables and their properties	6.1	Multidimensional random variable (using the example of a 2-dimensional one). Joint distribution function and its properties.	LC, NW
		6.2	Discrete two-dimensional random variable.	LC, NW
		6.3	Continuous two-dimensional random variable. Joint distribution density and its properties.	LC, NW
		6.4	Multidimensional normal law.	LC, NW
		6.5	Conditional distributions of random variables. Independent random variables.	LC, NW
		6.6	Functions of a two-dimensional random variable (calculation of distributions). Convolution formula.	LC, NW
Section 7	Numerical characteristics of random variables	7.1	Mathematical expectation of a random variable, its properties.	LC, NW
		7.2	Dispersion of a random variable, its properties.	LC, NW
		7.3	Covariance and correlation coefficient of random variables, their properties. Covariance matrix.	LC, NW
		7.4	Moments of the highest order. Median, quantile, mode, entropy.	LC, NW
Section 8	Convergence of random variables	8.1	Convergence of random variables. Types of convergence. Chebyshev's inequality. (Weak) law of large numbers for independent identically distributed random variables, its generalizations.	LC, NW

Section number	Name of the discipline section	Contents of the section (topic)		Type of educational work*
Section 9	Central limit theorem	9.1	Central limit theorem for independent identically distributed random variables.	LC, NW
Section 10	Introduction to mathematical statistics and parameter estimation theory	10.1	Basic concepts of mathematical statistics	LC, NW
		10.2	Estimates of unknown parameters, properties of estimates. Basic Point Estimation Methods	LC, NW
		10.3	Interval estimation.	LC, NW
Section 11	Testing statistical hypotheses	11.1	The concept of a statistical hypothesis. Errors of the first and second kind. Statistical test. Power of criterion.	LC, NW
		11.2	Algorithm for testing a statistical hypothesis. Neyman-Pearson Lemma. Criteria for testing parametric hypotheses. Chi-square goodness-of-fit test for testing the hypothesis about the type of distribution of a random variable.	LC, NW
		11.3	Student's test, Fisher's test, Kolmogorov-Smirnov test. Test based on sample correlation coefficient.	LC, NW
		11.4	Rank criteria. Wilcoxon test. Spearman's rank correlation coefficient. Criteria for checking the independence of two random variables.	LC, NW
Section 12	Applications of mathematical statistics	12.1	Regression analysis. Regression models. Least square method. Gauss-Markov scheme.	LC, NW
		12.2	Simple linear regression. Method of statistical tests. The concept of planning an experiment.	LC, NW
Section 13	Random processes	13.1	The concept of a random process. Classification and main characteristics of random processes	LC, NW
		13.2	Stationary random processes. Linear and nonlinear transformations, differentiation and integration of random processes.	LC, NW
		13.3	Stationary white noise. The concept of a Markov random process. Discrete and continuous Markov processes. Markov chain.	LC, NW

* - to be filled out only for full-time education: LC – lectures; LR – laboratory work; SZ – practical/seminar classes.

6. MATERIAL AND TECHNICAL SUPPORT OF DISCIPLINE

Table 6.1. Material and technical support of the discipline

Audience type	Auditorium equipment	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; board (screen) and technical means of multimedia presentations.	
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with a set of specialized furniture and technical means for multimedia presentations.	

Audience type	Auditorium equipment	Specialized educational/laboratory equipment, software and materials for mastering the discipline (if necessary)
For independent work	An auditorium for independent work by students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to EIOS.	

* - the audience for independent work of students is MANDATORY!

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF DISCIPLINE

Main literature:

1. V.E. Gmurman. Guide to solving problems in probability theory and mathematical statistics: Textbook for applied bachelor's degree. - 11th ed., revised. and additional - M.: Yurayt, 2014. - 404 p.

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

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

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

5. Kibzun A.I., Goryainova E.R., Naumov A.V. Probability theory and mathematical statistics: Basic course with examples and problems. - M.: Fizmatlit, 2007.

6. Kochetkov E.S., Smerchinskaya S.O. Probability theory in problems and exercises. – 2nd ed. — M.: FORUM, 2017

Additional literature:

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

2. W. Feller, Introduction to Probability Theory and Its Applications, vol. 1.2. - M.: Librocom, 2010

3. Ventzel E.S., Ovcharov Probability theory and its engineering applications. - M.: Knorus, 2010.

4. Ivchenko G.I., Medvedev Yu.I. Math statistics. - M.: Higher School, 1992

5. Pugachev V.S. Probability theory and mathematical statistics - M.: Nauka, 1979

Resources of the information and telecommunications network “Internet”:

1. EBS of RUDN University and third-party EBS, to which university students have access based on concluded agreements

- Electronic library system of RUDN University - EBS RUDN Universityhttp://lib.rudn.ru/MegaPro/Web
- EBS “University Library Online”http://www.biblioclub.ru
- EBS Lawhttp://www.biblio-online.ru
- EBS “Student Consultant”www.studentlibrary.ru
- EBS “Trinity Bridge”

2. Databases and search engines

- electronic fund of legal and regulatory technical documentationhttp://docs.cntd.ru/
- Yandex search enginehttps://www.yandex.ru/
- search systemGoogle https://www.google.ru/

- abstract databaseSCOPUS http://www.elsevierscience.ru/products/scopus/

Educational and methodological materials for students' independent work when mastering a discipline/module:*

1. A course of lectures on the discipline "Probability Theory and Mathematical Statistics".

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

8. ASSESSMENT MATERIALS AND POINT-RATING SYSTEM FOR ASSESSING THE LEVEL OF COMPETENCIES FOR A DISCIPLINE

Evaluation materials and point-rating system* for assessing the level of development of competencies (parts of competencies) based on the results of mastering the discipline "Theory of Probability and Mathematical Statistics" are presented in the Appendix to this Work Program of the discipline.

* - OM and BRS are formed on the basis of the requirements of the relevant local regulatory act of RUDN University.

DEVELOPER:

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HEAD OF BUP:

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