Theory of Probability

Syllabus

Requisites of the Course	
Cycle of Higher Education	***First cycle of higher education (Bachelor's degree)***
Field of Study	*12 Information Technologies*
Speciality	*121 Software engineering*
Education Program	*Software Engineering of Multimedia and Information Retrieval Systems*
Type of Course	*Normative*
Mode of Studies	*full-time*
Year of studies, semester	*2nd year, 3 semester*
ECTS workload	*4 credits (ECTS): 36 hours of lectures, 18 hours of classroom work, 66 hours of self-study.*
Testing and assessment	*Credit, modular control work, calendar control, calculation work*
Course Schedule	*http://rozklad.kpi.ua/*
Language of Instruction	*English*
Course Instructors	*Lecturer: senior teacher, Sushchuk-Slyusarenko Victoria Igorevna, sushchuk@pzks.fpm.kpi.ua; viss_kiev_58@ukr.net* *Practical classes: senior teacher, Sushchuk-Slyusarenko Victoria Igorivna*
Access to the course	*Google classroom*

Outline of the Course

1. Course description, goals, objectives, and learning outcomes

The study of the discipline "Theory of Probability" allows students to form the competencies needed to solve practical problems of professional activities related to data analysis, information processing and the use of modern information technology.

***The purpose** of the discipline "Theory of Probabilities" is the formation of students' ability to classify standard problems by signs and solve them; solve standard problems of probability theory (combinatorial methods, methods related to basic theorems, the method of characteristic functions, methods of calculating the characteristics of discrete and continuous distributions, the ability to use the binomial distribution and its extreme cases, the normal distribution, the law of large numbers, the central limiting theorem, etc.); perform standard calculations manually and using computer programs, knowledge of basic procedures.*
***The subject** of the discipline "Theory of Probability" is random events, actions on events, random variables and laws of their distribution.*

*The study of the discipline "Theory of Probabilities" contributes to the formation of **general competences (GC)** in students, necessary for solving practical tasks of professional activity related to the development, improvement and support of intelligent information systems for processing multimedia data:*
***GC01** Ability to abstract thinking, analysis and synthesis.*
***GC02** Ability to apply knowledge in practical situations*
***GC06** Ability to search, process and analyze information from various sources.*

The study of the discipline "Theory of Probabilities" contributes to the formation in students of the following ***program learning outcomes (PLO)*** *according to the educational program:*

PLO05 *Know and apply relevant mathematical concepts, methods of domain, system and object-oriented analysis and mathematical modeling for software development.*

PLO27 To be able to use the methods of statistical data analysis.

2. Prerequisites and post-requisites of the course (the place of the course in the scheme of studies in accordance with curriculum)

The successful study of the discipline "Theory of Probability" is preceded by the study of the disciplines "Mathematical Analysis" of the curriculum of bachelor's training in the specialty 121 Software Engineering.

The theoretical knowledge and practical skills obtained during the mastering of the discipline "Theory of Probability" ensure the successful mastering of the discipline "Algorithmic support of multimedia and information-search systems" and the implementation of course and diploma projects of the curriculum for bachelors in the specialty 121 Software Engineering.

3. Content of the course

The discipline "Theory of Probability" involves the study of the following topics:

Topic 1. The concept of probability theory. Basics of combinatorics. Classical, statistical and geometric definition of probability. Basic theorems of probability theory, conditional probability.

Topic 2. Formula of total probability. Bayes formula

Topic 3. Repeated independent tests. Bernoulli's formula, Poisson's formula.

Topic 4. Local and integral Moivre-Laplace theorems

Topic 5. Random variables: numerical characteristics of discrete random variables.

Topic 6. Basic laws of distribution of discrete random variables. Binomial distribution law, Poisson distribution law, geometric and hypergeometric distribution laws.

Topic 7. Continuous random variables. Distribution function of a continuous random variable, probability density. Basic theorems.

Topic 8. Exponent, normal distribution law of a random variable, lognormal distribution.

Topic 9. - distribution, distributions of Student and Fisher-Snedecor.

Topic 10. Multidimensional random variables. Two-dimensional discrete random variables.

Topic 11. Two-dimensional normal distribution law of a continuous random variable.

Topic 12. The law of large numbers and limit theorems.

Modular control work

Credit

4. Coursebooks and teaching resources

Basic literature:

1. Siegmund, David O. Probability theory. Encyclopedia Britannica, 27 Jan. 2023, https://www.britannica.com/science/probability-theory.

2. Philip B. Stark. Electronic summary of lectures. Philip B. Stark is Professor of Statistics and Associate Dean of Mathematical and Physical Sciences at the University of California, Berkeley, URL: https://www.stat.berkeley.edu/~stark/SticiGui/Text/reasoning.htm

3. Hartigan, J.A. (1983). Theories of Probability. In: Bayes Theory. Springer Series in Statistics. Springer, New York, NY. https://doi.org/10.1007/978-1-4613-8242-3_1

Educational content

5. Methodology

№	Type of training session	Description of the lesson
Topic 1. The concept of probability theory. Fundamentals of combinatorics. Classical, statistical and geometric definition of probability. Basic theorems of probability theory, conditional probability.		
1	*Lecture 1. Basic concepts of probability theory*	*Subject and tasks of the discipline. Definition of tests, events and operations on events. Basic theorems of probability theory, conditional probability. Classical definition of probability, theorems of addition and multiplication of probabilities, conditional probability.* *Task on self-study: Proving de Morgan's formula. Kolmogorov's axiomatics.*
Topic 2. The formula of total probability. Bayesian formula		
2	*Lecture 2. The formula of total probability. Bayesian formula*	*Full probability formula. Bayesian formula.* *Task on self-study: Application of the Bayesian formula*
3	*Practical lesson 1.* *The classical definition of probability. Full probability. Bayesian formula*	*Independent work №1.* *Task on self-study: task 1.2 of calculation work*
Topic 3. Repeated independent tests. Bernoulli's formula, Poisson's formula.		
4	*Lecture 3. Repeated independent tests. Bernoulli's formula, Poisson's formula. Bernoulli's theorem.*	*Repeated independent tests. Bernoulli's formula, Poisson's formula. Bernoulli's theorem.* *Task on self-study: Polynomial scheme.*
5	*Lecture 4. Local and integral Muavra-Laplace theorems*	*Local and integral Muavra-Laplace theorems. Examples of problem solving* *Task on self-study: The main problems on the elimination of consequences from the integral theorem of Muavra-Laplace.*
6	*Practical lesson 2.* *Repeated independent tests. Bernoulli's formula, Poisson's formula. Bernoulli's theorem, local and integral Muavra-Laplace theorems.*	*Independent work №2.* *Task on self-study: task 3,4 calculation work*
Topic 4. Random variables: numerical characteristics of discrete random variables.		
7	*Lecture 5. Random variables. Discrete random variables.*	*Numerical characteristics of discrete random variables. Definition of a random variable, distribution function. Properties of the distribution function, one-dimensional random variables. Discrete random variables. Definition of a discrete random variable, probabilistic characteristics of a discrete random variable: mathematical expectation, variance, initial moments, central moments.* *Task on self-study: Fashion and Median.*
8	*Lecture 6. Laws of distribution*	*Uniform distribution, Bernoulli distribution, binomial*

	of discrete random variables.	*distribution, geometric distribution. Problem solving* *Task on self-study: item 6, № 7, 31.*
9	*Practical lesson 3.* *Discrete random variables.*	*Independent work №3.* *Task on self-study: task 5.6 of calculation work*
Topic 6. Continuous random variables.		
10	*Lecture 7. Continuous random variables.*	*Definitions, numerical characteristics: mathematical expectation, variance, asymmetry, excess.* *Task on self-study: Quantiles, asymmetry, excess.*
11	*Lecture 8. Continuous random variables. Uniform and exponential distributions.*	*Basic characteristics of distributions, parameters. Problem solving* *Task on self-study: The second Poisson model. Geometric distribution.*
12	*Practical lesson 4.* *Continuous random variables. Uniform and exponential distributions.*	*Independent work №4.* *Task on self-study: task 7.8 of computational work*
Topic 7. Normal law of distribution of a random variable, lognormal distribution.		
13	*Lecture 9. Continuous random variables. Normal and lognormal distributions.*	*Basic characteristics of distributions, parameters. Problem solving* *Task on self-study: Practical application of random variables with normal and lognormal distributions.*
14	*Lecture 10. Problem solving.*	*Examples of solving and designing problems* *Task on self-study: repetition of topics 1-8*
15	*Practical lesson 5.* *Continuous random variables. Normal and lognormal distributions.*	*Independent work №5.* *Task on self-study: task 9 of the calculation work*
Topic 8. Gamma distribution - distribution, Student and Fischer-Snedekor distributions.		
16	*Lecture 11. Gamma distribution - distribution, Student and Fischer-Snedekor distributions.*	*The main characteristics of the Gamma distribution are the distribution, the Student's and Fisher-Snedekor's distributions. Their use in practice.* *Task on self-study: Hypergeometric distribution.*
Topic 10. Multidimensional random variables. Two-dimensional discrete random variables.		
17	*Lecture 12. Multidimensional random variables. Two-dimensional discrete random variables..*	*Two-dimensional discrete random variables. Definition of multidimensional random variables, properties of the distribution function of multidimensional random variables. Two-dimensional discrete random variables, properties of conditional probabilities, practical value of conditional mathematical expectation and conditional variance, conditional density function, two-dimensional continuous random variables* *Task on self-study: Composition of distribution laws.*
18	*Practical lesson 6.* *Correlation dependence, linear correlation.*	*Independent work №6.* *Task on self-study: task 10 of the calculation work*

19	*Lecture 13. Multidimensional continuous random variables.*	*Continuous normally distributed two-dimensional random variables. The practical significance of conditional probability densities.* *Task on self-study: Practical use of two-dimensional normal distribution properties.*
20	*Lecture 14. Dependent and independent random variables. Covariance and correlation coefficient.*	*Covariance. Correlation coefficient. Correlation and dependence of random variables.* *Task on self-study: Characteristic functions*
21	*Practical lesson 7.* *Systems of two random variables. Correlation and dependence of random variables of the system*	*Independent work №7.* *Task on self-study: task 11 of the calculation work*
Topic 11 Two-dimensional normal law of distribution of a continuous random variable.		
22	*Lecture 15. Two-dimensional normal law of distribution of a continuous random variable.*	*Problem solving* *Task on self-study: item 6, № 21.*
23	*Lecture 16. Law of large numbers: inequalities of Markov, Chebyshev*	*Inequalities of Markov, Chebyshev. Bernoulli's theorem* *Task on self-study: item 6, № 22, 39.*
24	*Practical lesson 8.* *Law of large numbers and limit theorems.*	*Independent work №8.* *Task on self-study: task 12 of the calculation work*
25	*Lecture 17. Law of large numbers: Poisson's, Chebyshev's theorems, Central limit theorem.*	*The law of large numbers* *Task on self-study: item 6, № 24, 40.*
26	*Practical lesson 9.* *Test.*	
Modular control work		

6. Self-study

The discipline "Theory of Probability" is based on independent preparations for classroom classes on theoretical and practical topics.

№	*The name of the topic submitted for independent processing*	*Number of hours*	*literature*
1	*Preparation for the lecture 1*	*1*	*1-3*
2	*Preparation of a practical lesson 1*	*1,5*	*1-3*
3	*Preparation for the lecture 2*	*1*	*1-3*
4	*Preparation for the lecture 3*	*1*	*1-3*
5	*Preparation of a practical lesson 2*	*1,5*	*1-3*
6	*Preparation for the lecture 4*	*1*	*1-3*

7	*Preparation for the lecture 5*	*1*	*1-3*
8	*Preparation of a practical lesson 3*	*1,5*	*1-3*
9	*Preparation for the lecture 6*	*1*	*1-3*
10	*Preparation for the lecture 7*	*1*	*1-3*
11	*Preparation of a practical lesson 4*	*1,5*	*1-3*
12	*Preparation for the lecture 8*	*1*	*1-3*
13	*Preparation for the lecture 9*	*1*	*1-3*
14	*Preparation of a practical lesson 5*	*1,5*	*1-3*
15	*Preparation for the lecture 10*	*1*	*1-3*
16	*Preparation for the lecture 11*	*1*	*1-3*
17	*Preparation of a practical lesson 6*	*1,5*	*1-3*
18	*Preparation for the lecture 12*	*1*	*1-3*
19	*Preparation for the lecture 13*	*1*	*1-3*
20	*Preparation of a practical lesson 7*	*1,5*	*1-3*
21	*Preparation for the lecture 14*	*1*	*1-3*
22	*Preparation for the lecture 15*	*1*	*1-3*
23	*Preparation of a practical lesson 8*	*1,5*	*1-3*
24	*Preparation for the lecture 16*	*1*	*1-3*
25	*Preparation for the lecture 17*	*1*	*1-3*
26	*Preparation for modular control work*	*7*	*1-3*
27	*Preparation for the test*	*15*	*1-3*
28	*Preparation of calculation work*	*15*	*1-3*
In total		*66*	

Policy and Assessment

7. Course policy

• Attendance at lectures and practical classes is mandatory.

• Rules of conduct in the classroom: activity, respect for those present, turning off the phones.

• Adherence to the policy of academic integrity.

• Rules for the protection of settlement work: the work must be done according to the option of the applicant, which is determined by his number in the group list.

8. Types of control and rating system for assessing learning outcomes (RSO)

1) Points for independent work in practical classes

Maximum number of points for a practical lesson: 5 points.

Evaluation criteria:

5-4 points - the answer is correct;

3-2 point - there are inaccuracies in the answer, but in general the answer is correct;

0-1 points - no answer or the answer is incorrect.

Maximum number of points for answers in practical classes:
5 points × 8 to take. = 40 points.

2) Points for modular control work

Modular control work is carried out after the completion of the discipline.

Evaluation criteria:

30-25 points - the decision is correct;
24-18 points - the decision has shortcomings;
17-9 points - there are significant errors in the decision;
9-0 points - no decision or wrong decision.
Maximum number of points for modular control:
30 points × 1 tests = 30 points.

3) Points for calculation work

Calculation work consists of 6 task. The maximum number of points for the calculated work is 5.
Evaluation criteria:
5 points - all points are done correctly, the answer is correct, complete, well-argued;
4-3 points - in some points there are shortcomings or incorrect calculations;
2-1 points - there are significant errors in the performance of work;
0 points - no work or its execution is incorrect.
Maximum number of points for the calculated work: 5 points × 6 = 30 points.
3) Calculation of the scale (R) rating
The rating scale for the discipline is equal to:
R = 40 points + 30 points + 30 points - 0 penalty points = 100 points.

Current control: written survey on the topic of the lesson, Modular contoroul work.
Calendar control: conducted twice a semester as a monitoring of the current state of compliance with the requirements of the syllabus.
Semester control: credit
Conditions of admission to semester control: semester rating more than 60 points.
The final performance score or the results of the Fail/ Pass Test are adopted by university grading system as follows:

Score	*Grade*
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Sufficient
Below 60	Fail
Course requirements are not met	Not Graded

1. **Additional information about the course**

In the case of a semester rating <30 points, the student is given the right to increase the score by writing an additional test.

Syllabus of the course

Is designed by teacher *senior teacher, Sushchuk-Slyusarenko Victoria Igorevna*

Adopted by Computer Systems Software Department (protocol № 12 from 26.04.23)

Approved by the Faculty Board of Methodology (protocol № 10 from 26.05.23)