Syllabus
Course Program

Probability Theory

Specialty
113 - Applied mathematics

Institute
Institute of Computer Modeling, Applied Physics and Mathematics

Educational program
Applied mathematics. Computer and mathematical modeling

Department
Mathematical modeling and intelligent computing in engineering (161)

Level of education
Bachelor's degree

Course type
Compulsory

Semester
4

Language of instruction
English

Lecturers and course developers

Kseniia Potopalska

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D. in Engineering, Associate Professor of the Department of Mathematical Modeling and Intelligent Computing in Engineering, 7 years of experience. Author of more than 40 scientific and methodological works. Leading lecturer in the disciplines: “Data-driven modeling and reverse engineering”, ‘Data-driven modeling and reverse engineering’, teacher of practice

More about the lecturer on the department's website

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D. in Engineering, Associate Professor of the Department of Mathematical Modeling and Intelligent Computing in Engineering, 8 years of experience. Author of more than 25 scientific and methodological works. Lecturer in the disciplines: “Mathematical methods of modeling and data processing”, ‘Probability theory’, ‘Introduction to the specialty’, ‘Neural networks and machine learning’, ‘Modeling in CAD systems’.

More about the lecturer on the department's website

General information

Summary

Probability theory is a discipline that is a mandatory component of the curriculum, a cycle of disciplines that form professional competencies. Students acquire theoretical knowledge and practical skills in probability theory. The course is taught in the 4th semester and includes: 32 hours of lectures, 16 hours of practical classes, 72 hours of independent work. The final control is an exam.

Course objectives and goals

Aims: to develop theoretical knowledge and practical skills in the application of probabilistic and statistical methods for the evaluation of stochastic processes. To present the main provisions of probability theory and basic methods for solving specific problems. To develop the ability to solve practical problems using the probabilistic approach and to conduct a comprehensive statistical analysis of mathematical models describing real phenomena and processes.

Format of classes

Lectures, practical work. Final control - exam

Competencies

GC06: Ability to think abstractly, analyze and synthesize
PC01: Ability to use and adapt mathematical theories, methods and techniques to prove mathematical statements and theorems.
PC03: Ability to choose and apply mathematical methods for solving applied problems, modeling, analysis, design, management, forecasting, decision-making.

Learning outcomes

PH02: To master the basic principles and methods of mathematical, complex and functional analysis, linear algebra and number theory, analytical geometry, theory of differential equations, in particular partial differential equations, probability theory, mathematical statistics and random processes, numerical methods.
PO05: To be able to develop and apply in practice algorithms related to the approximation of functional dependencies, numerical differentiation and integration, solving systems of algebraic, differential and integral equations, solving boundary value problems, finding optimal solutions.

Student workload

The total volume of the discipline is 120 hours (4 ECTS credits): lectures - 32 hours, practical work - 16 hours, independent work - 72 hours.

Course prerequisites

Mathematical analysis.

Features of the course, teaching and learning methods, and technologies

Classes are conducted interactively, using multimedia technologies. The student is obliged to attend all classes according to the schedule and perform laboratory work. Adhere to ethical behavior. In order to master the required quality of education in the discipline, attendance and regular preparation for classes are required.

Program of the course

Topics of the lectures

Topic 1: Basic concepts of probability theory.
Tests, events and their properties. Definition of probability and its properties. The classical formula for calculating probabilities.

Topic 2. Basic theorems of probability theory.
The concept of the sum and product of events. Theorem of addition of probabilities for incompatible events. Probability multiplication theorem. Theorem of addition of probabilities for compatible events. Probabilities of hypotheses. Bayes' formula for the total probability of the formula.

Topic 3. Repeating tests.

Repeating tests. Bernoulli's scheme and formula. Local and integral Moivre-Laplace Laplace theorems. Poisson's formula.

Topic 4. Random variables and laws of their distribution
Random variables. Classification of random variables. The concept of the law of distribution.

Topic 5. Discrete random variables.
Laws of distribution of discrete random variables. Numerical characteristics of discrete random variables.

Topic 6. Continuous random variables
Integral distribution function of a random variable. Differential function of distribution of random variables. Numerical characteristics of continuous random variables.

Topic 7. Density of distribution of a random variable, its properties.
The probability of a continuous variable falling into a given interval.

Topic 8. Laws of distribution of continuous random variables
Uniform law of distribution. Normal law of distribution. Exemplary law of distribution.

Topic 9: The function of one random argument.
The concept of a function, its definition, calculation of its numerical characteristics.

Topic 10. The function of two random arguments.
The concept of a function, its definition, calculation of its numerical characteristics.

Topic 11. System of random variables. The law of distribution.
Definition and properties. Distribution function. Basic properties of the distribution function.

Topic 12: Two-dimensional probability density. Conditional laws of probability distribution (discrete two-dimensional random variable)
Density of the joint probability distribution. Its properties. Conditional distribution of components.

Topic 13. Density and conditional law of distribution (continuous two-dimensional random variable)
The concept of a function, its definition, calculation of its numerical characteristics.

Topic 14. Numerical characteristics of a system of random variables
Correlation moment. Correlation coefficient of a system of random variables.

Topic 15. The law of large numbers
Definition of the law. Chebyshev's inequality.

Topic 16. Numerical characteristics of a system of random variables
Limit theorems of probability theory.

Topics of the workshops

Topic 1: Basic concepts of probability theory.
Solving problems to identify events and directly calculate probabilities.

Topic 2. Basic theorems of probability theory.
Solving problems on the application of the probability addition theorem for incompatible and compatible events. Solving problems on the application of the probability multiplication theorem. Bayes' formula for the total probability.

Topic 3. Repeating tests.
Solving problems with repeated trials. Practical use of Bernoulli's formula and the local and integral Moivre-Laplace theorem.

Test work 1. Random events

Topic 4. Random variables.
Classification of random variables. The concept of the law of distribution.

Topic 5. Discrete random variables.
Solving problems related to the determination of distribution laws and numerical characteristics of random variables.

Topic 6. Continuous random variables.
Solving problems on finding the integral distribution function of a random variable. Differential distribution function of random variables. Numerical characteristics of continuous random variables.

Topic 7. Density of distribution of a random variable, its properties.
Solving problems to determine the probability of a continuous variable falling into a given interval

Topic 8. Laws of distribution of continuous random variables
Solving problems related to the uniform, normal, and exponential laws of distribution.

Control work 2. Random variables

Topic 9: The function of one random argument.
Solving problems on calculating the numerical characteristics of a function of one random argument.

Topic 10. The function of two random arguments.
Solving problems on calculating the numerical characteristics of a function of two random arguments.

Topic 11. System of random variables
Solving problems on the construction of systems of random variables.

Topic 12: The law of distribution of a system of random variables.
Solving problems on the construction of the distribution function of systems of random variables and the application of its basic properties.

Topic 13. Two-dimensional probability density.
Consideration of cases with the density of a joint probability distribution.

Topic 14. Conditional laws of probability distribution (discrete two-dimensional random variable)
Solving problems on the conditional distribution of a discrete two-dimensional random variable.

Topic 15: Density and conditional law of distribution (continuous two-dimensional random variable)
Solving problems on finding the density and conditional distribution of a continuous two-dimensional random variable.

Topic 16. Numerical characteristics of a system of random variables
Solving problems on determining the numerical characteristics of a system of random variables

Control work 3 . Systems of random variables

Topics of the laboratory classes

Not covered by the curriculum

Self-study

Study of lecture material. Preparation for practical classes. Independent study of topics and issues that are not covered in lectures. Performing individual tasks..

Course materials and recommended reading

Assessment and grading

Criteria for assessment of student performance, and the final score structure

Points for the test are awarded according to the rating:
Performance of control works - 60 points
Completion of individual tasks - 30 points
Theoretical survey - 10 points.

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": show discipline, good manners, goodwill, honesty, responsibility. Conflict situations should be openly discussed in study groups with the teacher, and if it is impossible to resolve the conflict, they should be brought to the attention of the staff of the Institute's directorate.
Regulatory and legal support for the implementation of the principles of academic integrity of NTU "KhPI" is available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by

Date, signature

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Oleksiy VODKA

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Guarantor of the educational program
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