Syllabus

Course Program

Probability Theory

Specialty
113 Applied mathematics

Institute
ESI Computer Science and Information Technology

Educational program
Intelligent Data Analysis

Department
Computer Mathematics and Data Analysis

Level of education
Bachelor's level

Course type
Specialized (Professional), Mandatory

Semester
3

Language of instruction
Ukrainian

Lecturers and course developers

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Candidate of Technical Sciences, Associate Professor, Professor, Academic Secretary of the National Technical University "Kharkiv Polytechnic Institute." Work experience: 40 years. Author of numerous scientific and educational-methodological works. Leading lecturer in the disciplines: "Probability Theory," "Mathematical Statistics."
More about lecturer on the department webside

General information

Summary

The course is aimed at mastering the theoretical foundations of probability theory. Within the course, fundamental concepts of probability theory, basic laws of random variable distributions, and systems of discrete and continuous random variables are discussed.

Course objectives and goals

Acquiring essential competencies in the field of probability theory. Developing foundational theoretical knowledge and practical skills in solving relevant problems. Cultivating students' abilities in mathematical theoretical-probabilistic research of applied issues and the capability to translate problems into mathematical models of probability theory.

Format of classes

Lectures, practical sessions, consultations, self-study. Final control in the form of an exam.

Competencies

GC 1. Ability to learn and master modern knowledge.
GC 2. Ability to apply knowledge in practical situations.
GC 3. Ability to generate new ideas (creativity).
GC 6. Capability of abstract thinking, analysis and synthesis.
SC 3. Ability to choose and apply mathematical methods for solving applied problems, modelling, analysis, design, management, forecasting, decision-making.

Learning outcomes

LO 1. Demonstrate knowledge and understanding of basic concepts, principles, theories of applied mathematics and use them on practice.

LO 2. To know the basic principles and methods of mathematical, complex and functional analysis, linear algebra and theory numbers, analytic geometry, theory of differential equations, in particular partial differential equations, probability theory, mathematical statistics and random processes, and numerical methods.

LO 3. Formalize tasks formulated in the language of a particular subject fields; formulate their mathematical formulation and choose rational method of solution; solve the resulting problems with analytical and numerical methods, evaluate the accuracy and reliability of the results obtained.

LO 14. Demonstrate the ability to self-learn and continue professional development.

Student workload

The total workload of the discipline is 150 hours (5 ECTS credits): lectures – 32 hours, practical sessions – 42 hours, independent work – 76 hours .

Course prerequisites

Successful completion of the course requires knowledge and practical skills in the following disciplines: "Mathematical Analysis," "Linear Algebra," and "Analytical Geometry."

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

Lectures are conducted interactively using multimedia technologies. Practical sessions employ a project-based learning approach, gamification methods, with a focus on the application of information technologies. Educational materials are accessible to students through OneNote Class Notebook and Teams.

Program of the course

Topics of the lectures

Topic 1. Random Events

Random Events, Their Classification. Sample Space of Elementary Events. Operations on Events. Axiomatic Theory of Probability. Classical Definition of Probability and Its Properties. Statistical and Geometric Definitions of Probabilities. Independent Events. Conditional Probability. Addition Theorems of Probabilities. Multiplication Theorems of Probabilities and Their Consequences. Law of Total Probability. Bayes' Formulas. Independent Repeated Trials, Bernoulli Formula, Generating Function.

Topic 2. Random Variables

Random Variables. Discrete and Continuous Random Variables. Distribution Function and its Properties. Probability Density Function and its Properties. Numerical Characteristics of Random Variables. Mathematical Expectation, its Properties, Mode, Median. Central Moments. Variance and its Properties. Skewness Coefficient. Kurtosis. Distribution Laws of Discrete Variables. Binomial Law and its Characteristics. Poisson Distribution. Flow of Events. Geometric and Hypergeometric Laws. Distribution Laws of Continuous Variables. Uniform and Exponential Laws. Normal Distribution Law. Probability of Falling into an Interval. "3-Sigma Rule". Distributions of Continuous Random Variables Related to Normal.

Topic 3. Systems and Functions of Random Variables

Systems of Random Variables (SRV). Distribution law of the system (X, Y) and its properties. Distribution function of the system. Probability density function of the system and its properties. Unconditional and conditional probability density functions of the system (X, Y). Conditional mathematical expectations. Numerical characteristics of the system. Correlation moment. Coefficient of correlation and its physical interpretation.

Topics of the workshops

Topic 1. Random Events

Elements of combinatorics: combinations, permutations, and arrangements. Sampling schemes with and without replacement. Calculation of probabilities of simple events using the classical definition. Solving problems on geometric probability. Solving problems using the addition theorem and multiplication theorem of probabilities. Solving problems based on the formula of total probability and Bayes' formula. Bernoulli trials scheme.

Topic 2. Random Variables

Construction of the distribution law of discrete random variables. Probability distribution function and its properties. Laws of distribution of discrete random variables. Solving problems with normal, uniform, and exponential distributions. Finding the density function and distribution function of continuous random variables.

Topic 3. Systems and Functions of Random Variables

Building the distribution law of a system of discrete random variables. Finding unconditional and conditional distributions. Constructing the density function of the system. Finding numerical characteristics of the system of random variables. Calculating numerical characteristics of the system, correlation moment, and correlation coefficient.

Self-study

The course involves completing individual computational assignments for each topic. The results of these calculations are documented in a written report. Additionally, students are encouraged to utilize supplementary materials such as videos and articles for self-study and analysis.

Non-formal education

Within the framework of informal education according to the relevant Regulation (http://surl.li/pxssv), educational components or their individual topics may be recognized upon independent completion of professional courses/trainings, civic education, online education, professional internships, and the like. Specifically, certain topics of this component may be recognized upon successful completion of such courses:
1) https://www.coursera.org/learn/statistical-inferences#modules
2) https://www.coursera.org/learn/linear-regression-model#modules
3) https://www.coursera.org/learn/statistical-inference-for-estimation-in-data-science
4) https://www.coursera.org/learn/statistical-analysis-hypothesis-testing-sas
5) https://www.coursera.org/learn/stanford-statistics

Course materials and recommended reading

Basic literature

1. Васильків І.М. Основи теорії ймовірностей і математичної статистики : навч. посібник. –Львів : ЛНУ імені Івана Франка, 2020. – 184 с.
https://new.mmf.lnu.edu.ua/wp-content/uploads/2020/04/Vasyl-kiv-I.M.-TIMS_CHASTYNA_1.pdf
2. Теорія ймовірностей та математична статистика (конспект лекцій + тести) : навчальний посібник. Вид. 2-ге, допов. / Я. Т.Соловко, П. Г.Остафійчук, О. З.Гарпуль, С. А.Войтик. – Івано-Франківськ: Репозитарій / ЗВО «Університет Короля Данила», 2021. – 150 с.
http://repository.ukd.edu.ua/bitstream/handle/123456789/152/ТЙ_Навчальний%20посібник_2е%20видання.pdf?sequence=1&isAllowed=y
3. Вища математика: теорія ймовірностей та математична статистика. Навчальний посібник / Шелестовський Б. Г., Габрусєв Г. В., Габрусєва І. Ю. – Тернопіль: СМП "Тайп", 2023 – 142 с.
http://elartu.tntu.edu.ua/handle/lib/41009
4. Жалдак М. І. Теорія ймовірностей і математична статистика : Підручник для студентів фізико-математичних та інформативних спеціальностей педагогічних університетів. Видання четверте, доповнене / М. І. Жалдак, Н. М. Кузьміна, Г. О. Михалін. – Київ. НПУ імені М.П. Драгоманова, 2020 - 750 с. http://enpuir.npu.edu.ua/handle/123456789/35207

Additional literature

5. Гнєденко Б.В. Курс теорії ймовірностей. - К.: Київський університет, 2010.- 463с.
https://nmetau.edu.ua/file/gnedenko1988.pdf
6. Корніль Т. Л. Теорія ймовірностей у прикладах і задачах : навч.-метод. посібник / Т. Л. Корніль, Л. С. Тимченко, Г. О. Голотайстрова. – Харків : НТУ «ХПІ», 2017. – 124 с.
http://repository.kpi.kharkov.ua/handle/KhPI-Press/42987
7. Математична статистика : метод. вказівки і варіанти індивідуальних домашніх робіт для студ. економ. спец. / уклад.: Т. Л. Корніль, Л. С. Тимченко, Г. О. Голотайстрова ; Нац. техн. ун-т «Харків. політехн. ін-т» . – Харків : НТУ «ХПІ», 2018. – 68 с.
http://repository.kpi.kharkov.ua/handle/KhPI-Press/42984
8. Білоцерківський О.Б. Теорія ймовірностей і математична статистика: текст лекцій. Харків: НТУ «ХПІ», 2016. – 94 с.
https://repository.kpi.kharkov.ua/bitstreams/1acaca63-d223-4207-903b-0259126254a9/download
9. Теорія ймовірностей та математична статистика: навч.-метод. посібник / О. Є. Коноваленко, М. А. Ткачук. Харків: НТУ «ХПІ», 2018. – 94 с.
https://repository.kpi.kharkov.ua/bitstreams/00852b9d-ce80-4a29-9793-42148b513311/download

Assessment and grading

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

100% of the final grade is composed of assessment results, with 40% from the exam and 60% from continuous assessment.

Exam Structure: written assignment (2 theory questions + solution of 2 problems), oral presentation.

Continuous Assessment Breakdown:
- Tests: 20% of semester grade;
- Quizzes: 20% of semester grade;
- Independent work: 20% of semester grade.

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»: to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU «KhPI» are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by	Date, signature 29.08.2024		Head of the Department Olena AKHIIEZER
	Date, signature 29.08.2024		Guarantor of the Educational Program Olena AKHIIEZER