Syllabus

Course Program

Mathematical Statistics

Specialty
113 Applied mathematics

Institute
Educational and Scientific Institute of Computer Science and Information Technology

Educational program
Intelligent Data Analysis

Department
Computer Mathematics and Data Analysis

Level of education
Bachelor's level

Course type
Special (professional), Mandatory

Semester
4

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 discipline is aimed at mastering the theoretical foundations of mathematical statistics. The course covers the scientific principles of collecting and organizing statistical data; methods for statistically estimating numerical characteristics of random variables and their distributions; statistical tests for the consistency of empirical estimates with experimental data; methods for investigating statistical relationships and dependencies between random variables, as well as analysis and forecasting of trends.

Course objectives and goals

Acquisition of necessary competencies in the field of mathematical statistics. To form knowledge of the theoretical foundations of mathematical and statistical data processing, understanding the essence of the statistical method of research, and the ability to select appropriate methods for processing experimental material and use them correctly. Acquisition of necessary competencies in the field of probability theory.

Format of classes

Lectures, laboratory classes, 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 120 hours (4 ECTS credits): lectures – 28 hours, laboratory sessions – 32 hours, independent work – 60 hours.

Course prerequisites

To successfully complete the course, it is necessary to have knowledge and practical skills in the following discipline: "Probability Theory.".

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

Lectures are conducted interactively using multimedia technologies. During laboratory sessions, a project-based approach to learning is utilized, 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

Theme 1. Elements of Mathematical Statistics

Main tasks of mathematical statistics. Definition of basic terminology. Initial processing of empirical data. Sampling method. Diagrams, histograms, and frequency polygons. Empirical distribution function.

Theme 2. Estimation of Quantitative Characteristics

Statistical estimates of distribution parameters. Point estimates. Properties of estimates. Maximum likelihood function. Method of moments. Concept of confidence interval. Interval estimates.

Theme 3. Statistical Hypotheses

Definition and classification of statistical hypotheses. General methods for testing statistical hypotheses. Testing sample homogeneity and identifying outliers. Main methods for testing hypotheses about distribution type. Testing hypotheses about variance and mean of normally distributed data. Testing hypotheses about the significance of correlation between variables. Nonparametric hypotheses.

Theme 4. Regression and Factor Analysis

Application of analysis of variance to assess the influence of different factors. Construction of regression lines from experimental data. Estimation of parameters of the equation of simple regression using the method of least squares. Precision of least squares estimation. Testing the significance of parameters of the simple regression equation. Confidence interval for the regression line..

Topics of the laboratory classes

Topic 1. Random Variables

Generating random variables according to various distributions. Constructing their probability density functions and cumulative distribution functions. Graphical representation of data.

Topic 2. Elements of Mathematical Statistics

Loading data from various sources. Graphical representation of data. Construction of histograms, frequency polygons, empirical distribution functions. Data processing. Construction of a simple and grouped frequency distribution. Estimation using maximum likelihood method, method of moments. Construction of point and interval estimates.

Topic 3. Hypothesis Testing

Data analysis. Formulation and testing hypotheses about the distribution of data using various criteria. Testing hypotheses regarding the variance and mean of a normally distributed characteristic. Testing the hypothesis about the significance of the correlation between variables.

Topic 4. Regression Analysis

Constructing a regression line from experimental data.

Self-study

The course includes individual computational assignments for each topic. The results of these calculations are documented in written reports. Additionally, students are encouraged to explore supplementary materials such as videos and articles for independent 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/linear-regression-model#modules
2. https://www.coursera.org/learn/statistical-inference-for-estimation-in-data-science
3. https://www.coursera.org/learn/statistical-analysis-hypothesis-testing-sas
4. https://www.coursera.org/learn/stanford-statistics
5. https://www.coursera.org/learn/statistical-inferences#modules

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