Syllabus
Course Program

Probability theory and mathematical statistics

Specialty
121 – Software Engineering

Institute
Institute of Computer Science and Information Technology

Educational program
Software Engineering

Department
Software Engineering and Management Intelligent Technologies (321)

Level of education
Bachelor's level

Course type
Special (professional), Mandatory

Semester
3

Language of instruction
English, Ukrainian

Lecturers and course developers

Natalia Fonta
Natalia.Fonta@khpi.edu.ua
PhD, Associate Professor, Associate Professor of SEMIT Department. Number of scientific and educational publications is more than 60.
(Google Scholar: https://scholar.google.com.tw/citations?hl=ru&pli=1&user=we3S6nwAAAAJ;
Scopus: https://www.scopus.com/authid/detail.uri?authorId=57215861869;
ORCID: https://orcid.org/0000-0001-5593-1409).

Leading lecturer in disciplines: "Probability theory and mathematical statistics"," Numerical Methods ".
Scientific directions: development of information systems for strategic company management; application of computer intelligence methods and models for solving problems of managing complex organizational systems; business analytics.
More about the lecturer on the department's website

General information

Summary

The discipline is aimed at forming a holistic system of theoretical knowledge of the mathematical apparatus of probability theory and mathematical statistics, which helps to model, analyze and solve problems in computer science and intelligent systems, study, model and predict complex processes and phenomena by methods of probabilistic-statistical analysis, and also, aimed at the development of logical thinking of a specialist in the field of computer science and intelligent systems, promoting the formation of his skills and abilities of independent research of problems according to experimental observations.

Course objectives and goals

The purpose of course studying is to form specialists in computer science and intelligent systems theoretical knowledge and practical skills on the basics of probability theory and mathematical statistics, the ability of specialists in computer science and intelligent systems to apply probabilistic and statistical methods in their practice.

Format of classes

Lectures, laboratory classes, consultations. Final control is an exam.

Competencies

K01. Ability to think abstractly, analyze and synthesize.
K05. Ability to learn and master modern knowledge.
K06. Ability to search, process and analyze information from various sources.
K19. Knowledge of data information models, ability to create software for storing, extracting and processing data.
K26. Ability to think algorithmically and logically

Learning outcomes

PLO01. Analyze, purposefully search and select information and reference resources and knowledge necessary for solving professional problems, taking into account modern achievements of science and technology.
PLO05. To know and apply relevant mathematical concepts, methods of domain, system and object-oriented analysis and mathematical modeling for software development.
PLO11. Select input data for design, guided by formal methods of requirements description and modeling.
PLO18. To know and be able to apply information technologies for data processing, storage and transmission.
PLO23. Be able to document and present the results of software development.

Student workload

The total volume of the course is 150 hours (5 ECTS credits): lectures - 32 hours, laboratory classes - 32 hours, self-study - 86 hours.

Course prerequisites

The basis of studying the discipline is general knowledge of higher mathematics.

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

Teaching and learning methods:
interactive lectures with presentations, discussions, laboratory classes, teamwork, case method, student feedback, problem-based learning.
Forms of assessment:
written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), express surveys (CAS), online tests (CAS), final/semester control in the form of a semester exam, according to the schedule of the educational process (FAS).

Program of the course

Topics of the lectures

Topic 1. Theory of random events
The subject of probability theory. Basic definitions, theorems of the theory of random events.
Topic 2. Theory of random variables.
Numerical characteristics of discrete random variables.
Laws of probability distribution of random variables.
The law of large numbers. Limit theorems.
Multidimensional random variables.
Numerical characteristics of multidimensional random variables and probability distribution laws.
Topic 3 The main provisions of mathematical statistics.
Basic provisions of mathematical statistics.
Problems of mathematical statistics.

Collection and processing of statistical data.
Topic 4. Descriptive statistics.
Basic terms and tasks of descriptive statistics. Data sources in statistics.
Data collection and processing. Primary data processing.
Point estimates of distribution parameters.
Interval estimates of distribution parameters.
Topic 5. Statistical hypotheses.
General scheme of statistical hypothesis testing.
Testing of hypotheses about the appearance of the distribution law.
Verification of hypotheses about the parameters of the distribution Hypotheses about dispersion.
Testing hypotheses about distribution parameters. Hypotheses about the average.
Topic 6. Influence factors analysis.
Methods for analyzing the influence of a factor with independent samples.
Analysis of variance (ANOVA).
Methods for analyzing the influence of a factor with independent samples. Correlation analysis.
Methods for analyzing the influence of a factor in dependent samples.
Topic 7. Correlation-regression analysis.
Basics of correlation-regression analysis.
Normal regression. Paired linear regression.
Estimation of the regression model. Testing the significance of the sample correlation coefficient.
Coefficient of determination. Multiple regression analysis.
Forecasting based on statistical data processing.
Forecasting methods. Time series analysis.

Topics of the workshops

Workshops are not provided within the discipline.

Topics of the laboratory classes

Topic 1. Basic theorems of probability theory. Basic properties, characteristics of random events.
Topic 2. Distribution laws and numerical characteristics of discrete and continuous random variables.
Topic 3. Two-dimensional discrete random variable, its distribution law and numerical characteristics. Correlation, regression.
Topic 4. Basic provisions of descriptive statistics.
Topic 5. Verification of statistical hypotheses.
Topic 6. ANOVA analysis.

Self-study

Topic 1. Theory of random events
Development of probability theory and its use in artificial intelligence tasks.
Calculation task No. 1. Calculation of system reliability using the basic theorems of probability theory.
Topic 3 The main provisions of mathematical statistics
Stages of development and perspectives of mathematical statistics
Topic 4. Descriptive statistics.
Software applications designed for solving problems of mathematical statistics
Topic 6. Influence factors analysis.
Software for variance analysis
Topic 7. Correlation-regression analysis
Least squares method.
Using regression in tasks of intelligent data processing.
Peculiarities of using various statistical methods of information processing to solve forecasting problems

Students are recommended with additional materials (videos, articles) for self-study and processing

Course materials and recommended reading

Key literature

1. Naiko D.A. Shevchuk O. F. Probability theory and mathematical statistics: academic. manual / D.A. Naiko, O.F. Shevchuk – Vinnytsia: VNAU, 2020. – 382 p.
2. Prasanna Sahoo (2015) Probability and Mathematical Statistics: First Edition https://www.researchgate.net/publication/272237355_Probability_and_Mathematical_Statistics.
3. Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh (2015) An Introduction to Probability and Statistics, Third Edition. John Wiley & Sons, Inc.
4. Jay L. Devore (2015) Probability and Statistics for Engineering and the Sciences. 9th Ed. Cengage Learning.
5. Probability theory and mathematical statistics: teaching. guide./ O. I. Kushlyk-Dyvulska, N. V. Polishchuk, B. P. Orel, P. I. Shtablyuk. - K: NTUU "KPI", 2014. - 212 p.
6. Zaitsev E. P. Probability theory and mathematical statistics: teaching. manual / E. P. Zaitsev - K. : "Alerta", 2017. - 440 p.
7. William Mendenhall, Robert J. Beaver, Barbara M. Beaver (2020) Introduction to Probability and Statistics. 15th Ed. Cengage Learning.
8. Taboga, Marco (2017) Lectures on Probability Theory and Mathematical Statistics - 3rd Ed. CreateSpace Independent Publishing Platform. - 670 p
9. John Schiller,R. Alu Srinivasan, Murray Spiegel (2012) Schaum's Outline of Probability and Statistics, 4th Edition: 897 Solved Problems + 20 Videos (Schaum's Outlines). McGraw-Hill.
10. Rudenko V. M. Mathematical statistics: teaching. manual / V. M. Rudenko. - Kyiv: Center for Educational Literature, 2012. - 304 p.
11. O. I. Oghirko, N. V. Galayko O-36 Probability theory and mathematical statistics: study guide / O. I. Oghirko, N. V. Galayko. - Lviv: LvDUVS, 2017. - 292 p.
12. Methodological instructions for laboratory work in the discipline "Probability Theory and Mathematical Statistics": for students of special 121 – Software engineering, 122 – Computer science, 126 – Information systems and technologies in the field of knowledge, 12 – Information technologies. Part 1. Probability theory / edited by: V. V. Moskalenko, N. G. Fonta; National technical University "Kharkiv Polytechnic Institute". - Kharkiv: Madrid Printing House, 2022. - 108 p. http://repository.kpi.kharkov.ua/handle/KhPI-Press/59073.

Additional literature

1. Joseph K. Blitzstein, Jessica Hwang (2019) Introduction to Probability, 2nd Ed. Chapman & Hall/CRC Texts in Statistical Science.
2. Probability theory and mathematical statistics: a manual for independent work. – Lviv: Publishing House of the Lviv Commercial Academy, 2015. – 196 p.
3. ASA Leonard A. Asimow Ph.D. (2015). Probability & Statistics with Applications: A Problem Solving Text, 2nd Ed. ACTEX Publications.
4. Sheldon Ross (2018) A First Course in Probability. 10th Ed. Pearson Education, Inc.
Laboratory workshop on the academic discipline "Theory of Probability and Mathematical Statistics": teacher. manual / E.Yu. Zheleznyakova, I.L. Lebedeva, L.O. Norik, K.V. Stepanova – Kharkiv: KHNEU named after S. Kuznetsia, 2016. – 184 p.
5. Bulaenko M. V. The theory of probabilities. Synopsis of lectures on the discipline "Probability Theory and Mathematical Statistics"/M. V. Bulayenko; Hark. national Acad. urban farm - Kh.: KhNAMG, 2011. - 174 p.
6. Bradley Efron, Trevor Hastie (2021) Computer Age Statistical Inference. Algorithms, Evidence, and Data Science. Cambridge University Press.
7. Peter Bruce, Andrew Bruce (2017) Practical Statistics for Data Scientists: 50 Essential Concepts. O'Reilly Media, Inc.

Assessment and grading

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

100% final assessment in the form of an exam (16%) and a current assessment (84%).
16% exam: semester exam in accordance with the schedule of the educational process;
84% current assessment:
- 72% assessment of tasks in laboratory works;
- 12% assessment of calculated tasks.

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	08.06.2023	Head of the department Ihor HAMAIUN
	08.06.2023	Guarantor of the educational program Uliya LITVINOVA