Probability Theory and Mathematical Statistics

COURSE SYLLABUS

Code and name of specialty	122 – Computer Science	**Institute**	**Computer Sciences and Software Engineering**
Program name	Computer Science and intelligence systems	**Department**	Software Engineering and Management Information Technologies
Type of program	**Educational and Professional**	**Language of instruction**	**Ukrainian/English**

LECTURER

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Doctor of Technical Sciences, Associate Professor, Professor of SEMIT Department. Number of scientific and educational publications is more then 90. (https://publons.com/researcher/1588564/valentyna-moskalenko/; Web of Science ResearcherID R-9960-2018; https://scholar.google.com.ua/citations?user=eUidJHIAAAAJ&hl=ru; https://www.scopus.com/authid/detail.uri?authorId=36021571200; https://orcid.org/0000-0002-9994-5404).

Courses taught: "Probability Theory and Mathematical Statistics", "Fundamentals of Computer Science and Artificial Intelligence Methods", "Fundamentals of Information Systems and Technologies", "Software Requirements Engineering", "Fundamentals of Business Analysis", "Computational Intelligence Methods", "Methods of computational intelligence and intellectual analysis","Machine learning", "Business systems analytics"

GENERAL DESCRIPTION OF THE COURSE

Summary	"Probability Theory and Mathematical Statistics" is a discipline from the cycle of professional compulsory training in the specialty 122 "Computer Science". It is taught in the second semester in the amount of 180 hours (6 ECTS credits), in particular: lectures - 48 hours, laboratory - 16 hours, independent work - 116 hours. The course provides two content modules, two module tests and one calculated task. The discipline ends with an exam. 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	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
Types of classes and control	Lectures, Laboratory work, consultations. The course ends with a final exam
Term	2

Student workload (credits) / Type of course	6 / Mandatory	**Lectures (hours)**	48	**Workshops (hours)**	16	**Self-study (hours)**	116

Program competences	GC1. Ability to abstract thinking, analysis and synthesis. GC2. Ability to apply knowledge in practical situations.

	GC3. Knowledge and understanding of the subject area and understanding of professional activity. PC2. Ability to detect statistical patterns of nondeterministic phenomena, the use of methods of computational intelligence, including statistical, neural network and fuzzy data processing, methods of machine learning and genetic programming, etc.

Learning outcomes	Teaching and learning methods	Forms of assessment (continuous assessment CAS, final assessment FAS)
PLO3. Use knowledge of the random phenomena laws, their properties and operations on them, models of random processes, and modern software environments to solve problems of statistical data processing and construction of predictive models.	Interactive lectures with presentations, discussions, practical classes, teamwork, case method, method of feedback from students, problem-based learning	Written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), rapid surveys (CAS), online tests (CAS), assessment of calculated task (CAS), final / semester control in the form of a semester exam, according to the schedule of the educational process (FAS)
PLO4. Use the methods of computational intelligence, machine learning, neural network and fuzzy data processing, genetic and evolutionary programming to solve problems of recognition, prediction, classification, identification of control objects, etc.	Interactive lectures with presentations, discussions, practical classes, teamwork, case method, method of feedback from students, problem-based learning	Written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), rapid surveys (CAS), online tests (CAS), assessment of calculated task (CAS), final / semester control in the form of a semester exam, according to the schedule of the educational process (FAS)

ASSESSMENT AND GRADING

Ranges of points corresponding to grades

Total score (points) for all types of learning activities	ECTS grading scale	The national grading scale
90-100	A	excellent
82-89	B	good
74-81	C	
64-73	D	satisfactory
60-63	E	
35-59	FX	Unsatisfactory (with the exam retake option)
0-34	F	Unsatisfactory (with mandatory repetition of the course)

Allocation of grade points

100% final assessment in the form of exam (10%) and current assessment (90%).
10% exam: semester exam, according to the schedule of the educational process
90% current rating:
- 60% of assessment of tasks in laboratory works;
- 20% of assessment of Calculated tasks
- 10% intermediate control (2 modular control works)

Course policy	Follow the rules of the internal university regulations. Take an active part in the learning process. Students are required to attend classes according to schedule and adhere to ethical behavior. In the absence of students will need to complete all tasks to compensate for missed classes. Performing laboratory work requires prior preparation and advanced processing of all necessary materials. Written assignments must be submitted by the deadline.

COURSE STRUCTURE AND CONTENT

Lecture 1	The subject of probability theory. Theory of random events				Development of probability theory and its use in problems of artificial intelligence
Lecture 2	The theory of random variables. Numerical characteristics of discrete random variables	**Calculated task**	Calculation of system reliability using the basic theorems of probability theory		
Lecture 3	The theory of random variables. Numerical characteristics of continuous random variables	**Laboratory work 1**	Random events. Basic numerical characteristics of discrete random variables		
Lecture 4	The theory of random variables. Laws of probability distribution for random variable	**Laboratory work 2**	Distribution laws and numerical characteristics of discrete and continuous random variables		
Lecture 5	The theory of random variables. The law of large numbers. Boundary theorems				
Lecture 6	Multidimensional random variables, their numerical characteristics and probability distribution laws	**Laboratory work 3**	Two-dimensional discrete random variable, its distribution law and numerical characteristics		
Lecture 7	Problems of mathematical statistics. Collection and processing of statistical data				Stages of development and prospects of mathematical statistics
Lecture 8	Descriptive statistics	**Laboratory work 4**	Descriptive statistics		Application packages designed to solve mathematical statistics problems
Lecture 9	Statistical evaluation. Point estimates of distribution parameters				
Lecture 10	Statistical evaluation. Interval estimates of distribution parameters				
Lecture 11	Statistical hypotheses. General scheme for testing statistical hypotheses	**Laboratory work 5**	Test of statistical hypotheses		
Lecture 12	Statistical hypotheses. Test hypotheses about the type of distribution law				
Lecture 13	Statistical hypotheses. Test of hypotheses about distribution parameters: Hypotheses about variance				
Lecture 14	Statistical hypotheses. Test of hypotheses about distribution parameters. Hypotheses about the average			**Self-Study**	

Lecture 15	Analysis of the factors influence. Methods for analyzing the influence of the factor in independent samples				
Lecture 16	Analysis of the factors influence: Analysis of variance (ANOVA)	**Laboratory work 6**	Analysis of variance.		Software for analysis of variance
Lecture 17	Analysis of the factors influence: Methods for analyzing the influence of the factor in independent samples. Correlation analysis				
Lecture 18	Analysis of the influence of factors. Methods for analyzing the influence of the factor in dependent samples				Least squares method
Lecture 19	Fundamentals of correlation-regression analysis	**Laboratory work 7**	Regression analysis		Use of regression in data processing problems
Lecture 20	Normal regression. Paired linear regression.				
Lecture 21	Estimation of regression model. Checking the significance of the sample correlation coefficient. Coefficient of determination.				
Lecture 22	Multiple regression analysis				
Lecture 23	Forecasting based on statistical data processing	**Calculated task**	Determination of forecasts by regression model		Using various statistical methods of information processing to solve forecasting problems.
Lecture 24					

RECOMMENDED READING

Compulsory

1. Barkovsky V.V., Barkovskaya N.V., Lopatin O.K. (2012) Probability theory and mathematical statistics. Kyiv., CUL
2. Prasanna Sahoo (2015) Probability and Mathematical Statistics: First Edition Retryeved from: 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. Chernyak O.I., Obushna, A.V., Stavytsky O.M. (2002) Probability theory and mathematical statistics: a collection of problems: textbook. manual [2nd ed., Corrected]. Kyiv: Knowledge, KOO.
6. Zaitsev E.P. (2017) Probability theory and mathematical statistics: textbook. manual Kyiv: "Alerta"
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 Publishi
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., Rudenko V.M. (2012) Mathematical statistics: textbook. way. Kyiv: Center for Educational Literature.

Recommended

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 guide for independent work. (2015) Lviv: Lviv Commercial Academy Publishing House.
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.
5. Zheleznyakova, E. Yu., Lebedeva . L.O., Norik, I. L., Stepanova K.V.(2016) Laboratory workshop on the subject "Probability Theory and Mathematical Statistics": textbook. Kharkiv: KhNEU. S. Kuznets.
6. Bulaenko M.V. (2011) Probability theory. Synopsis of lectures on the subject "Probability Theory and Mathematical Statistics" (for 2nd year full-time and part-time students of educational and qualification level bachelor, direction 6.070101 "Transport technologies (by mode of transport)"). Kharkov: KNACH.
7. Bradley Efron, Trevor Hastie (2021) Computer Age Statistical Inference. Algorithms, Evidence, and Data Science. Cambridge University Press.
8. Peter Bruce, Andrew Bruce (2017) Practical Statistics for Data Scientists: 50 Essential Concepts. O'Reilly Media, Inc.

ACADEMIC INTEGRITY

Students are expected to adhere to the Code of Ethics of Academic Relations and Integrity of NTU “KhPI”.

The content of this syllabus is consistent with the course program.