Silabus
Selective Component   SC

Introduction to Probabilistic and Statistical Analysis

Name of the discipline:	**Introduction to Probabilistic and Statistical Analysis**
Higher education level:	first (Bachelor's degree)
Moodle course page:	https://dl2022.khadi.kharkov.ua/course/view.php?id=2967
Scope of the sample component	3 credits (90 hours)
Final control form	Credit
Consultations:	on schedule
Department name:	Department of higher mathematics
Language of instruction:	English
Course manager:	Yarkho Tetiana Aleksandrivna, Doctor of Pedagogical Sciences, Professor**;** Emelyanova Tetiana Viktorivna, Candidate of Physical and Mathematical Sciences, Associate Professor
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Summary of the educational component:
The purpose of studying the discipline is: general mathematical training of applicants, necessary for mastering the theoretical and practical foundations of applying methods and models of probabilistic and statistical analysis of experimental data of modern technical, technological and transport processes.

Subject of the discipline: construction of probabilistic models of mass homogeneous random phenomena in technical, technological and transport processes and their application to determine the parameters of the studied features based on experimental data.

The main objectives of the discipline are:
- study of basic concepts and facts of probability theory;
- formation of abilities to use the mathematical apparatus for the study of random variables;
- study of general information about the selective method, methods of point and interval estimation of unknown parameters of the general population under study;
- formation of the concept of statistical verification of parametric and nonparametric hypotheses;
- application of the general scheme for testing parametric hypotheses to solving practical problems;
- application of the hypothesis method based on the K. Pearson consistency criterion to solving practical problems.

Prerequisites for studying the educational component: elementary mathematics course of Secondary School; mandatory mathematical discipline of The Bachelor's degree "higher mathematics".

Competencies that the applicant acquires:

General competencies:
ability to communicate in the state language;
ability to search, process and analyze information from various sources;
ability to generate new ideas (creativity);
ability to abstract thinking, analysis, synthesis,comparison and classification, concretization and generalization;
ability to apply knowledge in practical situations;
 ability to express a personal logically constructed and reasoned point of view;
ability to recognize and resist illogical and false arguments and statements.

Special mathematical competencies:

knowledge, understanding of the essence of readiness to interpret and recognize mathematical objects and their properties;

proficiency in the symbolic aspect of mathematics;

knowledge of standard and standard mathematical problem statements;

ability to solve classical and applied mathematical problems of a reproductive nature;

ability to solve classical and applied mathematical problems that involve elements of creativity and research;

the ability to comprehend and adjust the acquired special competencies in order to increase their effectiveness.

Learning outcomes according to the educational program:

knowledge of the basic concepts and facts of the sections "random events" and "random variables";

knowledge of limit theorems of probability theory;

kowledge of methods for calculating the probabilities of complex random events;

ability to construct distribution laws for discrete and continuous random variables and calculate their numerical characteristics;

knowledge of general information about the sampling method, methods of point and interval estimation of unknown parameters of the general population under study;

ability to solve practical problems of finding point and interval estimates of the general population;

knowledge of the concept of statistical verification of parametric and nonparametric hypotheses;

application of the method of testing zero nonparametric hypotheses according to the K. Pearson consistency criterion to solving practical problems.

Thematic plan

№	Topic name (LC, PR, SR)	Number of hours	
		Ochne	Zaochne
1	LC 1 Random variables. RV distribution function and its properties. Discrete random variables and their numerical characteristics. Basic Laws of discrete RV distribution (Binomial, Poisson distribution, geometric, hypergeometric)	2	2
	PR1 Solving practical problems for constructing distribution series of DRV., determining the distribution laws and numerical characteristics of DRV.	2	2
	SR1 Wed random events. Probabilities of random events. Multiplication and addition theorems. Full probability formula. Bayes ' Theorem. Repeated independent tests in the Bernoulli scheme (review).	14	14
2	LC 2 Continuous random variables. Distribution density of a continuous RV(differential distribution function). Numerical characteristics of continuous RV. Basic Laws of distribution of continuous random variables (normal, logarithmic-normal, rectangular, exponential).	2	2
	PR2 Solving practical problems for determining the distribution laws and numerical characteristics of continuous RV.	2	2
	SR2 Generalized numerical characteristics of discrete and continuous random variables.	6	6
3	LC3 Systems of random variables. Distribution function and its properties. A system of two discrete random variables. Conditional distribution laws of composite systems.	2	2
	PR3 Solving practical problems for determining the numerical characteristics of a system of two discrete random variables.	2	2
	SR3 Systems of two continuous random variables. Conditional distribution laws.	6	6
4	LC4 Limit theorems of probability theory. The law of large numbers: Chebyshev's inequality, Chebyshev's theorem.	2	2
	PR4 Solving practical problems using Chebyshev's theorem in	2	2

	measurement practice.		
	SR4 The law of large numbers: Bernoulli's theorem. Central Limit Theorem.	2	2
5	LC5 General information about the selective method. Discrete and interval statistical distributions of the sample. Empirical distribution function.	2	2
	PR5 About graphical representation of statistical series. Numerical characteristics of the statistical distribution.	2	2
	SR5 Basic Laws of distribution of random variables used in Mathematical Statistics: G – function and its properties; χ^2 – distribution; t --- Distribution; F – distribution.	8	8
6	LC 6 Point estimates of distribution parameters. The concept of Point Estimation, properties of point estimates. Point estimates of mathematical expectation and variance. Methods for finding point estimates: the method of moments, the method of maximum likelihood.	2	2
	PR6 Solving practical problems for finding point estimates of the parameters of the general population.	2	2
	SR6 Substantiation of the study of the likelihood function by methods of differential calculus of one and many variables.	4	4
7	LC7 Interval estimates of parameters of an unknown distribution. The concept of interval estimation of parameters. General scheme for constructing confidence intervals for parameters of the normal distribution law. Confidence intervals for the mathematical expectation of normal RV X for known and unknown σ.	2	2
	PR7 Solving practical problems for finding interval estimates of parameters of normally distributed V. V. X based on statistical research data.	2	2
	SR7 Is the confidence interval for the root-mean-square deviation σ of a normally distributed random variable X.	4	4
8	LC8 Statistical verification of parametric hypotheses. Basic concepts. Statistical criterion for testing the null hypothesis. General scheme for testing statistical hypotheses.	2	2
	PR8 Solving practical problems to test statistical hypotheses about the mathematical expectation and variance of a normally distributed random variable.	2	2
	SR8 The concept of statistical testing of nonparametric hypotheses. Method for testing null nonparametric hypotheses using consistency criteria. The χ^2 - Pearson consistency criterion.	14	14
Together	LC	16	16
	PR	16	16
	SR	58	58

Training methods:
* lectures, practical exercises, explanations, etc.;
* standard calculation works;
* standardized tests;
* tasks for in-depth creative training;
* test papers;
* presentations of completed tasks and research;
* student presentations and presentations at scientific events;
* final comprehensive tests.

Evaluation system and requirements
1 Current academic performance:
1.1 the current success of applicants for performing educational types of work in training sessions and for

performing tasks of independent work is evaluated using a four-point Assessment Scale, followed by recalculation to a 100-point scale. When evaluating current academic performance, all types of work provided for in the curriculum are taken into account.

1.2 lectures are evaluated by determining the quality of performance of specified tasks.

1.3 practical exercises are evaluated by the quality of performing a control or individual task, performing and completing practical work.

1.4 assessment of the current academic performance of higher education applicants is carried out at each practical lesson (laboratory or seminar) on a four-point scale ("5", "4", "C", "2") and are entered in the academic performance log.

- "excellent": the applicant has perfectly mastered the theoretical material, demonstrates deep knowledge of the relevant topic or academic discipline, the main provisions;

- "good": the applicant has mastered the theoretical material well, has the main aspects from the original sources and the recommended literature of the RI, presents it in an argumentative manner; has practical skills, expresses his thoughts on certain problems, but admits certain inaccuracies and errors in the logic of presenting the theoretical content or when analyzing the practical one;

- "satisfactory": the applicant has mainly mastered the theoretical knowledge of the educational topic or discipline, is guided in the primary sources and recommended literature of the RI, but does not answer convincingly, confuses concepts, does not answer additional questions uncertainly, does not have stable knowledge; answering questions of a practical nature, shows inaccuracy in knowledge, does not know how to evaluate facts and phenomena, connect them with the future profession;

- "unsatisfactory": the applicant has not mastered the educational material of the topic (discipline), does not know scientific facts, definitions, almost does not navigate in primary sources and recommended literature, there is no scientific thinking, practical skills are not formed.

2 Final assessment:

An applicant for Higher Education receives a credit in the last lesson in the discipline based on the results of the current assessment. The average score for current activities is converted to points on a 100-point scale.

Higher education applicants who have an average current grade in the discipline below "3" (60 points) can improve their current score in the last lesson by passing tests in the discipline.

Assessment of applicants ' Knowledge by testing is carried out on a scale of:

- "Excellent": the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are formed, all the training tasks provided for in the training program are completed, the quality of their implementation is estimated by the number of points close to the maximum. (at least 90% of correct answers);

- "Very good": the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are mostly formed, all the training tasks provided for in the training program are completed, the quality of most of them is estimated by the number of points close to the maximum. (82% to 89% of correct answers);

- "Good": the theoretical content of the course is fully mastered, without gaps, some practical skills of working with the mastered material are not sufficiently formed, all the training tasks provided for in the training program are completed, the quality of None of them is evaluated with a minimum number of points, some types of tasks are completed with errors (from 74% to 81% of correct answers);

- "Satisfactory": the theoretical content of the course is partially mastered, but the gaps are not significant, the necessary practical skills of working with the mastered material are mostly formed, most of the training tasks provided for in the training program are completed, some of the completed tasks may contain errors (from 67% to 73% of correct answers);

- "Satisfactory enough": the theoretical content of the course is partially mastered, but the gaps are not significant, the necessary practical skills of working with the mastered material are mostly formed, most of the training tasks provided for in the training program are completed, some of the completed tasks may contain errors (from 60% to 66% of correct answers);

- "Unsatisfactory": the theoretical content of the course is partially mastered, the necessary practical skills of work are not formed, most of the provided training programs for training tasks are not completed, or the quality of their performance is estimated by a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of performing educational tasks(with the possibility of re-passing)(less than 60% of correct answers);

- "Unacceptable" - the theoretical content of the course is not mastered, necessary

practical work skills are not formed, all completed training tasks contain gross errors, and additional independent work on the course material will not lead to any significant improvement in the quality of

training tasks.(with a mandatory repeat course).

Table-correspondence of final rating ratings in points to national scale and ECTS scale ratings

Rating	Rating on the national scale (exam, credit)	Rating on the ECTS scale	
		Grade	Criteria
90-100	Excellent	**A**	"Excellent" - the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are formed, all the training tasks provided for in the training program are completed, the quality of their implementation is estimated by the number of points close to the maximum.
82 – 89	Good	**B**	"Good" - the theoretical content of the course is fully mastered, without gaps, the necessary practical skills of working with the mastered material are mostly formed, all the training tasks provided for in the training program are completed, the quality of most of them is estimated by the number of points close to the maximum.
75 – 81		**C**	"Good" - the theoretical content of the course is fully mastered, without gaps, some practical skills of working with the mastered material are not sufficiently formed, all the training tasks provided for in the training program are completed, the quality of performance of any of them is not evaluated with a minimum number of points, some types of tasks are performed with errors
67 – 74	Satisfactory	**D**	"Satisfactory" - the theoretical content of the course is partially mastered, but the gaps are not significant, the necessary practical skills of working with the mastered material are mostly formed, most of the training tasks provided for in the training program are completed, some of the completed tasks may contain errors.
60 – 66		**E**	"Enough" - the theoretical content of the course is partially mastered, some practical work skills are not formed, many of the training tasks provided for in the training program are not completed, or the quality of performance of some of them is estimated by a number of points close to the minimum.
35 – 59	Unsatisfactory	**FX**	"Unsatisfactory" - the theoretical content of the course is partially mastered, the necessary practical skills of work are not formed, most of the provided training programs for educational tasks are not completed, or the quality of their performance is estimated by a number of points close to the minimum; with additional independent work on the course material, it is possible to improve the quality of performing educational tasks(with the possibility of re-passing)
1 – 34		**F**	"Unacceptable" -the theoretical content of the course is not mastered, the necessary practical skills are not formed, all completed training tasks contain gross errors, additional independent work on the course material will not lead to any significant improvement in the quality of training tasks.(with a mandatory repeat course)

Course policy:
- the course involves working in a team, the environment in the classroom is friendly, creative, open to constructive criticism;
- mastering the discipline involves mandatory attendance at lectures and practical classes, as well as independent work;
- independent work involves the study of individual topics of the academic discipline, which are submitted in accordance with the program for independent study, or were considered briefly;
- all tasks provided for in the program must be completed on time;
- when studying the course, applicants for higher education must adhere to the rules of academic integrity set out in the following documents: "Rules of academic integrity of participants in the educational process of KHNADU (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_dobroch_1.pdf),

"Moral and ethical code of participants in the educational process of KHNADU (https://www.khadi.kharkov.ua/fileadmin/P_Standart/pologeniya/stvnz_67_01_MEK_1.pdf).
- cheating during test papers and tests is prohibited (including using mobile devices). Mobile devices can only be used during online testing.

Recommended literature:

1. Бондаренко Н.В. Теорія ймовірностей: навчальний посібник / : Н.В. Бондаренко, З.І. Наголкіна, М.С. Пастухова. – К.: КНУБА, 2016. – 111 ст.

2. Савченко О.Г., Валько Н.В., Кавун Г.М., Кузьмич Л.В. Теорія ймовірностей та математична статистика: [базовий курс з прикладами і задачами] – Херсон: РВЦ «Колос», ХДАУ, 2017. – 406 с.

3. Білоцерківський О. Б. Теорія ймовірностей і математична статистика : практикум для студентів спеціальності 076 «Підприємництво, торгівля та біржова діяльність» / О. Б. Білоцерківський. – Харків : НТУ «ХПІ», 2018. – 170 с.

4. Теорія ймовірностей та математична статистика: Частина 1. Випадкові події: Лекції і практикум [Електронний ресурс] : навч. посіб. для студ. спеціальності 143 «Атомна енергетика», спеціалізації «Атомні електричні станції» / КПІ ім. Ігоря Сікорського ; уклад.: І. В. Веригіна, О. В. Островська. – Електронні текстові данні (1 файл: 1,99 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2018. – 57 с.

5.Сосницька Н.Л. Теорія ймовірностей: навч.-метод. посібн. / Н.Л. Сосницька, О.А. Іщенко, Л.В. Халанчук. – Мелітополь: ТОВ «Колор Принт», 2020. – 116 с. – ISBN 978-966-2489-99-9.

6. Методичні вказівки до виконання лабораторних робіт (комп'ютерного практикуму) з дисципліни «Теорія ймовірностей і математична статистика» для студентів напряму підготовки 6.030601 «Менеджмент» студ. Видавн.-полігр. ін.- ту / Укл. О.І. Кушлик-Дивульська, Б.Р. Кушлик − К.: НТУУ «КПІ». − 2016. – 205с.

7. І.А. Рудоміно-Дусятська, Л.М. Козубцова, О.Ю. Пояркова, Т.В. Соловйова, В.Є. Сновида, Л.М. Цитрицька Теорія ймовірностей, теорія випадкових процесів та математична статистика (частина І). – К.: ВІТІ, 2018. – 187 с.

8. Теорія імовірностей та математична статистика [Електронний ресурс] : підручник для студ. спеціальностей 121 «Інженерія програмного забезпечення», 126 «Інформаційні системи та технології»/ Т. А. Ліхоузова; КПІ ім. Ігоря Сікорського. – Електронні текстові дані (1 файл: 5,12 Мбайт). – Київ : КПІ ім. Ігоря Сікорського, 2018. – 341 с.

9. Ярхо Т. О. Теорія ймовірностей для професійно-математичної підготовки бакалаврів технічного профілю:навчально-методичний посібник. Ч.1. Випадкові події / Т. О. Ярхо. – Х. : ХНАДУ, 2017. – 84 с.

Additional sources:
1. distance learning course: https://dl2022.khadi.kharkov.ua/course/view.php?id=2967

Developer (s)

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