Шаблон за версією 02

Затверджено наказом ректора СумДУ

від \_\_\_.\_\_\_\_.2019 р. № \_\_\_\_\_

**І Syllabus**

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| **1. General information on the course** |
| Full course name  | Probabilistic Economy Modeling Methods |
| Full official name of a higher education institution | Sumy State University |
| Full name of a structural unit | Educational and Research Institute of Business Technology “UAB”. Economic Cybernetics Department |
| Author | PhD, Vitaliia Koibichuk |
| Cycle/higher education level | First level of higher education, national qualifications framework – 6 level, QF-LLL – 6 level, FQ-EHEA – first cycle |
| Semester | 16 weeks during the third semester |
| Credit value | 5 ECTS credits, 150 hours, contact hours – 48 hrs (lectures – 16 hrs, laboratory sessions – 32 hrs), private study – 102 hrs |
| Language(s) | English |
| **2. Place in the study programme** |
| Relation to curriculum | Elective course for study program "Business analytics" of specialty 051 "Economics" |
| Prerequisites | Prerequisites are absent |
| Additional requirements | Additional requirements are absent |
| Restrictions | Restrictions are absent |
| **3. Aims of the course** |
| The purpose of the course is the formation of students basic mathematical knowledge for solving theoretical and practical problems in the professional activity of competent specialists' in a financial and business sphere, skills of analytical thinking and skills of using mathematical knowledge for the formation of real business processes and developments, and for solving economic problems. |
| **4. Contents**  |
| Theme 1 “Empirical and logical bases of probability theory” 1. The subject and problems of the course.
2. Basic definitions, rules and types of events.
3. Basic concepts and formulas.

Theme 2 “Basic theorems of probability theory, their economic meaning”1. Basic definitions and multiplication theorems of probabilities.
2. Basic concepts and addition theorems of probabilities.
3. The probability of at least one event.
4. Formula of a total probability and Bayes formula.

Theme 3. “Scheme of independent trials”1. Repeated independent trials and Bernoulli’s scheme.
2. The local de Moivre – Laplace theorem.
3. The integral de Moivre – Laplace theorem.
4. Poisson’s theorem.

Theme 4. “Random variables and their economic meaning”1. Definitions and types of random variables.
2. Distribution laws and distribution function of probabilities.
3. Basic numerical characteristics.
4. Additional numerical characteristics.

Theme 5 “Distribution laws and numerical characteristics of discrete random variables”1. Basic types and properties of distribution laws of a discrete random variable.
2. A flow of events.

Theme 6 “Basic distribution laws of a continuous random variable”1. A density distribution function and its properties.
2. Basic types and properties of distribution laws of a continuous random variable.
3. Student’s, Pearson’s and Fisher’s distributions.

Theme 7 “Preprocessing of statistical data”1. Basic definitions and problems of mathematical statistics.
2. Discrete and interval variational series.
3. A graphical presentation of a statistical distribution.
4. Basic numerical characteristics.

Theme 8 “A statistical estimation of parameters of a distribution”1. Basic statistical estimations and their properties.
2. Types of estimations.
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| **5. Intended learning outcomes of the course** |
| After successful study of the course, the student will be able to: |
| LO1. | understand the notion of probability theory, random, persistent and impossible events; methods for calculating the probability of the occurrence of the value |
| LO2. | calculate a probability of an elementary random event using classical and geometrical definitions of probability and use results in business processes |
| LO3. | use a concept of theory of random processes and probability theory for modeling of economic processes |
| LO4. | estimate basic numerical characteristics of a random variable using results of an investigation of a sample |
| LO5. | understand possibilities and a restriction of using instruments of mathematical statistics during solving of real economic problems |
| **6. Teaching and learning activities**  |
| **6.1 Types of training**  |
| Lectures (L) and laboratory classes (LC) are the types of training in the discipline:Theme 1. Empirical and logical bases of probability theory L 1. Empirical and logical bases of probability theory.The role of this course as a theoretical base of mathematical modeling of economic processes and phenomenons, which take into consideration possible risks. Basic definitions, rules, and types of events A probabilistic model of an experiment. Sure (certain), random and impossible events. Rules of operations with random events. A space of elementary events. A classical definition of a probability and its calculation. Basic formulas of a combinatorial analysis. A statistical definition of a probability. A geometrical definition of a probability. Euler- Venn diagram. LC 1. Laboratory work (LW ).LW1. Random events and operations on them. The classical definition of probability.1. The implementation of the tasks of LW 1 : to calculate the probability of an event in MS Excel; build the Euler-Venn diagrams in MS Excel.
2. Making the report of LW 1.

LC 2. LW 2. Application of a combinatorial analysis for solving problems of probability theory.1. The implementation of the tasks of LW 2: permutation without repetitions; arrangements without repetitions of *n* elements taken *k* at a time; combinations without repetitions of *n* elements taken *k* at a time; formulas of combinatorics with repetitions (combinations, arrangements, permutations).
2. The defense of LW 1.
3. Making the report of LW 2.

Theme 2. Basic theorems of probability theory, their economic meaningL 2. Basic theorems of probability theory, their economic meaning. Basic definitions and multiplication theorems of probabilities. Probabilistic space. Dependent and independent events. A conditional probability. Multiplication theorems of probabilities. Basic concepts and addition theorems of probabilities. A complete group of events. Complementary events. Joint (compatible) and disjoint (incompatible) events. Addition theorems of probabilities. The probability of at least one event. Calculation of a necessary number of trials, which occur with definite reliability in order to guarantee an occurrence of a random event at least once. The formula of a total probability and Bayes’ formula.LC 3. LW 3. Basic theorems of probability theory. Probability addition and multiplication theorems. A conditional probability.1. The implementation of the tasks of LW 3: probability addition theorem for incompatible and compatible events (solving tasks in MS Excel); multiplication theorem for independent and dependent events (solving tasks in MS Excel).
2. The defense of LW 2.
3. Making the report of LW 3.

LC 4. LW 4. Basic theorems of probability theory. A total probability formula.1. The implementation of the tasks of LW 3: a complete group of an events, the probability that at least one of events occurs, the complementary events (solving tasks in MS Excel).
2. The defense of LW 4.
3. Making the report of LW 4.

LC 5. LW 5. Basic theorems of probability theory. A total probability formula. Bayes’ formula.1. The implementation of the tasks of LW 3: a complete group of an events, the probability that at least one of events occurs, the complementary events,a total probability formula; Bayes’ formula (solving tasks in MS Excel).
2. The defense of LW 4.
3. Making the report of LW 4.

Theme 3. Scheme of independent trialsL 3. Scheme of independent trialsA scheme of repeated independent trials. Bernoulli’s formula. The local theorem of the de Moivre – Laplace. Gauss’s function, its properties. The integral theorem of the de Moivre – Laplace. Laplace’s function, its properties. A relationship between Gauss and Laplace functions. Low-probability events. Poisson’s theorem.LC 6. LW 6. Scheme of independent trials. 1. The implementation of the tasks of LW 6: Bernoulli’s formula; theorems of the de Moivre – Laplace (local and integral theorems); Poisson’s theorem (solving tasks in MS Excel).
2. The defense of LW 5.
3. Making the report of LW 6.

Theme 4. Random variables and their economic meaningL 4. Random variables and their economic meaningA definition of a random variable. Discrete and continuous random variables. Distribution laws of probabilities for a random variable and ways of finding (tabular, graphic, and analytical). A distribution function of probabilities, its properties. Basic numerical characteristics of a random variable: a mathematical expectation, variance, and a root-mean-square deviation. Properties of basic numerical characteristics. Additional numerical characteristics of distribution: a mode, a median, an excess. Initial and central theoretical moments, their application to a calculation of numerical characteristics of a distribution of a random variable.LC 7. LW 7. Distribution laws of probabilities for a random variables. Basic numerical characteristics of a random variable.1. The implementation of the tasks of LW 6: a distribution function of probabilities, its properties; numerical characteristics of a random variable: a mathematical expectation, variance, and a root-mean-square deviation, a mode, a median, an excess; initial and central theoretical moments, their application to a calculation of numerical characteristics of a distribution of a random variable (solving tasks in MS Excel).
2. The defense of LW 6.
3. Making the report of LW 7.

Theme 5. Distribution laws and numerical characteristics of discrete random variablesL 5. Distribution laws and numerical characteristics of discrete random variablesDistribution laws of a discrete random variable, which are often used in social, and economic investigations: a binomial distribution, a geometrical distribution, a hypergeometrical distribution. Specificities and properties of these distributions, their basic numerical characteristics and the economic meaning. A flow of events. The simplest flow of events and its properties.LC 8. LW 8. A distribution law of a discrete random variable.1. The implementation of the tasks of LW 7: a binomial distribution, a geometrical distribution, a hypergeometrical distribution; the simplest flow of events and its properties (solving tasks in MS Excel).
2. The defense of LW 7.
3. Making the report of LW 8.

LC 9. LW 9. Distribution laws and numerical characteristics of discrete random variables.1. The implementation of the tasks of LW 8 : calculate a mathematical expectation M(X), a variance D(X ) (using 2 ways) and a root-mean-square deviation σ(X ), a mode Mo(X ), a median Me(X ); find a distribution probability function.
2. The defense of LW 8:
3. Making the report of LW 9.

Theme 6. Basic distribution laws of a continuous random variableL 6. Basic distribution laws of a continuous random variableA density distribution function of a random variable and its properties. Distribution laws of a continuous random variable, which are often used in social and economic investigations: a uniform distribution, a normal distribution, and an exponential distribution. Properties of these distributions and their basic numerical characteristics. Influence of parameters of a distribution on a density function of probabilities at a normal distribution law. Student’s distribution, Pearson’s distribution, and Fisher’s distribution. Specificities and properties of these distributions.LC 10, 11. LW 10, 11. Continuous random variables1. The implementation of the tasks of LW 10 : find the integral distribution function F(x), plot the graphs of the functions f (x) (probability density function) and F(x) (distribution function). Solving tasks regarding the main continuous distributions (uniform distribution, exponential distribution, normal distribution).
2. The defense of LW 9:
3. Making the report of LW 11.

Theme 7. Preprocessing of statistical dataL 7. Preprocessing of statistical data Basic definitions and problems of mathematical statistics. A sampling method. Definitions of a population and its sample. An empirical distribution law. Ways of a presentation of sampling totalities and representation of results of observations. Discrete and interval variational series, rules of its construction. Defining limits of an interval by Sturges’s formula. A graphical presentation of a statistical distribution. A polygon and a histogram. A basic sampling of numerical characteristics and their asymptotic behavior.LC 12, 13. LW. The elements of mathematical statistics. Discrete statistical series.1. The implementation of the tasks of LW 12 : construct the discrete statistical series; calculate the numerical characteristics (the mean, the variance, the root-mean-square deviation, the corrected root-mean-square deviation, the mode, the median, the range); plot the distribution polygon of relative frequences.2. The defense of LW 12:3. Making the report of LW 13.Theme 8. A statistical estimation of parameters of a distributionL 8. A statistical estimation of parameters of a distributionStatistical estimations of parameters of a distribution of a population and their properties: unbiasedness, possibility, and an efficiency. Asymptotic efficiency of maximally plausible estimations. Types of estimations The method of moments. Point and interval estimations. A confidence interval for a mathematical expectation of a normal population.LC 14, 15. LW. Continuous statistical series.1. The implementation of the tasks of LW 14, 15: calculate the numerical characteristics (the mean, the variance, the root-mean-square deviation, the corrected root-mean-square deviation, the mode, the median, the range); plot the histogram of relative frequences, and make the assumption about the distribution law; construct the confidence interval of the population mean with the probability 95%, 99%.2. The defense of LW 13:3. Making the report of LW 15.LC 16. LW 16. End-of-module test. Defense of LW 15. |
| **6.2 Learning activities** |
| LA 1. Performing laboratory work LA 2. Independent preparation for the defense of laboratory work LA 3. Defense of laboratory workLA 4. Preparation for modular control |
| **7. Teaching methods**  |
| Discipline involves learning through:TM 1. interactive, thematic, overview lectures; TM 2. laboratory work.Lectures are giving students knowledge of the basic parts of probability theory and mathematical statistics; mastering of the fundamentals of probability theory and mathematical statistics and application of this knowledge in the economic investigations for solving economic problems (LO 1, LO 2, LO 3, LO 4, LO 5). In order to deeply and comprehensively master the discipline, students perform practical tasks in laboratory classes with a wide and diverse range of functions that correspond to the educational material (LO 1, LO 2, LO 3, LO 4, LO 5). During laboratory sessions students forming skills of application of elements of probability theory and mathematical statistics which are applied as an instrument of investigation and optimization economic problems for forming models of economic processes and developments, the obtainment of necessary the totality of theoretical and practical knowledge for solving specific business problems. A necessary element of successful mastering of the material of the discipline is the independent work of students with domestic and foreign special literature, special tools of business analytics, periodicals. The main types of independent work offered to students: the study of lecture material, search, selection, and review of literary sources on a given topic, preparation for laboratory classes, and preparation for modular control work. |
| **8. Methods and criteria for assessment** |
| **8.1. Assessment criteria** |
| The control measures use a 100-point rating scale.The system of assessment of knowledge, skills, and abilities of students takes into account the types of classes, which according to the curriculum of the discipline "Probabilistic Economy Modeling Methods" include lectures and laboratory classes, as well as independent work. |
| **8.2 Formative assessment** |
| The discipline provides the following methods of current formative assessment: Work at class sessions (M1), performance and protection of laboratory work (M2). Assessment is carried out during the semester. All work must be done independently. Individual tasks similar to each other will be rejected. The student's grade is formed as follows: 1. Work at class lessons – a total of 20 points, when attending 100% of classroom classes; in the absence of passes for a disreputable reason, the number of points is reduced proportionally (solving tasks – 10 points; performance of test tasks – 10 points).2. Execution and defence of laboratory work, covering 8 topics of the work program (40 points): demonstration of work on a computer and answers to questions on the performance of work. 3. Preparation of the written content modular control (M3) – 40 points: 2 events at the end of modular cycles, consisting of written tasks of control work (20 points for each event, 8 topics according to the work program). In special situations work during the semester can be done remotely: 1. situational task (solution) of 10 points.2. article (writing) 30 points.3. individual research assignment (performance) of 20 points |
| **8.3 Summative assessment** |
| The discipline provides such methods of summary summative assessment as verification and evaluation of written module test at the end of the each module cycle (M3).An overall positive assessment of the discipline can be obtained when at least 60% of the points are scored for the tasks.  |
| **9. Learning resources** |
| **10.1 Material and technical** **support** | The educational process requires the use of computers with the next software: Windows 10 (LR 1);Total Commander (LR 2);Microsoft Office 2013 (LR 3);Symantec AntiVirus Client (LR 4);Acrobat Reader (LR 5); Information and communication systems (LR 6);Library funds (LR 7). |
| **10.2 Information and methodical support** | Basic literature1. [Mary C. Meyer](https://www.goodreads.com/author/show/19505449.Mary_C_Meyer) Probability and Mathematical Statistics: Theory, Applications, and Practice in R. Colorado State University, 2019. 719 p.2.Rick Durrett Probability: Theory and Examples. Fifth edition. Cambridge University press, 2019. 430 p.3. Joseph K., Blitzstein Jessica Hwang Introduction to Probability. New York: CRC Press, 2015. 589 p.Additional literature1. Analytical and Computational Methods in Probability Theory : First International Conference, ACMPT 2017, Moscow, Russia, October 23-27, 2017, Proceedings / edited by Vladimir V. Rykov, Nozer D. Singpurwalla, Andrey M. Zubkov. — 1st ed. 2017. — Cham : Springer International Publishing, 2017. — XVI, 540 p.2. Zhluktenko V. I., Nakonechny`j S. I. Teoriya jmovirnostej i matematy`chna staty`sty`ka: Navch.-metod. posibny`k. U 2 ch. — Ch. I. Teoriya jmovirnostej. — K.: KNEU, 2000. — 304 s.Internet Resourses.1. B.Aruna Kumari Lecture notes on probability and statistics. URL: <http://www.crectirupati.com/sites/default/files/lecture_notes/P%20%26%20S%20Lecture%20Notes.pdf>.2. Introduction to Probability and Statistics. URL : <https://www.staff.ncl.ac.uk/d.j.wilkinson/teaching/mas131/notes.pdf> |