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| **Al-FARABI KAZAKH NATIONAL UNIVERSITY** Faculty of Mechanics and Mathematics **Department of Mathematical and Computer Modeling**  **SYLLABUS** Stochastic Calculations and Applications **Autumnal semester (First half-year) 2016 – 2017 academic year, the magistrates, 1 course** | | | | | | | | | | | | | |
| **Course code** | | **Course name** | | **Type** | Hour per week | | | | | | | **Credits** | **ECTS** |
| **Lecture** | **Seminar** | | **Laboratory** | | | |
|  | | Stochastic Calculations and Applications | | ED | **2** | **0** | | **1** | | | | **3** | **5** |
| Prerequisites | | | Mathematical Analysis, Algebra and Geometry, Information Science, Probability Theory and Mathematical Statistic, Stochastic Processes, ODE, PDE, Numerical Methods, Calculus, Calculations, Computations. | | | | | | | | | | |
| **Lecturer** | | | **Kanat Shakenov, Doctor of Physical and Mathematical Science, Professor** | | | | **Office-time** | | | According to timetable | | | |
| **e-mail:** | | | [shakenov@mail.ru](mailto:shakenov@mail.ru), [shakenov.kanat@kaznu.kz](mailto:shakenov.kanat@kaznu.kz). | | | |
| **Phone** | | | **+7 727 2211591, +7 705 182 3129** | | | | **Lecture hall** | | | **321** | | | |
| **Teacher (laboratory studies)** | | | **Kanat Shakenov, Doctor of Physical and Mathematical Science, Professor** | | | |  | | |  | | | |
| **e-mail:** | | | [shakenov@mail.ru](mailto:shakenov@mail.ru), [shakenov.kanat@kaznu.kz](mailto:shakenov.kanat@kaznu.kz). | | | | **Lecture hall** | | | **310** | | | |
| **Course description** | | | Research of the stochastic models and theirs computer simulation. | | | | | | | | | | |
| **Course aims** | | | Destination of the course: construction of the stochastic models and computer realization. | | | | | | | | | | |
| **Learning outcomes** | | | 1. Intimate knowledge of the stochastic models. 2. Ability simulate of the stochastic process. | | | | | | | | | | |
| **References and resources** | | | 1. Robert C.P., Casella G. Monte Carlo Statistical Methods. Second Edition. Springer. 2005. 2. Himmelblau D. Process Analysis by Statistical Methods. John Wiley and Sons, Inc. New York-London-Sydney-Toronto 1970. 3. Bharucha-Reid A.T. Elements of the Theory of Markov Processes and Their Applications. MC Graw-Hill Book Company, Inc. New York Toronto London 1960. 4. Sobol’ I.M. Monte Carlo Method. Moscow, Nauka. 1985. 5. Shakenov K.K. Monte Carlo Methods and Thiers Application. Almaty, al-Farabi Kazakh State National University. 1993. 6. Feller W. An Introduction to Probability Theory and its Applications. Volume 1. John Wiley, New York. 1970. Volume 2. John Wiley, New York. 1971. 7. Novosselov A.A. Modeling of financial risks. The series of lectures for students of Institute of Mathematics Siberian Federative University, Archives, Krasnoyarsk, 1998. 8. Mitropolsky A.K. Technique of statistical calculations. Moscow, Nauka. 1971. | | | | | | | | | | |
| **Course organization** | | | Structure of the course: 1.Lectures, 2. Laboratory**.** At a lectureto give the theoretical materials.At a laboratory to give stochastic calculations on PC. The homework may be preset (specified) according to the requirements. | | | | | | | | | | |
| **Course requirements** | | | 1. The students at first of theoretical materials (lectures) attend. They must to know theoretical materials. 2. Next, to conduct PC Laboratory. Student with PC must construct the numerical model and graphic plot. 3. Student on one's own (or with teacher) must know how computational process analyses. To draw a right conclusion and the model identify. | | | | | | | | | | |
| **Grading policy** | | | **Description of assignment** | | | | | **Weight** | **Learning outcomes** | | | | |
| Individual tasks  Group project  Analytical problem  Examinations.  Total | | | | | 35%  10%  15%  40%  100% | 1,2,34,5,6  2,3,4  4,5,6  1,2,3,4,5,6 | | | | |
| Your final score will be calculated by the formula  Below are minimum grades in percent:  95% - 100%: А 90% - 94%: А-  85% - 89%: В+ 80% - 84%: В 75% - 79%: В-  70% - 74%: С+ 65% - 69%: С 60% - 64%: С-  55% - 59%: D+ 50% - 54%: D- 0% -49%: F | | | | | | | | | | |
| **Discipline policy** | | | All work must be performed and defend within a specified time. Students who do not pass a regular job or received for his performance at least 50 % of points, have the opportunity to work on additional specified job schedule. Students who missed labs for a good reason, and spend their extra time in the presence of a laboratory, after the admission of the teacher. Students who have not complied with all types of work for the exam are not allowed. Also, take into account when assessing the activity and attendance of students during class  Be tolerant and respect other people's opinions. Objections formulated in the correct form. Plagiarism and other forms of cheating are not allowed. Unacceptable prompting and copying during delivery SSS intermediate control and final exam, copying solved problems others, exam for another student. Student convicted of falsifying any information rate, unauthorized access to the Intranet using cribs, with a final grade «F».  For advice on the implementation of independent work (SSS), and surrender their protection as well as for more information on the studied material and all other emerging issues by reading a course, contact the instructor during his office hours. | | | | | | | | | | |
| **Discipline schedule** | | | | | | | | | | | | | |
| **Week** | **Topic** | | | | | | **Number of hours** | | | | **Maximum grade** | | |
| **1 – 2** | **Lecture 1 – 4.** ElementaryProbability Theory.Probability. Examples. Definition and illustrations. Deductions from the axioms. Independent events. Arithmetical density. Examples. Exercises. Random Variables. Examples. Definition of Random Variables. Distribution and Expectation. Definition of Mathematical Expectation. Examples. Integer-valued random variables. Examples. Random variables with densities. General case. Exercises. | | | | | | **4** | | | | **8** | | |
| **1 – 2** | **Laboratory 1 – 4.** Distributions.Equiprobability distribution, Even/uniform distribution,Binomial, Poisson, Geometric, Cauchy, Conditional, Conjugate, Dirichlet, Discrete, Exponential, Generalized inverse normal, Generalized inverse Gaussian, Isotropic vector in 3D space. | | | | | | **4** | | | | **8** | | |
| **1 – 2** | **Students self-instruction (SSI) by subject (Homework, Project beginning etc. ) 1 – 4.**  Any kind type of RVG. Computer simulation. | | | | | |  | | | | **4** | | |
| **3 – 4** | **Lecture 5 – 8.** Methods of simulations of random variables. Pseudo-Random Number Generator. Uniform Random Variable on the interval . Uniform Simulation. Algorithm a Uniform Pseudo-Random Number Generation. The Inverse Transform. Optimal Algorithms. General Transformation Methods. Accept-Reject Methods. The Fundamental Theorem of Simulation. The Accept-Reject Algorithm. Problems. Random Walks. Markov Chains. Transition probabilities. Basic structure of Markov chains. Introduction. Tchebyshev inequality. Law of . Classic Monte Carlo Integration. Importance Sampling. Estimated variance. Principles. Finite Variance Estimators. | | | | | | **4** | | | | **8** | | |
| **3 – 4** | **Laboratory 5 – 8.** Random Walks. Markov Chains. Computer simulation of Markov Chains. Estimated of Integral  by Monte Carlo methods. | | | | | | **4** | | | | **8** | | |
| **3 – 4** | **SSI 5 – 8.** Computer simulation of Markov Chains. Computer simulation of Estimated of Integral. | | | | | |  | | | | **4** | | |
| **5 – 6** | **Lecture 9 – 12.** Queue System Modeling.Algorithm of calculations. Quality of product calculations. The Ruin of Gambler Problem. | | | | | | **4** | | | | **8** | | |
| **5 – 6** | **Laboratory 9 – 12.** Computer simulation of the Poisson distribution (Poisson flow) and others random parameters. Calculations of probabilistic characteristics of product. | | | | | | **4** | | | | **8** | | |
| **5 – 6** | **SSI 9 – 12.** Computer simulation others random parameters. | | | | | |  | | | | **4** | | |
| **7** | **Lecture 13 –14 .** Calculations of neutron passing through of plate. Problem statement. Breakdown of calculation by modeling of real trajectories. Reactor calculation. | | | | | | **2** | | | | **4** | | |
| **7** | **Laboratory 13 –14.** Computer simulation. | | | | | | **2** | | | | **4** | | |
|  | **SSI 13 –14.** Reactor calculation. | | | | | |  | | | | **2** | | |
|  | **IC 1** | | | | | |  | | | | **100** | | |
|  | **Midterm Exam** | | | | | |  | | | | **100** | | |
| **8** | **Lecture 15 –16.** Population growth.Elementary probability models of population breeding. Heterogeneous process of bearings and deaths. | | | | | | **2** | | | | **4** | | |
| **8** | **Laboratory 15 –16.** Computer simulation of elementary process of bearings and deaths. | | | | | | **2** | | | | **4** | | |
| **8** | **SSI 15 –16.** The Models ofPopulation Growth. | | | | | |  | | | | **2** | | |
| **9 – 10** | **Lecture 17 –20.** The Stochastic Models ofbreeding fight’s and vermin’s populations. | | | | | | **4** | | | | **8** | | |
| **9 – 10** | **Laboratory 17 –20.** Computer simulation of elementary process of bearings, deaths and immigration. | | | | | | **4** | | | | **8** | | |
| **9 – 10** | **SSI 17 –20.** The Models ofPopulations Breeding. | | | | | |  | | | | **4** | | |
| **11 – 12** | **Lecture 21 – 24.** The Stochastic Theory of Epidemics. The Model of Stochastic Epidemic. Nonlinear process of deaths. | | | | | | **4** | | | | **8** | | |
| **11 – 12** | **Laboratory 21 – 24.** Computer simulation of Stochastic Epidemic model. | | | | | | **4** | | | | **8** | | |
| **11 – 12** | **SSI 21 – 24.** Linear process of deaths. | | | | | |  | | | | **4** | | |
| **13 – 15** | **Lecture 25 – 30.** The Stochastic Models of Chemical Kinetics’. Elementary models of autocatalytic reaction. Unimolecular reaction. Bimolecular reaction and active mass law. | | | | | | **6** | | | | **10** | | |
| **13 – 15** | **Laboratory 25 – 30.** Computer simulation of elementary models of autocatalytic reaction, of unimolecular reaction and bimolecular reaction. | | | | | | **6** | | | | **10** | | |
| **13 – 15** | **SSI 25 – 30.** Some chain reactions. | | | | | |  | | | | **6** | | |
|  | **IC 2** | | | | | |  | | | | **100** | | |
|  | **Exam** | | | | | |  | | | | **100** | | |
|  | **Total** | | | | | |  | | | | **100** | | |

**Reviewed at the department meeting**

***Report №\_\_ from «\_\_» \_\_\_\_\_\_\_\_\_\_\_\_2017***

**Head of department D. Zhakebayev**

**Lecturer K. Shakenov**