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| **Al-FARABI KAZAKH NATIONAL UNIVERSITY**Faculty of Mechanics and Mathematics**Department of Mathematical and Computer Modeling****SYLLABUS** Modern Methods of Mathematical Modeling 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**  |
|  | Modern Methods of Mathematical Modeling  | 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 Sciences, Professor**  | **Office-time** | According to timetable |
| **e-mail:** | shakenov2000@mail.ru, shakenov.kanat@kaznu.kz.  |
| **Phone**  | **+7 727 2211591, +7 705 182 3129** | **Lecture hall**  | **321** |
| **Teacher (laboratory studies)** | **Saule Zamanova** **+7 701 773 0010** |  |  |
| **e-mail:** | **saule\_zamanova@mail.ru** | **Lecture hall** | **304** |
| **Course description** | Research of the modern determinate and stochastic models and theirs computer simulation.  |
| **Course aims** | Destination of the course: construction of the determinate and stochastic models and computer realization.  |
| **Learning outcomes**  | 1. Intimate knowledge of the determinate and stochastic models.
2. Ability simulate of the stochastic processes and numerical solution of the determinate models.
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| **References and resources**  | 1. Volterra V. Theory of Functionals and of Integral and Integro-Differential Equations. Dover Publications, ING. New York 1959.
2. Robert C.P., Casella G. Monte Carlo Statistical Methods. Second Edition. Springer. 2005.
3. Himmelblau D. Process Analysis by Statistical Methods. John Wiley and Sons, Inc. New York-London-Sydney-Toronto 1970.
4. 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.
5. Sobol’ I.M. Monte Carlo Method. Moscow, Nauka. 1985.
6. Mitropolsky A.K. Technique of statistical calculations. Moscow, Nauka. 1971.
7. Serovajsky S.Ya. Mathematical Modeling. Almaty, Kazakh University. 2000.
8. Shakenov K.K. Monte Carlo Methods and theirs Application. Almaty, Al-Farabi Kazakh State National University. 1993.
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| **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.
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| **Grading policy**  | **Description of assignment** | **Weight**  | **Learning outcomes** |
| Individual tasksGroup projectAnalytical problem Examinations. Total | 35%10%15%40%100% | 1,2,34,5,62,3,44,5,61,2,3,4,5,6 |
| Your final score will be calculated by the formula $$The final grade on discipline=\frac{LC1+LC2}{2}∙0,6+0,1MT+0,3FC$$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.** Mathematical Models of Aero- Hydromechanics. Navier – Stokes Equations.  | **4** | **8** |
| **1 – 2** | **Laboratory 1 – 4.** Numerical Solutions of Navier – Stokes Equations.  | **4** | **8** |
| **1 – 2** | **Students self-instruction (SSI) by subject (Homework, Project beginning etc. ) 1 – 4.**Finite Difference Method, FEA and Monte Carlo Methods.  |  | **4** |
| **3 – 4** | **Lecture 5 – 8.** Mathematical Models of Filtration Process. Musket – Leverett’s Model.  | **4** | **8** |
| **3 – 4** | **Laboratory 5 – 8.** Monte Carlo Methods for Musket – Leverett’s Models.  | **4** | **8** |
| **3 – 4** | **SSI 5 – 8.** Computer simulation of Markov Chains.  |  | **4** |
| **5 – 6** | **Lecture 9 – 12.** Mathematical Models Relaxational Filtration. Four Models. Monte Carlo Numerical Solutions.  | **4** | **8** |
| **5 – 6** | **Laboratory 9 – 12.** Computer Simulation of the Dirichlet Problem for Helmholtz Equation.  | **4** | **8** |
| **5 – 6** | **SSI 9 – 12.** Computer Simulation others Problems.  |  | **4** |
| **7** | **Lecture 13 –14 .** Classic Monte Carlo Integration. Importance Sampling. Estimated variance. Principles. Finite Variance Estimators.  | **2** | **4** |
| **7** | **Laboratory 13 –14.** Random Walks. Markov Chains. Computer simulation of Markov Chains. Estimated of Integral  by Monte Carlo methods. | **2** | **4** |
|  | **SSI 13 –14.** Computer simulation of Markov Chains. Computer simulation of Estimated of Integral. |  | **2** |
|  | **IC 1** |  | **100** |
|  | **Midterm Exam** |  | **100** |
| **8** | **Lecture 15 –16.** Queue System Modeling.Algorithm of calculations. Quality of product calculations. Calculations of neutron passing through of plate. Problem statement. Breakdown of calculation by modeling of real trajectories. Reactor calculation.  | **2** | **4** |
| **8** | **Laboratory 15 –16.** Computer simulation of the Poisson distribution (Poisson flow) and others random parameters. Calculations of probabilistic characteristics of product. | **2** | **4** |
| **8** | **SSI 15 –16.** Computer simulation. |  | **2** |
| **9 – 10**  | **Lecture 17 –20.** Population growth.Elementary probability models of population breeding. Heterogeneous process of bearings and deaths. 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**