**AL-FARABI KAZAKH NATIONAL UNIVERSITY**

**Faculty of Mechanics and Mathematics**

**Department of Mathematical and Computer Modeling**

**Educational program in the specialty «5B070500 - Mathematical and Computer Modeling»**

**SYLLABUS**

**Mathematical Modeling in Economics**

**Lent term, 2018-2019**

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| **Discipline’s code** | **Discipline’s title** | **Type** | **No. of hours per week** | | | | | **Number of credits** | **ECTS** |
| **Lect.** | **Pract.** | | **Lab.** | |
| **5B070500** | **Mathematical Modeling in Economics** | **ED** | **1** | **0** | | **1** | | **2** | **5** |
| **Lecturer** | Kanat Shakenov, Doctor of Physical and Mathematical Sciences, Professor | | | | **Office hours** | | Scheduled | | |
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| **Teacher (laboratory)** | Kanat Shakenov | | | | **Office hours** | | Scheduled | | |
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| **Academic Course Presentation** | The goal of this course is to acquaint students with various mathematical models in economics, such as the inter-sectoral balance model, economic planning and optimal economic growth model, competitive equilibrium model, as well as with certain branches of mathematics such as the theory of non-negative matrices and its applications in economics. As well as stochastic models in the economy.  As a result, the study of the discipline the student will be able to:  1. To solve problems of mathematical programming;  2. Work with convex sets and convex functions;  3. Solve the problems of linear programming described below in the calendar (graph) of the implementation of the content of the training course methods on Maple 17;  4. Work the tasks of stochastic modeling in the economy described below in the calendar (graph) of the implementation of the content of the training course methods on Maple 17; |
| **Prerequisites and post requisites** | Mathematical analysis, Linear algebra, Geometry, Computer science, Discrete mathematics, Probability theory and mathematical statistics, ODE, Mathematical modeling, Monte Carlo methods, Numerical methods 1, Numerical methods 2. |
| **Learning Outcomes** | By the end the course, students should be able to:   * Intimate knowledge of the mathematical programming. Monte Carlo Methods. * Ability simulate of the stochastic process and of the stochastic modeling in the economics. |
| **Literature and Information resources** | **Recommended Textbooks (main):**  1. Karmanov V.G. Mathematical programming. Moscow, Nauka, 1980. (In Russian).  2. Kundysheva E.S. Mathematical modeling in economics. Tutorial. Moscow, 2006. (In Russian).  3. Kalikhman I.L. Collection of programming tasks. Moscow, High School, 1975. (In Russian).  4. Zamkov O. O., Tolstopyatenko A. V., Cheremnykh Yu. N. Mathematical methods in economics: Textbook. - M .: MSU. M. V. Lomonosov, Publishing House "DIS", 1997. (In Russian).  5. Bolch B., Huan C.J. Multidimensional statistical methods for economics. Moscow, Statistics, 1979.  6. Ermakov S.M. Monte Carlo Methods and Adjacent Questions. Moscow, Nauka, 1975. (In Russian).  7. Sobol’ I.M. Monte Carlo Method. Moscow, 1985. (In Russian).   1. Sobol’ I.M. Monte Carlo Numerical Methods. Moscow, Nauka, 1973. (In Russian).   9. Barucha-Read A.T. Elements of the theory of Markov processes and their applications. M., Science, 1969.  10. Shakenov K.K. Monte Carlo methods and their applications. Almaty, KSNU, 1993. (In Russian).  11. Christian P. Robert, George Casella. Monte Carlo Statistical Methods. Second Edition. Springer. 2004  **Additional textbooks:**   1. Ashmanov S.A. Introduction to Mathematical Economics, Moscow, Science, 1984. (In Russian). 2. Nikaydo H. Convex structures and mathematical economics, M., Mir, 1972. 3. Aubin J.-P. Nonlinear analysis and its economic applications, M., Mir, 1988. 4. 4. Moulin E. Theory of games with examples from mathematical economics, M., Mir, 1985. 5. Ekland I. Elements of mathematical economics, M., Mir, 1983. 6. Allen R. J. Mathematical economics. M., Mir, 1963. 7. Baldin K.V. Mathematical methods in economics. Theory, examples, variants of examinations: Tutorial. K.V. Baldin, O.F. Bystrov. M., MSU. 1965. (In Russian). |
| **Academic policy course in the context of university moral and ethical values** | **Rules of academic behavior:**  1. For each class lesson (laboratory class) you must prepare in advance, according to the schedule below. Preparation of the assignment should be completed before the classroom session on which the topic is being discussed.  2. The IWS delivered a week later will be accepted, but the score is reduced by 50%  3. Midterm Exam is held according to the program  4. Academic values:  1. Laboratory classes, IWS should be independent, creative  2. Inadmissible plagiarism, forgery, use of cheat sheets, cheating at all stages of knowledge control.  Students with disabilities can receive advice by email: kanat.shakenov@kaznu.kz |
| **Organization of the course** | Course structure: 1. Lectures, 2. Laboratory classes. The lectures give theoretical materials. In laboratory classes, students solve problems on the topic on the 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. |
| **Evaluation system** | Criteria-based evaluation: assessment of learning outcomes in correlation with descriptors (verification of formation of competences on attestation controls and examinations).  Summative assessment: evaluation of attendance and activity in the classroom; evaluation of assignments and Student’s Individual Studies (SIS1, SIS2).  These types of evaluation are given in the table below:   |  |  | | --- | --- | | Types of work | % | | Individual tasks | 35% | | Group project | 10% | | Analytical problem | 15% | | Exams | 40% | | TOTAL | 100% |   Your final grade is calculated by the formula:  Total = 0.6\*(At1+At2)\2+0.1\*MidTermExam+0.3\*FinalExam    The final grade will be calculated according to the evaluation system accepted in University:  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 |
| **Policy of Discipline** | 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. |

**STRUCTURE AND CONTENT OF DISCIPLINE**

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| **Week** | **Topics** | **Hours** | **Max point** |
| **Module 1. Linear programming problems. Leontiev model** | | | |
| **1** | Lecture 1. Introduction. The subject of mathematical programming. About models. Examples of mathematical models. Elements of convex analysis. Euclidean space. Convex sets. Projection. Separation theorems. Cone Farkash theorem. Convex functions. | 1 |  |
| Lab 1. Determination of the economic parameters of the enterprise. Examples of mathematical models. The use of matrix algebra in economic calculations. Balance models. | 2 | 3 |
| **2** | Lecture 2. Basics of mathematical programming. Problems of mathematical programming. Extreme properties and extreme properties on convex sets. Sufficient conditions for optimality. Lagrange function. Conditions of optimality. | 1 |  |
| Lab 2. Problems of mathematical programming. Determination of the economic parameters of the enterprise. Extreme properties and extreme properties on convex sets. Sufficient conditions for optimality. Lagrange function. Conditions of optimality. | 2 | 3 |
| **3** | Lecture 3. The theory of linear programming. Basic concepts. Basic theorems. Algebraic characteristics of the corner point. Dual problems with mixed constraints. The canonical form of a linear programming problem. | 1 |  |
| Lab 3. Algebraic characteristics of a corner point. Dual problems with mixed constraints. The canonical form of a linear programming problem. | 2 | 3 |
| **4** | Lecture 4. Finite methods for solving linear programming problems. Simplex method. Graphic solution. Convex shapes. | 1 |  |
| Lab 4. Determination of the maximum and minimum of a linear function under certain conditions. Simplex method. Recurrent relations of the simplex method algorithm (connection between the parameters of successive iterations). | 2 | 3 |
| **5** | Lecture 5. The method of finding the initial corner point. Degeneracy. Perturbation method. Modified Simplex Method | 1 |  |
| Lab 5. Solving linear programming problems by the simplex method on Maple 17. | 2 | 3 |
| IWST. Consultation and Reception.  IWS1. IWS 2. Acceptance of test work on the topics "Lab. 1, 2, 3, 4, 5 ". | 1 | 60 |
| **6** | Lecture 6. Method of penalty functions. Description of the method. The convergence theorem. Questions of sustainability in mathematical programming. Correct and incorrect tasks. Regularization method. Convergence. | 1 |  |
| Lab 6. Problem solving by the method of penalty functions on Maple 17. | 2 | 3 |
| **7** | Lecture 7. The method of one-dimensional minimization. Search for a segment containing a minimum point. Fibonacci method and the golden section. Parabolic method. Tangent method. The method of cubic approximation. | 1 |  |
| Lab 7. Search for the segment containing the minimum point. Fibonacci method and the golden section. Parabolic method. Tangent method. The method of cubic approximation. Solving these problems on Maple 17. | 2 | 3 |
| IWST Consultation and Reception  IWS 3. Acceptance of control work on topics   “Lab. 6, 7 ". | 1 | 30 |
| **LC 1** | Accumulative (Lab, IWS). |  | 100 |
| **8** | **Midterm exam** |  | **100** |
| **8** | Lecture 8. Construction of linear economic models. Leontiev's model of a diversified economy. Productive model Leontiev. Total Cost Vector | 1 |  |
| Lab 8. Eigenvectors of non-negative matrices. Eigenvalues of the Leontief matrix. Finding eigenvectors and values on Maple 17. | 2 | 3 |
| **9** | Lecture 9. Transport Problems. Determination of the initial transportation plan. The method of "northwest" corner. The minimum element method. Vogel method. Getting the optimal plan of the transport problem using the method of potentials. | 1 |  |
| Lab 9. Problem solving: Determination of the initial transportation plan. The method of "northwest" corner. The minimum element method. Vogel method. Obtaining an optimal transport plan using the potential method on Maple 17. | 2 | 3 |
| **10** | Lecture 10. Transport Problems. Determination of the initial transportation plan. The method of "northwest" corner. The minimum element method. Vogel method. Getting the optimal plan of the transport problem using the method of potentials. | 1 |  |
| Lab 10. Problem solving: Determination of the initial transportation plan. The method of "northwest" corner. The minimum element method. Vogel method. Obtaining an optimal transport plan using the potential method on Maple 17. | 2 | 3 |
| IWST Consultation and Reception  IWS 4. Acceptance of tasks on the topics “Lab. 8, 9, 10 ". | 1 | 15 |
| **Module 2. Stochastic Modeling in Economics** | | | |
| **11** | Lecture 11. Theory of queuing. Calculation of the queuing system. Application to telephony. Application to machine maintenance. The problems of idle machines. Model Palma. Model Takach’s. Machine maintenance patrol master. The process of group service. Service processes with requests that refuse to queue up. | 1 |  |
| Lab 11. Modeling of random variables and processes on Maple 17. | 2 | 3 |
| **12** | Lecture 12. Correlation analysis. The concept of regression. | 1 |  |
| Lab 12. Solving examples of correlation analysis on Maple 17. | 2 | 3 |
| IWST Consultation and Reception  IWS 5. Acceptance of tasks on the topics “Lab. 11, 12 ". | 1 | 25 |
| **13** | Lecture 13. Regression analysis. Linear regression. Nonlinear regression. Linear regression model. Evaluation methods. Covariance analysis. Model. Hypothesis. Criterion test hypothesis. Linear contrasts. Two accompanying variables. | 1 |  |
| Lab 13. Solution of examples of regression analysis on Maple 17. Solution of examples of covariance analysis on Maple 17. | 2 | 3 |
| IWST Consultation and Reception  IWS 6. Acceptance of tasks on the topics “Lab. 13 ". | 1 | 30 |
| **14** | Lecture 14. Dispersion analysis. Variance analysis - classification by one feature. Analysis of variance, classification by two signs. | 1 |  |
| Lab 14. Solving examples of Dispersion analysis of variance on Maple 17. | 2 | 3 |
| **15** | Lecture 15. Planning an experiment. The general idea of experiment planning. Full and fractional factor experiments. | 1 |  |
| Lab 15. Conducting and processing the results of the experiment on Maple 17. | 2 | 3 |
|  | IWST Consultation and Reception  IWS 7. Acceptance of tasks on the topics “Lab. 14, 15 ". | 1 | 30 |
| **LC 2** | Accumulative (Lab, IWS). |  | 100 |
|  | **Exam** |  | **100** |

Dean of the Faculty D. B. Zhakebayev

Chairman of the Faculty Methodical Bureau U. Kusherbaeva

Head of Department A.A. Issakhov

Lecturer K.K. Shakenov