**Syllabus***Spring semester, 2018-2019 Academic year*

Academic course information

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Discipline’s code | Discipline’s title | Type | No. of hours per week | | | Number of credits | ECTS |
| Lect. | Pract. | Lab. |
| KTKZOU 5302 | Constructive theory of boundary value optimal control problems | IET | 1 | 1 | 0 | 2 | 3 |
| Lecturer | Aisagaliev Serikbay Abdigalievich, d.t.s., professor | | | Office hours | | 15.00-15.50  16.00-16.50 | |
| e-mail | - | | |
| Telephone number | +77055756509 | | | Auditory | | 307 (Faculty) | |

|  |  |
| --- | --- |
| Academic presentation of the course | **Type of university**: The component of choice. Theoretical, practical; elective.  **Aim of course:** Acquaintance of students with unsolved problems of mathematical control theory in the following areas: according to integral equations, controllability and speed of processes, according to the theory of extremal problems, constructive theory of boundary problems, stability of solving equations with differential inclusions, as well as with the results of new fundamental research in the above areas.  **As a result of the course PhD students must be able to:**  1. Know the basic mathematical concepts included in this program, their relationship, interdependence and mutual influence not only among themselves but also with other mathematical disciplines.  2. be able to accurately and thoroughly substantiate the reasoning without cluttering it with unnecessary details.  3. acquire practical skills to solve problems in order to mathematically correctly set a specific simple task of practice, choose the method of its solution and solve it;  4. To be able to work with literature on the main sections of higher mathematics. |
| Prerequisites | Differential equations; theory of motion stability; matrix theory |
| Post requisites |  |
| Information resources | **Literature**:   1. Aisagaliev S.A., Zhunussova Zh.Kh. Mathematical programming textbook. – Almaty: Kazakh University, 2012. – 208 p. 2. Aisagaliev S.A., Zhunussova Zh.Kh. Optimal control. Tutorial. Approved by the Section RUMS and RISO Al-Farabi Kazakh National University. -Almaty, Kazakh University, 2014. – 200 p. 3. Aisagaliev S.A, Kabidoldanova А.А. Effective management lectures. - Almaty: Kazakh University, 2014. – 226 p. 4. Aisagaliev S.A. Theory of stability of dynamic systems. - Almaty: University University, 2012. – 216 p. 5. Aisagaliev S.A., Kabidoldanova A.A. Optimal control of dynamic systems. - Palmarium Academic Publishing (Verlag, Germany), 2012. – 288 p. 6. Aisagaliev S.A. “Theory of controllability of dynamic systems” - Almaty: Kazakh University, 2014 (volume 10 pp) 7. Aisagaliev S.A. “Constructive theory of boundary value problems for ordinary differential equations” - Almaty: Kazakh university, 2015. - 207 p. 8. Aisagaliev S.A. Problems of the qualitative theory of differential equations. - Almaty: Kazakh university. 2016.-397 p. 9. Aisagaliev S.A. Lectures on the qualitative theory of differential equations. - Almaty, Kazak University, 2018. - 201 p. 10. Aisagaliev S.A. Lectures on the qualitative theory of differential equations. – Almaty, Qazaq Universiteti, 2018. – 196 p. 11. Aisagaliev S.A. Methods for solving boundary value problems. - Almaty: KazGU publishing house, 2002.   **Additional literature:**   1. Alekseev V.M., Tikhomirov V.M., Fomin S.V. Optimal control. - M.: Science, 1979. 2. Aisagaliev S.A. Regional problems of optimal control. -Almaty: KazGU publishing house, 1999. 3. Aisagaliev S.A., Aisagaliyeva S.S. Lectures on optimization methods. - Almaty: Gylym, 1996. |
| Academic policy of the course in the context of university moral and ethical values | **Academic Behavior Rules:** Obligatory attendance of classes, intolerance for being late, commitment to deadlines for completion and delivery of assignments (CDS, Practical classes, midterm exams, individual projects).  **Academic values:** According to Article 5 of the Code of Honor of students of Al-Farabi Kazakh National University, a student must strictly fulfill his academic duties and prevent academic and legal violations (plagiarism, forgery, use of cribs, deceit of and disrespectful attitude to teaching stuff, absenteeism and coming late without respectful reasons).  All students can receive counseling assistance in person, by phone at the numbers indicated or by e-mail provided. |
| Evaluation and attestation policy | **Criteria-based evaluation:** evaluation of achieving learning outcomes in accordance with the descriptors (checking competencies acquired at weeks of the intermediate control, midterm and final examinations)  **Summative evaluation:**  Final score of the discipline =  IC1, IC2 are intermediate controls, МТ is Midterm, FE – final exam.  Percent-rating letter system for assessing of achievements of leaning outcomes by students:  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 |

Calendar (schedule) the implementation of the course content**:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Week / date** | **Topic title (lectures, practical classes, Independent work of students)** | **Number of hours** | **Maximum score** |
| **1** | **2** | **3** | **5** |
| **1** | **Lecture 1.** Statement of the problem. Basic definitions. Valid control. Optimal control. Lower bound. Minimizing sequence. | **1** |  |
| **Practical class 1.** Convergence to the set. Global minimum. | **1** | **7** |
| **2** | **Lecture 2.** Weierstrass theorem in a Banach space. Bicompact sets. Convex sets and convex functionals. Convex hull. Theorems on convex sets. | **1** |  |
| **Practical class 2.** Reaching the lower bound. Lower semicontinuity. Weak lower semicontinuity of functionals. Convex functionals. The criterion for convexity of smooth functionals. | **1** | **8** |
| **3** | **Lecture 3.** The gradient of the functional on the set of solutions of ordinary differential equations. Proof of the theorem. | **1** |  |
| **Practical class 3.** Proof of the theorem. | **1** | **8** |
| **Independent work of student with teacher:** An example solution. |  | **15** |
| **4** | **Lecture 4.** Lipschitz condition for gradient of functional. | 1 |  |
| **Practical class 4.** Conditions of optimality. | 1 | 8 |
| **5** | **Lecture 5.** Linear systems. Discrete systems. | 1 |  |
| **Practical class 5.** Functional gradient Conditions of optimality. | 1 | 8 |
| **Independent work of student with teacher:** Proof of the theorem. An example solution. |  | 15 |
| **6** | **Lecture 6.** Gradient method. Algorithm. Convergence. Minimizing sequence. | 1 |  |
| **Practical class 6.** Evaluation of the rate of convergence. | 1 | 8 |
| **7** | **Lecture 7.** Gradient projection method. Algorithm. Convergence. Minimizing sequence. | 1 |  |
| **Practical class 7.** Convergence rate estimate. | 1 | 8 |
| **Independent work of student with teacher:** Proof of the theorem. An example solution. |  | 15 |
| **RUBLIC CONTROL 1** | | | **100** |
| **8** | **Lecture 8. Midterm.** Optimum speed of linear systems. Formulation of the problem. | 1 |  |
| **Practical class 8.** Optimum speed of linear systems. Formulation of the problem. | 1 | 6 |
| **MIDTERM** | | | **100** |
| **9** | **Lecture 9.** Optimum speed of linear systems. Integral equation. | 1 |  |
| **Practical class 9.** The principle of immersion for optimal performance of linear systems. | 1 | 6 |
| **Independent work of student with teacher:** The principle of immersion for optimal performance of linear systems. |  | 13 |
| **10** | **Lecture 10.** The existence of a solution for the problem of optimal speed of linear systems. | 1 |  |
| **Practical class 10.** The existence of a solution for the problem of optimal speed of linear systems. | 1 | 6 |
| **11** | **Lecture 11.** Functional gradient for optimal performance problem. | 1 |  |
| **Practical class 11.** Minimizing sequences for HSE. | 1 | 6 |
| **Independent work of student with teacher:** Minimizing sequences for HSE. |  | 13 |
| **12** | **Lecture 12.** Optimum speed of nonlinear systems. Formulation of the problem. | 1 |  |
| **Practical class 12.** Optimum speed of nonlinear systems. Formulation of the problem. | 1 | 6 |
| **13** | **Lecture 13.** The immersion principle for the optimal performance problem of nonlinear systems. | 1 |  |
| **Practical class 13.** The existence of a solution for OSPNS. | 1 | 6 |
| **Independent work of student with teacher:** The existence of a solution for OSPNS. |  | 13 |
| **14** | **Lecture 14.** Functional gradient for OSPNS. | 1 |  |
| **Practical class 14.** Functional gradient for OSPNS. | 1 | 6 |
| **15** | **Lecture 15.** Minimizing sequences for OSPNS. | 1 |  |
| **Practical class 15.** The construction of the optimal solution for OSPNS. | 1 | 6 |
| **Independent work of student with teacher:** The construction of the optimal solution for OSPNS. |  | 13 |
| **RUBLIC CONTROL 2** | | | **100** |
| **EXAM** | | | **100** |
| **TOTAL** | | | **100** |

Head of the department of DE and CT Kh.Khompysh

Chairman of the Faculty Methodical Bureau U.R.Kusherbayeva

Lecturer S.A. Aisagaliev