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

Academic course information

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| Discipline’s code | Discipline’s title | Type | No. of hours per week | Number of credits | ECTS |
| Lect. | Pract. | Lab. |
| MRKZ5304 | Methods for Solving Boundary Value Problems | IET | 1 | 1 | 0 | 2 | 3 |
| Lecturer  | Aisagaliev Serikbay Abdigalievich, d.t.s., professor | Office hours | 15.00-15.5016.00-16.50 |
| e-mail | - |
| Telephone number | +77055756509 | Auditory |  307 (Faculty) |

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| Academic presentation of the course | **Type of university**: The component of choice. Theoretical, practical; elective.**Aim of course:** To acquaint undergraduates with new directions in the theory of boundary value problems and to involve them in fundamental research on unsolved problems in the theory of boundary value problems of ordinary differential equations.**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.
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| 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 =$\frac{IC1+IC2}{2}∙0.6+0.1MT+0.3 FE$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**:**

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| --- | --- | --- | --- |
| **Week / date** | **Topic title (lectures, practical classes, Independent work of students)** | **Number of hours** | **Maximum score** |
| **1** | **2** | **3** | **5** |
| **1** | **Lecture 1.** General formulation of a boundary value problem without phase and integral constraints. Review of existing methods for solving boundary value problems of linear ordinary differential equations (LODE). | **1** |  |
| **Practical class 1.** Boundary value problems of variational calculus and optimal control | **1** | **7** |
| **2** | **Lecture 2.** Fredholm integral equation of the first kind. Necessary and sufficient conditions for the existence of a solution. The general solution of the linear Fredholm integral equation of the first kind | **1** |  |
| **Practical class 2.** Solvability and construction of a general solution of an integral equation with examples | **1** | **8** |
| **3** | **Lecture 3.** Boundary value problems for linear systems. Transformation. Linear controlled system. The existence of a solution. Construction of a general solution of a linear controlled system | **1** |  |
| **Practical class 3.** Examples of controllability of linear systems | **1** | **8** |
| **Independent work of student with teacher:** Controllability of linear systems. Example. |  | **15** |
| **4** | **Lecture 4.** The boundary problem for linear systems. Reduction to an optimal control problem with a free right end. Boundary value problems for linear systems. Convex functional. Lipschitz conditions. | 1 |  |
| **Practical class 4.** The boundary problem for the second order system. Transformation. Second order linear controlled system. The fundamental matrix. | 1 | 8 |
| **5** | **Lecture 5.** Boundary value problems for linear systems. Functional gradient. Minimizing sequences | 1 |  |
| **Practical class 5.** The boundary problem for the second order system. Reduction to the initial problem of optimal control | 1 | 8 |
| **Independent work of student with teacher:** Boundary value problems for linear systems. Functional gradient. Minimizing sequences |  | 15 |
| **6** | **Lecture 6.** Boundary value problem for linear systems. Necessary and sufficient condition for solvability. Boundary value problems for linear systems. Construction of the solution of the boundary value problem. | 1 |  |
| **Practical class 6.** The boundary problem for the second order system. Calculation of the gradient of the functional | 1 | 8 |
| **7** | **Lecture 7.** The gradient projection method in a Banach space and its application to the boundary value problem. Estimation of the rate of convergence of the gradient projection method and its application to the boundary value problem.  | 1 |  |
| **Practical class 7.** Construction of a minimizing sequence. Solution of a boundary value problem for a second order system | 1 | 8 |
| **Independent work of student with teacher:** Estimation of the rate of convergence of the gradient projection method and its application to the boundary value problem. |  | 15 |
| **RUBLIC CONTROL 1** | **100** |
| **8** | **Lecture 8. Midterm.** Boundary value problems for linear systems with phase constraints. Transform. Linear controlled system. Boundary value problems for linear systems with phase constraints. Reduction to the initial problem of optimal control | 1 |  |
| **Practical class 8.** A boundary value problem for a second-order linear system with phase constraint | 1 | 6 |
| **MIDTERM** | **100** |
| **9** | **Lecture 9.** Boundary value problems for linear systems with phase constraints. Gradient of a functional. Boundary value problems for linear systems with phase constraints. Minimizing sequences | 1 |  |
| **Practical class 9.** Boundary value problems for a second-order linear system with phase constraints. Reduction to the initial problem of optimal control. | 1 | 6 |
| **Independent work of student with teacher:** Boundary value problems for linear systems with phase constraints. Gradient of a functional. Boundary value problems for linear systems with phase constraints. Minimizing sequences |  | 13 |
| **10** | **Lecture 10.** Boundary value problems for linear systems with phase constraints. Necessary and sufficient condition for solvability. Construction of a solution of a boundary value problem with phase constraints | 1 |  |
| **Practical class 10.** Construction of minimizing sequences. Solution of a boundary value problem with phase constraint for a second order system | 1 | 6 |
| **11** | **Lecture 11.** Boundary value problems for LODE with phase constraints. Transformation. Linear controlled system. Construction of a set of controls. Building of a managed system solution | 1 |  |
| **Practical class 11.** Boundary value problem for LODE with phase and integral constraints for a second-order system | 1 | 6 |
| **Independent work of student with teacher:** Gradient of a functional. Example. |  | 13 |
| **12** | **Lecture 12.** Boundary problems of LODE. Reduction to the initial problem of optimal control. Boundary value problems for LODE with phase and integral constraints. Functional gradient | 1 |  |
| **Practical class 12.** The boundary value problem for LODE for a second-order system. Initial problem of optimal control | 1 | 6 |
| **13** | **Lecture 13.** Boundary value problems for LODE with phase and integral constraints. Minimizing sequences. Boundary value problems for LODE with restrictions. Necessary and sufficient conditions for solvability | 1 |  |
| **Practical class 13.** Construction of a minimizing sequence for the second order LODE boundary-value problem | 1 | 6 |
| **Independent work of student with teacher:** Boundary value problems for LODE with restrictions. Necessary and sufficient conditions for solvability |  | 13 |
| **14** | **Lecture 14.** Boundary value problems for LODE with restrictions. Construction of the solution of the boundary value problem. Boundary value problems for LODE with restrictions. Weak convergence. Limit points | 1 |  |
| **Practical class 14.** Construction of the solution of the boundary value problem for LODE with second order restrictions | 1 | 6 |
| **15** | **Lecture 15.** Weierstrass theorem in a Banach space. Weakly compact sets. Weakly semicontinuous functionals from below. Weierstrass theorem in a reflexive Banach space | 1 |  |
| **Practical class 15.** Weakly semicontinuous functionals from below. | 1 | 6 |
| **Independent work of student with teacher:** Construction of a minimizing sequence for the second-order LODE boundary-value problem. Example. |  | 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