**DAUGAVPILS UNIVERSITY**

**DESCRIPTION OF THE STUDY COURSE**

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| Name of study course | Contemporary methods in the theory of boundary value problems for ordinary differential equations I |
| Code of study course (DUIS) | MateD037 |
| Scientific branch | Mathematics |
| Course level | 7 |
| Credits | 2 |
| ECTS credits | 3 |
| Total contact hours | 16 |
| Number of lecture hours | 12 |
| Number of seminar hours | 4 |
| Hours of practical work | - |
| Hours of laboratory work | - |
| Number of hours of independent work | 64 |
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| Course author(-s) | |
| Dr.math., Professor Felikss Sadirbajevs (DU) | |
| Course docent(-s) | |
| Dr.math., Associated Professor Armands Gricāns (DU) Dr.math., Professor Felikss Sadirbajevs (DU) | |
| Prior knowledge | |
| MateD012, MateD014 | |
| Annotation of the study course | |
| The aim of the course is to provide knowledge of boundary value problems for ordinary differential equations and the types of boundary value problems. The problems in the theory of boundary value problems are discussed and some methods for studying boundary value problems are discussed.  Course tasks:  - to become familiar with the types of boundary value problems for ordinary differential equations;  - to learn about typical problems, including the existence of solutions problem, the unity of solutions problem, the problem of evaluating the number of solutions;  - to become familiar with the Fuchscian problem, and Fuchscian spectra;  - to learn about quasilinear problems and methods for studying them. | |
| Calendar plan of the study course | |
| Course structure: lectures (L) - 12 hrs, seminars (S) - 4 hrs, students' independent work (Pd) - 64 hrs.  1. Ordinary differential equations (basic concepts). Classification of ODE. (L2, Pd8)  2. Cauchy problem for systems. Compressed representations. (L2, Pd8)  3. Linear boundary value problems. Fuchsian boundary value problem. (L2, Pd8)  4. Quasilinear boundary value problems. (L2, Pd8)  5. Picard problem. Approach. (S2, Pd8)  6. Non-linear boundary value problems for scalar DEs. Green's function method. (L2, Pd8)  7. Non-linear boundary value problems for scalar DEs. Method of upper and lower functions. (S2, Pd8)  8. Green's function method. (L2, Pd8) | |
| Study outcomes | |
| Knowledge:   1. Understands the basic theory of boundary value problems for ordinary differential equations. 2. Understands the classification of ordinary differential equations. 3. Understands the classification of boundary value problems for ordinary differential equations.   Skills:   1. Is able to determine the type of an ordinary differential equation. 2. Is able to apply the compressed representation theorem to prove the existence of solutions to boundary value problems. 3. Is able to construct a Green's function for a two-point homogeneous boundary value problem. 4. Is able to interpret Fuchsian spectra. 5. Is able to apply numerically the method of fitting to solve problems.   Competence:   1. Actively participates in discussions on types of differential equations, properties of boundary value problems, methods of proving existence of solutions. 2. Independently develops own competence by identifying current trends in the application of ordinary differential equations in mathematical modelling. | |
| Description of the organization and tasks of students' independent work | |
| Students carry out 3 independent works on the following topics:   1. Study specific border problems; 2. Constructing the solution of an inhomogeneous differential equation with boundary conditions using the Green's function; 3. Numerical solution of a nonlinear boundary value problem. | |
| Requirements for obtaining credits | |
| CRITERIA FOR EVALUATING THE LEARNING OUTCOMES  The acquisition of the study course is evaluated by using 10-point scale according to the laws and regulations of the Republic of Latvia and in accordance with the "Regulations on studies at Daugavpils University" (approved at DU Senate meeting on 17.12.2018., Minutes No. 15), based on the following evaluation criteria of learning outcomes: the scope and quality of acquired knowledge, acquire skills and competencies in accordance with the planned study results.  EVALUATION OF LEARNING OUTCOMES   |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Type of test | Learning outcomes | | | | | | | | | | | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | | 1. Independent work I |  | + | + | + |  |  |  | + | + | + | | Independent work II | + | + | + |  |  | + | + |  | + | + | | Independent work III | + | + | + | + | + | + | + | + | + | + | | Test | + | + | + | + | + | + | + | + | + | + |   Final differentiated test assessment. The mark is calculated as the average mark of the independent work. | |
| Course content | |
| 1 Ordinary differential equations (basic concepts). Classification of ODE. (L2, Pd8)  2. Cauchy problem for systems. Compressed representations. (L2, Pd8)  3. Linear boundary value problems. Fuchsian boundary value problem. (L2, Pd8)  4. Quasilinear boundary value problems. (L2, Pd8)  5. Picard problem. Approach. (S2, Pd8)  6. Non-linear boundary value problems for scalar DEs. Green's function method. (L2, Pd8)  7. Non-linear boundary value problems for scalar DEs. Method of upper and lower functions. (S2, Pd8)  8. Green's function method. (L2, Pd8) | |
| Mandatory sources of information | |
| 1. C. De Coster. **[Two-Point Boundary Value Problems: Lower and Upper Solutions](https://biblio.du.lv/Alise/lv/book.aspx?id=45561&ident=1042294)** Elsevier, 2006. 490 p. 2. C. H. Edwards, D. E. Penney, D. Calvis. Differential Equations and Boundary Value problems, 5th edition, Pearson Education, Inc., 2015. 3. L. Elsgolc. Differential equations and calculus of variations (Ļ.E.Эльсгольц, Лев Эрнестович Дифференциальные уравнения и вариационное исчисление.Наука, 1969. 424 c.) 4. J. Mawhin. From successive approximations to topology. [(13) (PDF) Boundary value problems for nonlinear ordinary differential equations : from successive approximations to topology (researchgate.net)](https://www.researchgate.net/publication/242012980_Boundary_value_problems_for_nonlinear_ordinary_differential_equations_from_successive_approximations_to_topology) | |
| Additional sources of information | |
| 1. C. Chicone. Ordinary Differential Equations With Applications, Springer, 1999. 2. J. Dugundji, A. Granas. Fixed Point Theory, Springer, 2003. 3. D. Jordan, P. Smith. Nonlinear Ordinary Differential Equations: An Introduction for Scientists and Engineers (Oxford Texts in Applied and Engineering Mathematics), Oxford University Press, 2007. 4. J. Mawhin. Topological degree methods in nonlinear boundary value problems. – Reg. conf. series in math., # 40. AMS publication. 1977. 5. J. Leray et J. Schauder. Topologie et équations fonctionnelles. Annales de École Norm. sup., 13 (1934), 45 –78. 6. N. Lloyd. Topological degree, Cambridge University Press, 1978. 7. D. O'Regan D., Y.J. Cho, Y.-Q Chen. Topological degree theory and applications (Series in Mathematical Analysis and Applications), Volume 10, 2006. 8. D. O'Regan, R. Precup. Theorems of Leray-Schauder Type And Applications (Series in Mathematical Analysis and Applications), Volume 3, CRC, 2002. 9. R.P. Agarwal, D. O'Regan. An introduction to ordinary differential equations, Springer, 2008. | |
| Periodicals and other sources of information | |
| 1. K. Schmit, R.C. Thompson. Nonlinear Analysis and Differential Equations. An Introduction <http://www.math.utah.edu/~schmitt/ode1.pdf> | |
| Notes | |
| Part A of the doctoral study program "Mathematics".  The course is taught in Latvian or English. | |