**DAUGAVPILS UNIVERSITY**

**DESCRIPTION OF THE STUDY COURSE**

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| Name of study course | Current problems in differential equations and dynamical systems theory II |
| Code of study course (DUIS) | MateD036 |
| 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., Assoc. Professor Armands Gricāns (DU)  Dr.math., Professor Felikss Sadirbajevs (DU) | |
| Prior knowledge | |
| MateD012,   MateD014,   MateD015 | |
| Annotation of the study course | |
| The aim of the course is to provide knowledge of selected topics in the theory of linear differential equations. The list of selected questions includes homogeneous and inhomogeneous equations, Sturm theory, selected special functions.  Course tasks:  - to acquire knowledge of selected problems in the theory of linear differential equations;  - to acquire knowledge of the Sturm comparison theorems;  - to acquire knowledge of special values and special functions;  - acquire a basic knowledge of Bessel, Mathieu, elliptic functions, orthogonal polynomials. | |
| Calendar plan of the study course | |
| Course structure: lectures (L) - 12 hrs, seminars (S) - 4 hrs, students' independent work (Pd) - 64 hrs.  1. Linear non-homogeneous ODEs. (L2, Pd8)  2. Linear systems with constant coefficients. (L2, Pd8)  3. Linear systems with periodic coefficients. (L2, Pd8)  4. Oscillation and comparison theorems for second-order ODEs. Sturm's theorems. (L2, Pd8)  5. Special features. Sturm-Lewis theory of property values (L2, Pd8)  6. Linear DE solutions - special functions. Legendre functions. Bessel functions (S2, Pd8)  7. Matthieu's functions. Elliptic functions. (L2, Pd8)  8. Orthogonal polynomials. (S2, Pd8) | |
| Study outcomes | |
| Knowledge:   1. Is familiar with the basic theory of linear ordinary differential equations. 2. Is familiar with the theorems of Sturm theory. 3. Is familiar with the relationship between the theory of Mathieu and the theory of linear DE with constant coefficients. 4. Is familiar with the relation of elementary functions to differential equations. 5. Is familiar with some special functions.   Skills:   1. Is able to solve linear DEs with constant coefficients. 2. Is able to analyze linear DEs with periodic coefficients. 3. Is able to apply Sturm's comparison theorems. 4. Is able to find eigenvalues and eigenfunctions for linear problems. 5. Is able to use these special functions and orthogonal polynomials in the analysis of some practical problems.   Competence:   1. Actively participates in discussions on special tools and techniques in the theory of differential equations. 2. Independently develops his/her competence by identifying current trends in the theory of linear differential equations (fractal DEs, time scale DEs). | |
| Description of the organization and tasks of students' independent work | |
| Students carry out 4 independent works on the following topics:   1. Linear DEs with constant coefficients. 2. Comparison theorems. 3. Problems of eigenvalues and eigenfunctions. 4. Special functions and orthogonal polynomials. | |
| 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. | 11. | 12. | | Independent work I | + | + |  |  |  | + |  | + |  |  | + | + | | Independent work II | + |  | + |  |  |  |  |  | + |  | + | + | | Independent work III |  |  | + | + |  | + | + |  |  |  | + | + | | Independent work IV |  |  | + | + | + |  | + |  |  | + | + | + | | Test | + | + | + | + | + | + | + | + | + | + | + | + |   Final differentiated test assessment. The mark is calculated as the average mark of the independent work. | |
| Course content | |
| 1. Linear non-homogeneous ODEs. (L2, Pd8)  2. Linear systems with constant coefficients. (L2, Pd8)  3. Linear systems with periodic coefficients. (L2, Pd8)  4. Oscillation and comparison theorems for second-order ODEs. Sturm's theorems. (L2, Pd8)  5. Special features. Sturm-Lewis theory of property values (L2, Pd8)  6. Linear DE solutions - special functions. Legendre functions. Bessel functions (S2, Pd8)  7. Matthieu's functions. Elliptic functions. (L2, Pd8)  8. Orthogonal polynomials. (S2, Pd8) | |
| Mandatory sources of information | |
| * 1. C. H. Edwards, D.E. Penney, D. Calvis. Differential equations and boundary value problems. Computing and Modeling. Pearson Education, Inc. 2015.   2. J. Mathews, R.L. Walker. Mathematical method of physics. V.A. Benjamin Inc. 1964 (Дж. Мэтьюз, Р. Уокер. Математические методы физики, М., Атомиздат, 1972).   3. A.D. Polyanin, V. Zaitsev. Handbook of Ordinary Differential Equations: Exact Solutions, Methods, and Problems. Boca Raton : CRC Press, 2018.   4. I. Stakgold. [**Green's Functions and Boundary Value Problems**](https://biblio.du.lv/Alise/lv/book.aspx?id=47418&ident=1044823). John Wiley & Sons, 1998. 692 p. | |
| Additional sources of information | |
| 1. R.P. Agarwal, D. O'Regan. Ordinary and partial differential equations: with special functions, Fourier series, and boundary value problems, Springer, 2009. 2. W.E. Boyce, R.C. DiPrima. Elementary differential equations and boundary value problems - 8th ed. - Hoboken: Wiley, 2005. 3. W.E. Boyce, R.C. DiPrima. Elementary differential equations and boundary value problems. - 8th ed. - Hoboken : Wiley, 2005. - 277 p. - (Student Solutions Manual). 4. 7. M. Abramowitz, I. Stegun (1964). Handbook of Mathematical Functions. U.S. Department of Commerce, National Bureau of Standards. 5. E.A. Coddington, N. Levinson. Theory of Ordinary Differential Equations. – Mc Graw – Hill, 1955. (Э.А. Коддингтон, Н. Левинсон. Теория обыкновенных дифференциальных уравнений. – М., ИЛ, 1958). 6. P. Hartman. Ordinary differential equations.- John Wiley, 1964 7. H. Ricardo. A modern introduction to differential equations, Academic Press, 2009. 8. 5. D.A. Sanchez. Ordinary differential equations and stability theory: An introduction summary, Dover Publications, 1979. | |
| Periodicals and other sources of information | |
| 1. A. Mattuck. Differential equations [Differential Equations | Mathematics | MIT OpenCourseWare](https://ocw.mit.edu/courses/18-03-differential-equations-spring-2010/) | |
| Notes | |
| Part B course of the doctoral study program "Mathematics".  The course is taught in Latvian and English. | |