**DAUGAVPILS UNIVERSITY**

**DESCRIPTION OF THE STUDY COURSE**

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| Name of study course | Differential equations. Basic course I |
| Code of study course (DUIS) | MateD012 |
| 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., Associated Professor Armands Gricāns (DU)  Dr.math., Associated Professor Ināra Jermačenko (DU) | |
| Course docent(-s) | |
| Dr.math., Associated Professor Armands Gricāns (DU)  Dr.math., Associated Professor Ināra Jermačenko (DU) | |
| Prior knowledge | |
| - | |
| Annotation of the study course | |
| The aim of the course is to provide a basic knowledge of the theory of metric spaces and linear normal spaces.  Course tasks:  - to learn the basic theory of linear continuous operators;  - to learn the basic theory of compact sets in functional spaces;  - to learn the basic theory of Hilbert spaces. | |
| Calendar plan of the study course | |
| Course structure: lectures (L) - 12 hrs, seminars (S) - 4 hrs, students' independent work (Pd) - 64 hrs.  1. Metric spaces. Linear normal spaces. (S2, Pd8)  2. Banach spaces. Linear continuous representations in Banach spaces. Hahn - Banach theorem. (L2, Pd8)  3. Connected space and connected operators. Banach-Steinhaus theorem. (L2, Pd8)  4. Topology of the space of linear continuous operators. (L2, Pd8)  5. Compact sets. (L2, Pd8)  6. Compact sets in functional spaces. Arcel-Ascoli theorem. (L2, Pd8)  7. Hilbert spaces. The orthogonal complement of a Hilbert space. Fourier series. (L2, Pd8)  8. Bessel's inequality and Parseval's equation. Partition of Hilbert space into orthogonal subspaces. Rice's theorem. (S2, Pd8) | |
| Study outcomes | |
| Knowledge:   1. Is familiar with the basic theory of linear continuous operators. 2. Is familiar with the basic theory of compact sets in functional spaces. 3. Is familiar with the basic theory of Hilbert spaces.   Skills:   1. Is able to justify the linearity and continuity of the operator. 2. Is able to justify the compactness of a cluster of function spaces. 3. Is able to analyze Fourier series in Hilbert spaces.   Competence:   1. Actively participates in discussions on the basic issues in the theory of metric spaces and linear normal spaces. 2. Independently develops own competence by identifying current trends in the use of metric spaces and the theory of linear normal spaces in mathematics. | |
| Description of the organization and tasks of students' independent work | |
| Students carry out 3 independent works on the following topics:   1. linear continuous operators; 2. compactness of clusters of functional spaces; 3. Fourier series in Hilbert spaces. | |
| 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. | | | 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. 1. Metric spaces. Linear normal spaces. (S2, Pd8)  2. Banach spaces. Linear continuous representations in Banach spaces. Hahn - Banach theorem. (L2, Pd8)  3. Connected space and connected operators. Banach-Steinhaus theorem. (L2, Pd8)  4. Topology of the space of linear continuous operators. (L2, Pd8)  5. Compact sets. (L2, Pd8)  6. Compact sets in functional spaces. Arcel-Ascoli theorem. (L2, Pd8)  7. Hilbert spaces. The orthogonal complement of a Hilbert space. Fourier series. (L2, Pd8)  8. Bessel's inequality and Parseval's equation. Partition of Hilbert space into orthogonal subspaces. Rice's theorem. (S2, Pd8)  Independent work - 64 acad. h. Students complete 3 independent works, the average mark of which is the differentiated credit mark. | |
| Mandatory sources of information | |
| 1. T. Buhler, D.A. Salamon, Functional analysis, 2017. <https://people.math.ethz.ch/~salamon/PREPRINTS/funcana.pdf> 2. L. Debnath, P. Mikusinski. Introduction to Hilbert Spaces with Applications, Elsevier, 2005. 3. T. Cīrulis. Funkcionālanalīze, Rīga, 2002. 4. R. Precup. Methods in Nonlinear Integral Equations, Kluwer Academic Publishers, 2002. 5. B.P. Rynne, M.A. Youngson. Linear Functional Analysis, Springer, 2008. 6. K. Saxe. Beginning Functional Analysis, Springer, 2002. | |
| Additional sources of information | |
| 1. Y. Eidelman, V. Milman, A. Tsolomitis. Functional Analysis. An Introduction, AMS, 2004. 2. A. Pietsch. History of Banach Spaces and Linear Operators, Birkhauser, 2007. 3. M. Schechter. Principles of Functional Analysis: Second Edition. American Mathematical Society, Providence, Rhode Island, 2002. | |
| 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. | |