**DAUGAVPILS UNIVERSITY**

**DESCRIPTION OF THE STUDY COURSE**

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| Name of study course | Differential equations. Basic course II |
| Code of study course (DUIS) | MateD014 |
| 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 | |
| MateD012 | |
| Annotation of the study course | |
| The aim of the course is to provide a basic knowledge of nonlinear operators in Hilbert space and the representation of metric spaces by rigid point theory.  Course tasks:  - to learn the basics of the theory of operators in Hilbert spaces;  - to learn the basic theory of compressible representations;  - to learn the Bohl-Brauer and Schauder theorems and their applications;  - to learn the basic issues of topological degree theory. | |
| Calendar plan of the study course | |
| Course structure: lectures (L) - 12 hrs, seminars (S) - 4 hrs, students' independent work (Pd) - 64 hrs.  1. Compact operators in Hilbert spaces. Operator spectrum and resolvent. (L2, Pd8)  2. Self-connected operators, spectrum. Hilbert-Schmidt theorem. (L2, Pd8)  3. Fredholm theorems and their applications. (L2, Pd8)  4. Fixed points of representations. Compressive representations in metric spaces. (L2, Pd8)  5. Banach principles of a fixed point, their applications. (S2, Pd8)  6. Fixed points of non-extensible representations. (S2, Pd8)  7. Bol-Brauer and Schauder's theorem for a fixed point, their applications. (L2, Pd8)  8. Topological degree of a representation and its applications. (L2, Pd8) | |
| Study outcomes | |
| Knowledge:   1. Is familiar with the basic theory of operators in Hilbert spaces. 2. Is familiar with the basic theory of compressible representations. 3. Is familiar with the Boolean-Brauer and Schauder theorems and their applications. 4. Is familiar with the basic issues of topological degree theory.   Skills:   1. Is able to justify the compactness of the operator in Hilbert spaces. 2. Is able to apply Banach's principles to the determination of fixed points. 3. Is able to apply the Bohl-Brauer and Schauder theorems. 4. Is able to apply topological degree to the determination of rigid points.   Competence:   1. Actively participates in discussions on the basic issues of Hilbert space theory of operators and fixed point principles. 2. Independently develops own competence by identifying current trends in the use of operators in Hilbert spaces and rigid point principles in mathematics. | |
| Description of the organization and tasks of students' independent work | |
| Students carry out 4 independent works on the following topics:   1. operators in Hilbert spaces; 2. Banach's principles for the determination of fixed points; 3. Bohl-Brauer and Schauder theorems; 4. Topological degree. | |
| 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. | | | 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. Compact operators in Hilbert spaces. Operator spectrum and resolvent. (L2, Pd8)  2. Self-connected operators, spectrum. Hilbert-Schmidt theorem. (L2, Pd8)  3. Fredholm theorems and their applications. (L2, Pd8)  4. Fixed points of representations. Compressive representations in metric spaces. (L2, Pd8)  5. Banach principles of a fixed point, their applications. (S2, Pd8)  6. Fixed points of non-extensible representations. (S2, Pd8)  7. Bol-Brauer and Schauder's theorem for a fixed point, their applications. (L2, Pd8)  8. Topological degree of a representation and its applications. (L2, Pd8)  Independent work - 64 acad. h. Students complete 4 independent works, the average mark of which is the differentiated credit mark | |
| Mandatory sources of information | |
| 1. R.P. Agarwal, M. Meehan, D. O’Regan. Fixed point theory and applications, CUP, 2004. 2. V. Berinde V. Iterative approximation of fixed points, LNM1912, Springer, 2007. 3. T. Cīrulis. Funkcionālanalīze, Rīga, 2002. 4. L. Debnath, P. Mikusinski. Introduction to Hilbert Spaces with Applications, Elsevier, 2005. 5. P. Drabek, J. Milota. Methods of Nonlinear Analysis. Applications to Differential Equations, Birkhauser Advanced Texts, 2007. 6. S. Khatri, Applied functional analysis, 2014.   <https://sumeetkhatri.files.wordpress.com/2017/06/functionalanalysis.pdf>   1. D. O'Regan. Topological Degree Theory and Applications, Chapman & Hall/CRC, 2006. | |
| Additional sources of information | |
| 1. J. Andres. Topological Fixed Point Principles for Boundary Value Problems, Kluwer Academic Publishers, 2003. 2. R.F. Brown. Handbook of Topological Fixed Point Theory, Springer, 2005. 3. R.F. Brown. A Topological Introduction to Nonlinear Analysis, Birkhauser, 2004. 4. Y. Eidelman, V. Milman, A. Tsolomitis. Functional Analysis. An Introduction, AMS, 2004. 5. A. Granas. Fixed Point Theory, Springer, 2003. 6. R. Precup. Methods in Nonlinear Integral Equations, Kluwer Academic Publishers, 2002. 7. 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. | |