Subject code	ECTS credits
MAT4002	6

Course title in Lithuanian

FUNKCINĖ ANALIZĖ

Course title in English

FUNCTIONAL ANALYSIS

Short course annotation in Lithuanian (up to 500 characters)

Studentai bus susipažinę bei gebės operuoti pagrindinėmis mato ir integralo teorijos bei funkcinės analizės sąvokomis, žinos pagrindines metrines erdves ir mokės tikrinti jų savybes; gebės apibrėžti sutraukiančius atvaizdžius, įdėtųjų rutulių sąvoką ir su ja susijusius metrinių erdvių separabilumą, kompaktiškumą, kompaktiškumo sąlygas ir nejudamo taško principą; supras įvairias sąvokas tiesinėse ir normuotose erdvėse; gebės įrodyti ir taikyti funkcinės analizės pagrindines teoremas.

Short course annotation in English (up to 500 characters)

Acquiring knowledge of measure and integral theory as well functional analysis, the student operates with main terms of mentioned topics, knows main metric spaces and verifies their properties; determinates and conceives the conception of the embedded balls and relates with this fact the separability, compactness, conditions for compactness and fixed point principle; conceives various terms of linear and normed spaces; proves and applies main theorems of functional analysis.

Prerequisites for entering the course

Mathematical Analysis, Algebra, Number Theory, Geometry, Differential Equations, Complex Variable Theory, Probability Theory.

Course aim

Main aim of the course is to introduce basic elements of measure and integral theory and functional analysis, showing connections between different branches of mathematics, to summarize courses of mathematics foundations, and to develop mathematical and personal skills studying various spaces, their properties and possibilities of application.

Links between course outcomes, criteria of learning achievement evaluation, study methods and methods of learning achievement assessment

No	Course outcomes	Criteria of learning achievement evaluation	Study methods	Methods of learning achievement assessment
1.	Understanding meaning and relations between main terms of measure and integral theory as well of functional analysis, formulating and proving of statements.	Student demonstrates knowledge and ability to formulate and prove known and/or simple modified propositions, and illustrates main concepts with examples and counterexamples.	Lecture, practical exercises (tasks), literature analysis, individual work, tutorials	Midterm, Test, Exam
2.	Identification of space's type, description main properties of such space.	Student recognizes the type of space and demonstrates the knowledge verifying the existence of properties of given certain space.	Lecture, practical exercises (tasks), individual work, tutorials	Midterm, Test
3.	Identification of a problem and, using functional relations between objects of algebra, mathematical analysis, probability theory, geometry,	Student analyses the initial information, recognizes well known situations in certain branches of mathematics, and demonstrates the ability to apply different methods for	Lecture, practical exercises (tasks), literature analysis, individual work, tutorials	Midterm, Test, Exam

	complex-variable functions and so one, as well applying various methods from such branches, solution this problem.	the solution of functional analysis problem.		
4.	Evaluating self-work and understanding the influence to the team-work results as consequences in presentation of literature analysis.	Student assess self-work, critique evaluates importance of teamwork doing translation of functional analysis' text from foreign language and after that presentation in public.	Literature analysis, integrated study subject and foreign language learning, group work, individual work, group tutorials	Self-assessment, assessment by colleagues and lecturer

Links between study programme outcomes and course outcomes

Study programme outcomes	**Running number of course outcome**			
	1	**2**	**3**	**4**
Know and comprehend concepts and propositions of fundamental mathematical subjects, recognize and apply them solving practical/theoretical tasks	+	+		
Summarize and evaluate critically scientific and professional literature, as well as use various tools for collecting of information for the study process and for solving fixed practical/theoretical problems	+			+
Identify the problem, collect and analyze real/theoretical data using various mathematical methods, tools and IT technologies		+	+	
Operating with formal mathematical symbols and terms, determine mathematical connections between various mathematical quantities; conceive mathematical propositions and logical proofs, construct and prove new statements	+		+	
Think logically and analytically, evaluate alternative ways of task solving and implement optimal solutions		+		+
Work individually and/or in groups by developing and adopting appropriate mathematical models and tools for use in case analysis			+	+

Content

No	**Content (topics)**
1	Elements of measure and integral theory. 1.1. Operations over sets. Mapping of sets. Cardinality. 1.2. Systems of sets. Limit of sets sequence. 1.3. Conception of measure. Measure of elementary sets. Measurable sets. 1.4. Measurable functions. 1.5. Lebesgue measure.
2	Metric spaces. 2.1. Definition of metric space. Spaces of sequences and functions. 2.2. Classification of sets and points in metric spaces. Mapping of metric spaces. 2.3. Complete metric spaces. Complement. 2.4. Theorem on embedded balls. 2.5. Retracting mappings. 2.6. Baire theorem on categories. 2.7. Separable metric spaces. 2.8. Compact sets. Arzela-Ascoli theorem.
3	Linear spaces. 3.1. Definition of linear space, examples. 3.2. Hamel basis. Construction of linear spaces. 3.3. Sets and functions in linear spaces.

	3.4. Hahn-Banach theorem.
4	Normed spaces. 4.1 Concept and examples. 4.2 Equivalence of norms. Isomorphic spaces. 4.3 Banach spaces.
5	Spaces with inner product. 5.1. Euclidean and unitary spaces. 5.2. Norm. 5.3. Hilbert spaces. 5.4. Orthogonality. 5.5. Orthogonal representation.

Distribution of workload for students (contact and independent work hours)

Lectures	**45 hours**
Practical work	**30 hours**
Individual students work	**85 hours**
Total:	**160 hours**

Structure of cumulative score and value of its constituent parts

Mid-term exam (25 %), Test (12.5 %), Evaluation of translation of mathematical text and presentation (12.5%), Final exam (50%).

Recommended reference materials

No	Publication year	Authors of publication and title	Publishing house	Number of copies in		
				University library	*Self-study rooms*	*Other libraries*
Basic materials						
1.	2007	V. Paulauskas, A. Račkauskas. Funkcinė analizė. I knyga. Erdvės.	Vilnius: Vaistų žinios		1	
2.	1983	K. Josida. Funkcionalinė analizė	Vilnius: Mokslas	2	1	
3.	1992	E.T. Copson, Metric spaces	Cambridge: Cambridge University Press	2		
4.	2004	Y. Eidelman, V. Milman, A. Tsolomitis. Functional Analysis. An Introduction	Providence RI: AMS		1	
Supplementary materials						
1.	2005	J.B. Conway. A Course in Functional Analysis.	New York: Springer-Verlag			
2.	2006	M.E. Taylor, Measure Theory and Integration,	Providence RI: AMS	AMS, Vol. 76		

Course programme designed by

Prof. dr. Roma Kačinskaitė