

## DESCRIPTION OF THE COURSE OF STUDY

<b>Course code</b>	0541.6.MAT2.C.AF	
<b>Name of the course in</b>	Polish	<b>Analiza funkcjonalna</b>
	English	<b>Functional Analysis</b>

## 1. LOCATION OF THE COURSE OF STUDY WITHIN THE SYSTEM OF STUDIES

<b>1.1. Field of study</b>	mathematics
<b>1.2. Mode of study</b>	full-time studies
<b>1.3. Level of study</b>	Graduate (Master)
<b>1.4. Profile of study*</b>	general academic profile of studies
<b>1.5. Person/s preparing the course description</b>	dr Joanna Garbulińska-Węgrzyn
<b>1.6. Contact</b>	jgarbulinska@ujk.edu.pl

## 2. GENERAL CHARACTERISTICS OF THE COURSE OF STUDY

<b>2.1. Language of instruction</b>	Polish and English
<b>2.2. Prerequisites*</b>	Mathematical Analysis III, IV, Topology I, Linear Algebra and Geometry

## 3. DETAILED CHARACTERISTICS OF THE COURSE OF STUDY

<b>3.1. Form of classes</b>	Lectures and classes	
<b>3.2. Place of classes</b>	classes in the UJK teaching room	
<b>3.3. Form of assessment</b>	Exam (lectures), graded credit (classes)	
<b>3.4. Teaching methods</b>	Lectures – information lecture Classes - discussions, solving problems	
<b>3.5. Bibliography</b>	<b>Required reading</b>	1. W. Rudin, Functional Analysis, McGraw-Hill, 1991 2. W. Johnson, J. Lindenstrauss, Handbook of the geometry of Banach spaces. Vol.1, Elsevier, 2001
	<b>Further reading</b>	1. W. Johnson, J. Lindenstrauss, Handbook of the geometry of Banach spaces. Vol.2, Elsevier, 2003 2. W. Rudin, Real and Complex Analysis, McGraw-Hill, 1987

## 4. OBJECTIVES, SYLLABUS CONTENT AND INTENDED LEARNING OUTCOMES

<b>4.1. Course objectives (including form of classes)</b>	
<i>Lecture:</i>	
C1 - introduction to the theory and basic methods of functional analysis and applications of this field of mathematical analysis.	
C2 - acquisition of basic skills in the use of functional analysis methods.	
C3 - presentation of the basic properties of objects that are the subject of functional analysis.	
<i>Classes:</i>	
C1 - mastering the computational apparatus of functional spaces.	
C2 - developing the habit of learning, improving one's own workshop and formulating questions to deepen one's understanding of functional analysis.	
<b>4.2. Detailed syllabus (including form of classes)</b>	
<b>Lectures</b>	
Norms, normed spaces, Banach spaces, topological vector spaces. Unitary spaces and Hilbert space. Norm induced by a scalar product. Orthogonal projection theorem, orthonormal systems, Schmidt orthonormalization method. Schwarz inequality and Bessel inequality. Fourier series. Parseval identity. Bounded operators. Hahn-Banach theorem. Open mapping theorem closed graph theorem. Elements of spectral theory.	
<b>Classes</b>	
Examples of Hilbert and Banach spaces. Inequalities of: Jensen, Minkowski and Holder. $L^p$ and $W^{p,q}$ . Distributions and their applications in harmonic analysis. Fourier series and applications. Applications of Hilbert and Banach spaces. Elements of spectral theory.	
<b>4.3 Intended learning outcomes</b>	

<b>Code</b>	<b>A student, who passed the course</b>	<b>Relation to learning outcomes</b>
within the scope of <b>KNOWLEDGE:</b>		
W01	understands the role and importance of the construction of mathematical reasonings in functional analysis	MAT2A_W01

W02	has in-depth knowledge and is up-to-date in the development of functional analysis	MAT2A_W03
W03	knows the concepts and methods of functional analysis and its applications in mathematical analysis, in particular knows the properties of classical Banach and Hilbert spaces	MAT2A_W08
W04	knows the relationship between the issues of a selected field of mathematics and other branches of theoretical and applied mathematics	MAT2A_W17
<b>within the scope of ABILITIES:</b>		
U01	constructs mathematical reasoning, proves theorems, selects counterexamples to refute erroneous hypotheses, checks the correctness of inferences in the formal proofs	MAT2A_U01
U02	sees formal structures related to the basic branches of mathematics in the considered mathematical issues and understands the importance of these structures	MAT2A_U03
U03	uses analysis tools, including differential and integral calculus, elements of complex and Fourier analysis	MAT2A_U04
U04	recognizes mathematical structures in selected practical and theoretical issues from other fields of science	MAT2A_U12
U05	searches for the necessary information in various sources, also in English; sees the need to use scientific and popular science magazines	MAT2A_U13
<b>within the scope of SOCIAL COMPETENCE:</b>		
K01	analyzes the logical accuracy of his own and other people's statements, strives for precision in the writing of the text	MAT2A_K01
K02	aims to fully understand the issues by asking the right questions	MAT2A_K04

<b>4.4. Methods of assessment of the intended learning outcomes</b>																					
<b>Teaching outcomes (code)</b>	<b>Method of assessment (+/-)</b>																				
	<b>Exam oral/written*</b>			<b>Test*</b>			<b>Project*</b>			<b>Effort in class*</b>			<b>Self-study*</b>			<b>Group work*</b>			<b>Others* e.g. standardized test used in e-learning</b>		
	<i>Form of classes</i>			<i>Form of classes</i>			<i>Form of classes</i>			<i>Form of classes</i>			<i>Form of classes</i>			<i>Form of classes</i>			<i>Form of classes</i>		
	<i>L</i>	<i>C</i>	<i>...</i>	<i>L</i>	<i>C</i>	<i>...</i>	<i>L</i>	<i>C</i>	<i>...</i>	<i>L</i>	<i>C</i>	<i>...</i>	<i>L</i>	<i>C</i>	<i>...</i>	<i>L</i>	<i>C</i>	<i>...</i>	<i>L</i>	<i>C</i>	<i>...</i>
W01	+																				
W02	+																				
W03	+																				
W04	+																				
U01																					
U02																					
U03																					
U04																					
U05																					
K01	+																				
K02	+																				

\*delete as appropriate

<b>4.5. Criteria of assessment of the intended learning outcomes</b>		
<b>Form of classes</b>	<b>Grade</b>	<b>Criterion of assessment</b>
<b>lecture (L) (including e-learning)</b>	<b>3</b>	at least 50% and no more than 60% of the total number of points possible
	<b>3,5</b>	more than 60% and no more than 70% of the total number of points possible
	<b>4</b>	more than 70% and no more than 80% of the total number of points possible
	<b>4,5</b>	more than 80% and no more than 90% of the total number of points possible
	<b>5</b>	more than 90% of the total number of points possible
<b>classes (C)* (including e-learning)</b>	<b>3</b>	at least 50% and no more than 60% of the total number of points possible
	<b>3,5</b>	more than 60% and no more than 70% of the total number of points possible
	<b>4</b>	more than 70% and no more than 80% of the total number of points possible
	<b>4,5</b>	more than 80% and no more than 90% of the total number of points possible
	<b>5</b>	more than 90% of the total number of points possible

### 5. BALANCE OF ECTS CREDITS – STUDENT’S WORK INPUT

Category	Student's workload	
	Full-time studies	Extramural studies
<i>NUMBER OF HOURS WITH THE DIRECT PARTICIPATION OF THE TEACHER /CONTACT HOURS/</i>	<b>64</b>	
<i>Participation in lectures*</i>	30	
<i>Participation in classes, <del>seminars, laboratories</del>*</i>	30	
<i>Preparation in the exam/ <del>final test</del>*</i>	4	
<i>INDEPENDENT WORK OF THE STUDENT/NON-CONTACT HOURS/</i>	<b>36</b>	
<i>Preparation for the lecture*</i>	12	
<i>Preparation for the classes, <del>seminars, laboratories</del>*</i>	12	
<i>Preparation for the exam/<del>test</del>*</i>	12	
<b>TOTAL NUMBER OF HOURS</b>	<b>100</b>	
ECTS credits for the course of study	<b>4</b>	

*\*delete as appropriate*

**Accepted for execution** (date and legible signatures of the teachers running the course in the given academic year)

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