

FACULTY OF PURE AND APPLIED MATHEMATICS**SUBJECT CARD****Name in Polish: Wybrane Zagadnienia Analizy Funkcjonalnej****Name in English: Selected Problems of Functional Analysis****Main field of study:****Specialization (if applicable):****Level and form of studies: 3rd level****Kind of subject: general course****Subject code: MAT1307****Group of courses: ~~TAK~~ / NIE***

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30				
Number of hours of total student workload (CNPS)	90				
Form of crediting	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	3				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	2				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student is able to handle methods of functional analysis.
2. Student is able to study supplementary areas of knowledge and skills.

SUBJECT OBJECTIVES

C1 Students will learn selected notions of advanced functional analysis, including notions of unbounded operators, distributions and Sobolev spaces,

C2 The student should acquire the ability to critical analysis of a given phenomenon that allows for the creation of a theoretical model

C3 The student should acquire the skills of oral and written presentation of results of scientific work in a form accessible for non-specialists in the field related to the present issue

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 complex systems and interdisciplinary application of agent-based modeling

PEK_W02 analysis and modeling complex systems

relating to skills:

PEK_U01 critical analysis of natural and social phenomena

PEK_U02 discussion and presenting knowledge in writing and oral form for non-specialists

relating to social competences:

PEK_K01 awareness of the role of interdisciplinary collaboration

PEK_K02 awareness of the role of popularization of science

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Lec1	Unbounded operators: definition, operator extension, graph, closability, spectrum, examples.	2
Lec2	Self-adjoint operators: adjointness, symmetry, self-adjointness and essential self-adjointness, criteria for self-adjointness	2
Lec3	Spectral theorem for bounded hermitian operators: functional calculus, spectral projectors and measures.	2
Lec4	Spectral theorem for unbounded self-adjoint operators: three forms of the spectral theorem.	2
Lec5	Illustration of the spectral theorem: Laplacian and harmonic oscillator.	2
Lec6	Mathematical model of quantum mechanics.	2
Lec7	Semigroups of operators: heat and Poisson semigroups for positive self-adjoint operators with illustration for Laplacian and harmonic oscillator, one-dimensional unitary groups of operators, Stone's theorem.	2
Lec8	Introduction to the distribution theory: basic ideas, weak derivatives, test functions.	2
Lec9	Elements of Fourier analysis: Schwartz' space, convolutions.	2
Lec10	Distributions: operations on distributions, convergence in the spaces of distributions, different kinds of distributions.	2
Lec11	Tempered distributions: Fourier transform of a distribution,	2
Lec12	Applications to main equations of mathematical physics: fundamental solutions, examples of fundamental solutions for classic differential operators.	2
Lec13	Sobolev spaces H_s : definition, basic properties, Sobolev embedding theorem.	2
Lec14	Local Sobolev spaces $H_{s,loc}$: definition and properties, elliptic operators, elliptic regularity theorem.	2
Lec15	Sobolev spaces $W^{k,p}$: basic properties.	2
	Total hours	30

TEACHING TOOLS USED

N1 lecture
 N2 consultations
 N3 written assignments: problem solutions

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the semester end))	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01, PEK_U02	participation in the course
F2	PEK_W01, PEK_W02, PEK_U01, PEK_U02, PEK_K01, PEK_K02	solutions of the problems
$P=0.5 \cdot F1 + 0.5 \cdot F2$		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- [1] J. Conway, „A course in Functional Analysis”, Graduate Texts in Mathematics, Springer 1997
- [2] M. Reed and B. Simon, „Methods of modern mathematical physics”, vols. 1-4, Academic Press, New York 1972
- [3] W. Rudin „Analiza Funkcjonalna”, PWN 2001

SECONDARY LITERATURE:

- [1] R. Strichartz , “A Guide to Distribution theory and Fourier transforms”, World Scientific (1994)
- [2] S. Ramamurti, “Mechanika kwantowa”, PWN 2007

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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**MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
SELECTED PROBLEMS OF FUNCTIONAL ANALYSIS
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives***	Programme content***	Teaching tool number***
PEK_W01	I3_W06	C1,C2	Lec1-15	N1,N2,N3
PEK_W02	I3_W06	C1,C2	Lec1-15	N1,N2,N3
PEK_U01	I3_W06	C1,C2	Lec1-15	N1,N2,N3
PEK_U02	I3_U02	C2	Lec1-15	N2,N3
PEK_U03	I3_U05	C2,C3	Lec1-15	N2,N3
PEK_K01	I3_K01	C3	Lec1-15	N2,N3
PEK_K02	I3_K04	C3	Lec1-15	N2,N3

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above