COURSE DESCRIPTION CARD - SYLLABUS

Course name
Functional Analysis [S1MwT1>E-AF]

Course

Field of study
Mathematics in Technology

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge in domain of calculus and topology on the level of studies of the first-cycle. Convergence of number sequences,, continuity of real valued functions.

Course objective

To learn the basics of functional analysis. To acquire the ability to apply the acquired knowledge to both theoretical and practical issues in other areas.

Course-related learning outcomes

Knowledge:
to use the functional analysis to other fields of mathematics with particular emphasis on linear algebra and topology.

Skills:
Ability to use notions of linear spaces, vectors, linear operators, norm of operators, linear functionals. Ability to use these concepts for proving of various properties of linear spaces. Explanation of the meaning of geometric interpretation of these notions and and using other tools of functional analysis.

Social competences:
Ability to precise formulation of mathematical problems and trying of solving them. Ability to search for information single-handedly in literature, also in English.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture
-Assessment of knowledge and skills on the basis of a project made individually by the student. The final assessment of the project may consist of both the merits of the project itself and its verbal defence.
- obtaining additional points for activity during classes, including for the preparing presentations (discussing additional aspects of the issues, in particular the application of the discussed theory in other sciences or a reference to the location in the history of mathematics) and for comments on improving teaching materials
Passing threshold: at least 50% of points. The issues for the exam, on the basis of which the questions are prepared, will be sent to students with the use of university electronic systems.

Tutorials:

- continuous assessment - rewarding activity (additional points) manifested in the discussion and cooperation in solving practical tasks,
- continuous assessment - rewarding the increase in the ability to use the techniques learned,
- obtaining additional points for activity during classes, including for the preparing presentations (discussing additional aspects of the issues, in particular the application of the discussed theory in other sciences or a reference to the location in the history of mathematics) and for comments on improving teaching materials
- active participation in consultations deepening knowledge and directing further work.
The knowledge acquired in the exercises is verified on the basis of a project carried out independently by the student. The final assessment of the project may consist of both the merits of the project itself and its verbal defence. . Passing threshold: at least 50% of points.
The rules for completing the course and the exact thresholds for passing the course will be provided to students at the beginning of the semester with the use of university electronic systems.

Programme content

I. Lecture
Theoretical issues (definitions, lemmas, theorems, conclusions, properties) and relevant examples for the issues:
basic topological concepts necessary to understand functional analysis, metric spaces, Baire's theorem, normed spaces and Banach spaces, linear (continuous) operators and functionals, the norm of an operator and its properties, finite and infinite dimensional spaces. Selected fundamental theorems of functional analysis.

II. Tutorials.
The exercises relate to the theory presented in the lecture.

Course topics

I. Lecture
Theoretical issues (definitions, lemmas, theorems, corollaries, properties) and relevant examples for the issues:

Topological concepts fundamental to the understanding of functional analysis. Metric spaces. Convergence and balls in metric spaces. Cauchy sequence, complete metric spaces. Baire's theorem. Normed spaces and Banach spaces. Equivalent norms. Linear (continuous) operators and functionals. The norm of an operator and its properties. Weak convergence. Finite and infinite dimensional spaces. Banach's contraction principle and its applications. The open mapping theorem and the closed graph theorem. The sequences of continuous and linear operator – the Banach-Steinhaus theorem. The Hahn-Banach theorem. The separable spaces. Depending on time, selected topics on Schauder bases will be discussed.

II. Tutorials.

The following exercises are provided for your consideration. The following tasks are based on examples of normed and metric spaces, examples of spheres and convergence in these spaces, and examples of linear (continuous) functions. The following examples illustrate weakly convergent sequences. In accordance with the available time, selected facts from the theory of continuous l_p spaces will be discussed.

Teaching methods

I. Lectures

1. a lecture conducted on the blackboard in an interactive way with the formulation of questions to a group of students, the lecture supplemented by a computer presentation
2.the activity of students is taken into account (preparation of historical talks on mathematicians related to the presented material, papers on the use of algebra in engineering sciences, presenting evidence left to be done on their own) during classes when issuing the final grade,
3.initiating discussions during the lecture,
4. theory presented in connection with the current knowledge of students from previous lectures.

II. Tutorials

1. solving example tasks on the blackboard
2. detailed reviewing of the solutions to the tasks by the tutor and discussion of the comments.

Bibliography

Basic
1. R.E. Megginson, An Introduction to Banach Space Theory, Springer Verlag 1998.
2. J. Musielak, Wstęp do analizy funkcjonalnej, Warszawa PWN 1989.
3. S. Prus, A. Stachura, Analiza funkcjonalna w zadaniach, Warszawa PWN 2007.

Additional
1. M. Malec, Elementarny wstęp do współczesnej anlizy matematycznej, Wydawnictwa AGH, 1996.
2. N L Carothers, A Short Course on Banach Space Theory.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	55	2,00