Combinatorial Analysis - course description

General information

Course name	Combinatorial Analysis
Course ID	11.1-WK-MATD-AK-W-S14_pNadGenT0E38
Faculty	Faculty of Mathematics, Computer Science and Econometrics
Field of study	Mathematics
Education profile	academic
Level of studies	Second-cycle studies leading to MS degree
Beginning semester	winter term 2020/2021

Course information

Semester	2
ECTS credits to win	5
Course type	optional
Teaching language	polish
Author of syllabus	• dr Magdalena Łysakowska

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Credit with grade
Class	30	2	-	-	Credit with grade

Aim of the course

Introducing students to basic definitions, theorems and methods of combinatorial analysis and examples of applications of them.

Prerequisites

Completed courses of mathematical analysis, linear algebra and discrete mathematics.

Scope

Lecture

1. The binomial coefficients (2 h)
2. Rook polynomials (2 h)
3. Latin squares (2 h)
4. Van der Waerden's Theorem, Schur's Theorem (2 h)
5. Map-colourings, Four – Colour Theorem (3 h)
6. Minimax theorems (4 h)
7. Combinatorial designs (2 h)
8. Perfect codes, Hadamard's matrices (5 h)
9. Sperner's Lemma (3 h)
10. Minkowski's Theorem, Radon's Theorem, Helly's Theorem, Tverberg's Theorem (5 h)

Class

1. Proving combinatorial identities (2 h)
2. Applications of rook polynomials (3 h)
3. Making latin squares; proving properties of latin squares (3 h)
4. Applications of van der Waerden's and Schur's Theorems (2 h)

Test (2 h)

5. Applications of Four - Colour Theorem and minimax theorems (4 h)
6. Proving properties of combinatorial designs; applications of combinatorial designs (3 h)
7. Constructing of perfect codes (3 h)
8. Applications of Sperner's Lemma and basic theorems of combinatorial geometry (6 h)

Test (2 h)

Teaching methods

Traditional lecture, discussion exercises, work in groups.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form

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A student is able to perform proofs of basic combinatorial identities; to apply root polynomials to solve practical exercises; to use Hadamard's matrices and combinatorial designs to construct codes.	• K_U10	• a final test • activity during the classes • an exam - oral, descriptive, test and other	• Lecture • Class
A student is able to perform the proof of Fisher's Theorem, knows the definition and examples of finite projective planes, is able to point connections between combinatorial designs and projective planes.	• K_W04	• a final test • activity during the classes • an exam - oral, descriptive, test and other	• Lecture • Class
A student knows Sperner's Lemma, Schur's Theorem, van der Waerden's Theorem, Minkowski's Theorem, Radon's Theorem, Helly's Theorem, Tverberg's Theorem, knows proofs of this theorems and examples of their applications.	• K_W03 • K_W04	• a final test • activity during the classes • an exam - oral, descriptive, test and other	• Lecture • Class
A student knows König-Egarváry's, Menger's, Ford-Fulkerson's Theorems, Four – Colour Theorem and is able to apply them to solve practical exercises.	• K_W03	• a final test • activity during the classes • an exam - oral, descriptive, test and other	• Lecture • Class

Assignment conditions

1. Checking of preparedness of students and their activity during exercise
2. Colloquiums with tasks of different difficulty, allowing to evaluate whether the students have achieved specified learning outcomes in minimal level
3. Written exam

The grade of the module is the arithmetic mean of the exercise grade and the exam grade. The prerequisite of the exam is to get a positive assessment of the exercise. The condition to obtain a positive evaluation of the module is the positive evaluation of the exam.

Recommended reading

1. W. Lipski, W. Marek, Analiza kombinatoryczna, PWN, Warszawa,1986.
2. K. A. Rybnikow (red.), Analiza kombinatoryczna w zadaniach, PWN, Warszawa, 1988.
3. J. Matoušek, Lectures on Discrete Geometry, Springer, New York, 2002.

Further reading

1. Z. Palka, A. Ruciński, Wykłady z kombinatoryki, WNT, Warszawa, 1998.
2. R. L. Graham, D. E. Knuth, O. Patashnik, Matematyka konkretna, PWN, Warszawa, 2011.
3. V. Bryant, Aspekty kombinatoryki, WNT, Warszawa, 1997.

Notes

Modified by dr Alina Szelecka (last modification: 18-09-2020 13:46)