COURSE DESCRIPTION CARD - SYLLABUS

Course name
Discrete Mathematics [S1DSwB1>MD]

Course

Field of study
Data Science in Business

Year/Semester
1/2

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
0

Laboratory classes
0

Other
0

Tutorials
60

Projects/seminars
0

Number of credit points

5,00

Coordinators

dr Grzegorz Nowak
grzegorz.nowak@put.poznan.pl

dr inż. Marcin Nowak
marcin.nowak@put.poznan.pl

Lecturers

Prerequisites

Basic knowledge and skills in mathematical analysis.

Course objective

The aim of the course is to introduce students to the fundamental structures and methods of discrete mathematics, which are applicable in data analysis. Students will learn to formalize problems using set theory, mathematical logic, combinatorics, graph theory, and algebraic structures. Special emphasis will be placed on modeling relationships and data structures, analyzing graph algorithms, number theory in the context of cryptography, and the basics of computational complexity. The acquired knowledge will enable the practical application of discrete mathematics methods in data analysis, machine learning, and computational optimization.

Course-related learning outcomes

Knowledge:

1. Defines basic concepts of discrete mathematics, including propositional and predicate calculus, sets, recursion, and generating functions [DSB1_W01].
2. Characterizes basic combinatorial techniques, such as permutations, combinations, and the inclusion-exclusion principle, and describes their applications in data analysis [DSB1_W02].
3. Explains basic concepts and algorithms of graph theory and describes their applications in social network analysis and recommendation systems [DSB1_W03].

Skills:
1. Applies methods of propositional and predicate calculus, as well as proof techniques, in the analysis of logical and computational problems [DSB1_U02].
2. Solves combinatorial and recursive problems using generating functions and combinatorial numbers [DSB1_U05].
3. Applies graph algorithms, such as shortest path search or the Chinese postman problem, to data analysis and process optimization [DSB1_U03].
4. Uses the Chinese remainder theorem, the Euclidean algorithm, and other number theory methods in the context of cryptography and data security [DSB1_U09].
5. Analyzes the properties of algebraic structures, such as groups and rings, and their applications in data analysis [DSB1_U07].

Social competences:
1. Identifies opportunities for applying discrete mathematics in data analysis and business decision-making, highlighting its practical significance [DSB1_K01].
2. Utilizes discrete mathematics techniques in teamwork, integrating graph, combinatorial, and cryptographic methods in the analysis of real-world problems [DSB1_K02].
3. Applies algorithmic thinking and logical reasoning to solve analytical problems and formulate arguments in expert discussions [DSB1_K03].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Two midterm exams, each graded on a 50-point scale. The final grade is determined by the total score from both exams. The first exam takes place in the middle of the course, while the second one is held at the end. The passing threshold is 50 points in total from both exams.

Programme content

The course covers fundamental topics in discrete mathematics, with a particular focus on their applications in data analysis. It includes propositional and predicate calculus, proof methods, sets, and fundamental combinatorial techniques such as permutations, combinations, and the inclusion-exclusion principle. Students will become familiar with the concept of recurrence, generating functions, and selected combinatorial numbers, including Fibonacci, Catalan, and Stirling numbers.
The course also covers graph theory, including basic definitions, graph traversal algorithms, and their applications in social network analysis and recommendation systems. Classical graph problems such as the shortest path problem, the Chinese postman problem, and the traveling salesman problem will be discussed. Additionally, students will be introduced to number theory and its applications in cryptography, including the Chinese remainder theorem, the Euclidean algorithm, and the fundamentals of data security.
Furthermore, the course includes the theory of relations and algebraic structures such as semigroups, groups, and rings, with a focus on their applications in data analysis.

Course topics

Propositional and predicate calculus
Quantifier calculus
Methods of proving implications. The principle of mathematical induction
Sets and set operations
Permutations, combinations, variations
Inclusion-exclusion principle
Combinatorics in data analysis
The pigeonhole principle

Generating functions
Recurrence relations. Formulating and solving simple and linear recurrence equations
Complex recurrence relations. Fibonacci, Catalan, and Stirling numbers
Fundamental concepts of graph theory and networks (nodes, edges, paths, cycles)
Directed and undirected graphs
Trees and their applications in data analysis
Graph traversal algorithms (BFS, DFS)
Graphs in social network analysis and recommendation systems
Classical graph problems and algorithms: shortest paths, minimum spanning tree, Chinese postman problem, traveling salesman problem
Graphs as data models
Congruences and the Chinese remainder theorem
Prime numbers and their applications in data security
Euclidean algorithm and extended Euclidean algorithm
Cryptography in data analysis
Basic types of relations
Equivalence and order relations
Semigroups, groups, and rings in the context of data analysis
Computational complexity. Problem classes P, NP, NP-completeness
Heuristic and approximation algorithms
Applications of complexity theory in data analysis

Teaching methods

Written exercises. Analysis of teaching materials provided to students. Group work.

Bibliography

Basic:
Ross Kenneth A., Wright Charles R. B.: Matematyka dyskretna, PWN,Warszawa 2012.
Wojciech Kordecki, Anna Łyczkowska-Hanćkowiak: Matematyka dyskretna dla informatyków, Helion 2018.

Additional:
White, R. T., & Ray, A. T. (2022). Matematyka dyskretna dla praktyków: algorytmy i uczenie maszynowe w Pythonie (F. Kamiński, Tłum.). Wydawnictwo Naukowe PWN.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	65	2,50