University of Gdańsk

Subject card

Subject name and code	Discrete Mathematics, PG_00204152						
Field of study	Informatics						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2026/2027			
Education level	Bachelor's studies		Subject group	Obligatory subject group in the field of study			
Mode of study	full-time studies		Mode of delivery	at the university			
Year of study	1		Language of instruction	Polish			
Semester of study	1		ECTS credits	6.0			
Learning profile	practical		Assessment form	exam			
Conducting unit	Division of Combinatorial Optimisation -> Institute of Informatics -> Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Paweł Żyliński				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study	SUM	
	Number of study hours	60		0.0	90.0	150	
Subject objectives	Familiarization with the issues of discrete mathematics, which is the basis of computer science. Developing students' skills in abstract understanding of problems and general mathematical culture. Familiarizing students with English nomenclature.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[INFPL3_U01] can apply mathematical knowledge to formulate, analyse and solve tasks related to computer science, design and analyze algorithms in terms of their correctness and computational complexity	can determine the relevant order-theoretic properties of the given partially ordered set. can determine whether a given relation is an equivalence relation and identify the equivalence class of an element; is able to convert notation between various counting systems, is able to perform operations in various counting systems; can calculate the number of permutations, combinations, the value of Newton's binomial; can apply formulas for the numbers of disordered and ordered partitions, also for Stirling numbers of the second kind and Bell numbers; can apply algorithms generating basic combinatorial objects; knows how to apply the inclusion-exclusion principle and Dirichlet's box principle; is able to examine the independence of random events/ variables, is able to apply Chebyshev's theorem for calculating the Bernoulli distribution; can prove basic properties of random variables, e.g. properties of the expected value; can estimate the complexity of various recursive algorithms, e.g. merge sort; can solve recursive equations (e.g, by the characteristic equation method) and inequalities; knows how to use the algorithm for finding a path/Euler cycle, the shortest path in a graph, searching a tree/graph, building a binary search tree; can construct a binary expression tree as well as compute the expression/value of a binary expression tree; can prove basic properties of graphs, e.g. the handshaking lemma; can apply Hall's marriage theorem;	[SU4] test/exam - oral or written [SU5] implementation of a problem task

Course outcome	Subject outcome	Method of verification
[INFPL3_W01] knows and understands advanced mathematical concepts including the basics of algebra, discrete mathematics (elements of logic and set theory, combinatorics and graph theory), probabilistic methods and applies this knowledge to modeling IT problems, designing algorithms, analyzing data and solving computational problems	knows the concept of a set and constructions on sets, knows the concept of a binary relation; knows the concept of an equivalence relation, understands the basic properties of relations; knows the concept of a partial order, understands the relevant order-theoretic characteristics of the given poset; knows the concept of the counting system, knows the binary system, including Gray coding, hexadecimal system, knows the representation of integers and real numbers in the computer; knows the numbers of permutations, combinations, with and without repetitions, Newton's binomial, as well as the idea of Stirling numbers of the second kind and Bell numbers; knows the inclusion-exclusion principle and Dirichlet box principle; knows the basics of probability theory, in particular the concepts of a complete system of events, independent events, a random variable, as well as the Bernoulli distribution and the concepts of expected value and variance of a random variable; knows Markov and Chebyshev's inequalities; knows the concept of recursion, inductive proofs, recursive algorithms, knows the theorems about the complexity of such algorithms; knows the concept of a graph, distinguishes directed and undirected graphs and their selected subclasses, knows their basic properties, knows the concepts of a path, a cycle, Euler and Hamilton cycles, a matching, and knows basic graph algorithms; knows the concepts of tree, binary tree and binary search tree, and also knows selected algorithms related to binary trees and their applications, including binary expression trees;	[SW4] test/exam - oral or written
[INFPL3_K02] is ready to recognize the importance of knowledge in solving cognitive problems and practical and seeking opinions experts in case of difficulties with independent problem solving	can precisely formulate questions to deepen one's understanding of a given topic or find missing elements of reasoning	[SK5] implementation of a problem task

Subject contents	1. Arithmetic: counting systems, representation of numbers in a computer. 2. Relations: partial order, equivalence relations, abstraction classes of equivalence relations, Hasse diagram. 3. Combinatorics: sequences, functions, permutations, Newton's binominal, Dirichlet's box principle, generating combinatorial objects. 4. Probability calculus: independnce of events, Bernoulli scheme, random variables, expected values, averages, variances, Markov and Chebyshev's inequalities. 5. Mathematical induction, recursion, Fibonacci sequence formula, divide and conquer principle (merge sort), recursive data types, algorithms on such types (binary trees, Polish and reverse Polish notation). 6. Elements of graph theory: directed and undirected graphs, Euler and Hamilton paths and cycles, bipartite graphs and Hall's theorem, spanning trees, graph coloring, graph algorithms, finding the shortest path.
Prerequisites and co-requisites	

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
exam (x1)	51.0%	25.0%
activity in classes	51.0%	5.0%
test (x2)	51.0%	70.0%

Recommended reading	Basic literature	1. Andrzej Szepietowski, *Matematyka dyskretna*, Wydawnictwo UG, 2005
	Supplementary literature	1. H. Furmańczyk, K. Horodecki, P. Żyliński Matematyka dyskretna dla studentów kierunku informatyka, wyd. Uniwersytetu Gdańskiego, 2010 2. M. Murat, I. Gorgol, Matematyka dyskretna w zadaniach, PWN, 2024 3. R. L. Graham, D. E. Knuth, O. Patashnik, Matematyka konkretna, PWN, 1998 4. K. Ross, Ch. Wrigth, Matematyka dyskretna, PWN, 2000
	eResources addresses	

Example issues/ example questions/ tasks being completed	1. The graph in Figure X is the Hasse diagram of a partial order relation on the set of numbers A={1,2,3,4,5,6,7,8,9,10}. Complete the table below. If no such element(s) exist, enter #. a) Maximal elements of A: ... b) Minimal elements of A: ... c) Greatest lower bound of the set {7,8,9}: ... d) Lower bounds of the set {1,4}: ... e) Least upper bound of the set {8,9}: ... f) What is the width of the relation?: ... 2. Decompose the permutation P = (14,2,7,3,4,1,10,8,13,9,11,12,5,6) into transpositions. 3. Determine the number of permutations P = (_,_,_,_,_,_) that satisfy the condition P^2= Id. 4. Provide the definition of graph isomorphism. 5. Indicate the two smallest (in terms of the number of vertices) trees with the same degree sequences, which are not isomorphic. 6. Give the definitions: bipartite graph, forest and Hamilton cycle. 7. Draw, in the form of a Venn diagram, the relationships between two classes of graphs (along with exemplary representatives): wheels and regular graphs. 8. What can you say about the sum alpha(G) + omega(G) for a given graph G in the context of its number of vertices? Justify this property. 9. Formulate Bayes' Theorem in its multiple-event version. 10. Prove that for any random variable *X* the following holds: Var[*c*·*X*]=*c*^2·Var[*X*], where *c* is a constant.
Work placement	Not applicable

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