

## Subject card

|                                             |                                                                                                                                                                                                                                                        |                                                          |                                         |                                     |                                                |            |     |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------|-------------------------------------|------------------------------------------------|------------|-----|
| Subject name and code                       | Discrete mathematics, PG_00143985                                                                                                                                                                                                                      |                                                          |                                         |                                     |                                                |            |     |
| Field of study                              | Informatics                                                                                                                                                                                                                                            |                                                          |                                         |                                     |                                                |            |     |
| Date of commencement of studies             | October 2025                                                                                                                                                                                                                                           |                                                          | Academic year of realisation of subject |                                     | 2025/2026                                      |            |     |
| 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                         |                                     |                                                |            |     |
| 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                                                                 |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
|                   | [INFL3_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 | <p>is able to convert notation between various counting systems, is able to perform operations in various counting systems;</p> <p>can calculate the number of permutations, combinations, the value of Newton's binomial;</p> <p>can apply formulas for the numbers of disordered and ordered partitions, also for Stirling numbers of the second kind and Bell numbers;</p> <p>can apply algorithms generating basic combinatorial objects;</p> <p>knows how to apply the inclusion-exclusion principle and Dirichlet's box principle;</p> <p>is able to examine the independence of random events/variables, is able to apply Chebyshev's theorem for calculating the Bernoulli distribution;</p> <p>can prove basic properties of random variables, e.g. properties of the expected value;</p> <p>can estimate the complexity of various recursive algorithms, e.g. merge sort;</p> <p>can solve recursive equations (e.g. by the characteristic equation method) and inequalities;</p> <p>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;</p> <p>can construct a binary expression tree as well as compute the expression/value of a binary expression tree;</p> <p>can prove basic properties of graphs, e.g. the handshaking lemma;</p> <p>can apply Hall's marriage theorem;</p> | <p>[SU4] test/exam - oral or written</p> <p>[SU5] implementation of a problem task</p> |

|                                 | Course outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Subject outcome                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Method of verification                 |
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|                                 | [INFL3_W01] has knowledge in mathematics covering the basics of algebra, discrete mathematics (elements of logic and set theory, combinatorics and graph theory), probabilistic methods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>knows the concept of a set and constructions on sets, knows the concept of a binary relation;</p> <p>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;</p> <p>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;</p> <p>knows the inclusion-exclusion principle and Dirichlet box principle;</p> <p>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;</p> <p>knows the concept of recursion, inductive proofs, recursive algorithms, knows the theorems about the complexity of such algorithms;</p> <p>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;</p> <p>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;</p> | [SW4] test/exam - oral or written      |
|                                 | [INFL3_K02] can precisely formulate questions to deepen his/her own understanding of a given topic or to find missing elements of reasoning                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 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                | <p>1. Arithmetic: counting systems, representation of numbers in a computer.</p> <p>2. Combinatorics: sequences, functions, permutations, Newton's binomial, Dirichlet's box principle, generating combinatorial objects.</p> <p>3. Probability calculus: independence of events, Bernoulli scheme, random variables, expected values, averages, variances, Markov and Chebyshev's inequalities.</p> <p>4. 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).</p> <p>5. 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.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                        |
| Prerequisites and co-requisites | no requirements                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                        |

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| Assessment methods and criteria                                | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Passing threshold                                                                                                                                                                                                                                                                                                                                                                                    | Percentage of the final grade |
|                                                                | exam (x1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 51.0%                                                                                                                                                                                                                                                                                                                                                                                                | 25.0%                         |
|                                                                | activity in classes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0.0%                                                                                                                                                                                                                                                                                                                                                                                                 | 5.0%                          |
|                                                                | test (x2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 51.0%                                                                                                                                                                                                                                                                                                                                                                                                | 70.0%                         |
| Recommended reading                                            | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1. Andrzej Szepietowski, <i>Matematyka dyskretna</i> , Wydawnictwo UG, 2005                                                                                                                                                                                                                                                                                                                          |                               |
|                                                                | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1. H. Furmańczyk, K. Horodecki, P. Żyliński <i>Matematyka dyskretna dla studentów kierunku informatyka</i> , wyd. Uniwersytetu Gdańskiego, 2010<br><br>2. M. Murat, I. Gorgol, <i>Matematyka dyskretna w zadaniach</i> , PWN, 2024<br><br>3. R. L. Graham, D. E. Knuth, O. Patashnik, <i>Matematyka konkretna</i> , PWN, 1998<br><br>4. K. Ross, Ch. Wrigth, <i>Matematyka dyskretna</i> , PWN, 2000 |                               |
|                                                                | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                      |                               |
| Example issues/<br>example questions/<br>tasks being completed | 1. Decompose the permutation $P = (14,2,7,3,4,1,10,8,13,9,11,12,5,6)$ into transpositions.<br><br>2. Determine the number of permutations $P = (\_,\_,\_,\_,\_,\_) $ that satisfy the condition $P^2= Id$ .<br><br>3. Provide the definition of graph isomorphism.<br><br>4. Indicate the two smallest (in terms of the number of vertices) trees with the same degree sequences, which are not isomorphic.<br><br>5. Give the definitions: bipartite graph, forest and Hamilton cycle.<br><br>6. Draw, in the form of a Venn diagram, the relationships between two classes of graphs (along with exemplary representatives): wheels and regular graphs.<br><br>7. 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.<br><br>8. Formulate Bayes' Theorem in its multiple-event version.<br><br>9. Prove that for any random variable $X$ the following holds: $Var[c \cdot X]=c^2 \cdot Var[X]$ , where $c$ is a constant. |                                                                                                                                                                                                                                                                                                                                                                                                      |                               |
| Work placement                                                 | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                      |                               |

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