COURSE DESCRIPTION CARD - SYLLABUS

Course name
Discrete mathematics [S1Cybez1>MATD]

Course

Field of study
Cybersecurity

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
30

Laboratory classes
0

Other
0

Tutorials
30

Projects/seminars
0

Number of credit points

5,00

Coordinators

dr Lidia Typańska-Czajka
lidia.typanska-czajka@put.poznan.pl

Lecturers

Prerequisites

Students starting this course should have a basic knowledge of mathematics and computer science adequate to admission requirements. In addition, in the field of social competence, the student must present such attitudes as: honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

Course objective

The course presents fundamentals - basic ideas and methods - of discrete mathematics, particularly from the field of logic, set theory, graph theory, transversal theory and combinatorics. Its general objective is to develop the students' capabilities for expressing ideas appearing in the field of computing in terms of functions and relations, applying logic principles, various proving techniques, recursion and approaches known from graph theory for solving problems related to computer science. Moreover, the course develops the students' ability of logical reasoning and expressing their concepts and ideas in an understandable way.

Course-related learning outcomes

Knowledge:
1 The student has the knowledge of discrete mathematics necessary to formulate and solve complex

cyber security problems using the concepts of formal logic and multiplicity theory. He knows the basic laws of logic and multiplicity theory, as well as the properties of relations and functions that allow him to perceive and analyze the essential relationships present in the IT problems being solved. [K1_W001]
2. has the knowledge necessary to formulate complex tasks in the terms of graph theory and to solve these tasks using the methods of this theory. [K1_W001]
3. Has the knowledge necessary to formally describe cybersecurity problems using combinatorial objects, and recognizes the relationship between the number of these objects and the number of potential solutions to problems. He knows the counting techniques for determining the number of objects and is aware of their relationship to estimating the time consumption of algorithms. [K1_W005]
4. Knows and understands the principle of mathematical induction and can use inductive reasoning and recursion to formally describe and solve real-world problems. [K1_W001]
5. Knows the basic principles of estimating the growth rate of functions necessary to determine the computational complexity of algorithms [K1_W004]
6. Has an extended and in-depth knowledge of linear algebra, mathematical analysis, discrete mathematics, probability and statistics necessary to describe and analyze the operation of elements and systems appropriate to the field of study. [K1_W001]

Skills:
1 The student is able to use discrete mathematics concepts to formally describe cybersecurity engineering tasks. [K1_U05]
2. The student is able to apply methods based on logic, multiplicity theory, and graph theory to formulate and solve engineering tasks related to cybersecurity.[K1_U05]
3. The student is able to plan and carry out computer simulations and measurements, including simulations and measurements related to the operation of ICT systems, is able to present the obtained results in numerical and graphical form, interpret them and draw appropriate conclusions.[K1_U04]
4. The student is able to apply methods for estimating the rate of growth of function values and appropriate notations for determining the computational complexity of algorithms.[K1_U05]
5. When formulating and solving engineering tasks in the field of cyber security, he is able to use known mathematical models and algorithms, as well as simulation, experimental and analytical methods. [K1_U05]

Social competences:
1. Is able to express herself/himself precisely and logically in terms of discrete mathematics.[K1_K02]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes gained during lectures are verified based on the results of 90-minute written exam in form of multiple-choice test. The test contains close-ended questions related to the programme content presented by particular lecturers and it is evaluated separately. Positive grade is obtained by acquiring at least 50% of the maximum number of points. Thresholds for particular grades are increased with 10%. Using auxiliary materials during the exam is not allowed.
Learning outcomes gained during tutorials are verified based on the results of two written tests consisting of a few open-ended questions (exercises). The final grade is determined based on the number of points gained during both tests. Positive grade is obtained by acquiring at least 50% of the maximum number of points. Using auxiliary materials during the tests is not allowed.
The course completion rules and the exact passing thresholds will be communicated to students at the beginning of the semester through the university’s electronic systems and during the first class meeting (in each form of classes).

Programme content

Basic ideas and methods of discrete mathematics important for solving problems arising in computing science, particularly selected topics of: logic and set theory, relations and functions, asymptotic notations, mathematical induction, properties of integers, recursion, special numbers, combinatorics

Course topics

Lectures cover the following topics:
1. Fundamentals of logic and set theory.

2. Relations and functions. Asymptotic notation.
3. Combinatorics: principles of counting, generating combinatorial objects, the rules of sum and product, variations with/without repetitions, permutations with/without repetitions, combinations with/without repetitions, set partition, binomial coefficient, multinomial coefficient.
4. Mathematical induction: the well-ordering principle, the first and second principle of mathematical induction.
5. Recursion: recurrence definitions, relations, problems and algorithms, mathematical induction for recursively defined sets.
6. Special numbers: Stirling numbers of the first and second kind, Bell numbers, Eulerian numbers of the first and second kind, harmonic numbers, Fibonacci numbers, Marsenne numbers.
7. Introduction to graph theory: directed and undirected graphs, paths, walks, cycles, Eulerian and Hamiltonian graphs, graph colouring, trees, etc.
8. Properties of integers: primes, divisibility rules, etc.
9. Fundamentals of transversal theory: Hall's theorem, tournaments, minimax theorems.
10. Advanced principles of counting: inclusion and exclusion principle, Dirichlet's principle - the pigeonhole principle.
11. Generating functions.
12. Latin squares: Latin square design, orthogonal Latin squares.
13. Rook polynomials: decomposition.
14. Graph theory II.
Tutorials, synchronised with the content of the lectures, illustrate issues presented during these lectures with exercises.

Teaching methods

1. Lectures: multimedia presentations of programme contents with numerous examples.
2. Tutorials illustrating programme contents presented during lectures with exercises solved by teachers using a blackboard or by students eager to present their ideas. Discussions in a student group on the ideas proposed by particular students.

Bibliography

Basic:
1. Aspekty kombinatoryki, V. Bryant, WNT, Warszawa, 2007.
2. Discrete and combinatorial mathematics. An applied introduction, R.P. Grimaldi, Addison Wesley Publishing Company, New York, 1999.
3. Matematyka dyskretna, K.A. Ross, Ch.R.B. Wright, PWN, Warszawa, 2012.
4. Matematyka konkretna, R.L. Graham, D.E. Knuth, O. Patashnik, PWN, Warszawa, 2012.

Additional:
1. Kombinatoryka dla programistów, W. Lipski, WNT, Warszawa, 2007.
2. Matematyka, t. I, G. Decewicz, W. Żakowski, WNT, Warszawa, 2005.
3. Wprowadzenie do algorytmów, CT.H. Cormen, Ch.E. Leiserson, R.L. Rivest, PWN, Warszawa, 2012.

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