SYLLABUS

Name: ***Discrete Mathematics and Mathematical Logic (InfAAu>SI3DMaML19)***
Name in Polish:
Name in English: ***Discrete Mathematics and Mathematical Logic***

Information on course:

Course offered by department: Faculty of Automatic Control, Electronics and Computer Science
Course for department: Silesian University of Technology

Default type of course examination report:

EGZ

Language:

English

Course homepage:

https://platforma2.polsl.pl/rau2/course/view.php?id=910

Short description:

The aim of education is to efficiently use the methods and concepts of discrete mathematics and mathematical logic, the ability to formulate problems and their description in the language of mathematics and the interpretation of obtained results. The aim of education is also to present the connections between the branches of discrete mathematics and computer science.

Description:

ECTS: 4
Total workload: 100 h (60 contact hours / 40 students' own work hours)
Forms of contact hours:
Lecture: 30 h
Table classes: 15 h
Laboratories: 15 h
Students' own work: 40 h (preparation for table classes and laboratories, preparation for passing the theoretical and practical part of the exam, writing both parts of exam)

Lectures:
1. An introduction to set theory (sets, algebra of sets, Venn-Euler diagrams, Bool algebra, family of sets, cartesian product, n-tuples).
2. Relations (basic definitions and properties, binary relations, equivalence reaction, closures of relations, order relation, alphabetic order, lexicographic order, image and inverse image of a set).
3. Propositional logic (PL) (syntax, semantics, tautology, axiomatics, formal systems – proof systems – assumption, semantic tables, resolution, SAT problems, apagogical proofs).
4. Predicate calculus (PC) (syntax, semantics, satisfaction and truth of formulas, axiomatics, formal systems, formal proofs, proof automatization, decidability).
5. Automated reasoning (clauses, Horn clauses, normal forms (CNF, DNF), Davies-Putnam algorithm, resolution, bottom-up reasoning, top-down reasoning).
6. Rough Sets (basic notions and definitions, decision logic, attribute reduction, reducts, algorithms for attribute reduction, algorithms for decision rule induction, rough sets in concept description, decision algorithm).
7. Foundations of rule based expert systems.
8. An Introduction to inductive reasoning.
9. Mathematical induction (natural numbers, principles of mathematical induction, weak and strong induction the application in proving the theorems).
10. Counting (equinumerosity of sets, the sum and product laws, simple counting schemes, decomposition of permutations into cycles, Newton's binomial coefficients, counting of integral functions, ordered arrangements, the principle of inclusion and exclusion, Sterling and Bell numbers, partitioning a set into subsets of specific cardinalities, Dirichlet's pigeonhole principle, combinations with repetitions)
11. Recurrence (recursive definitions, general recurrence, recurrence relations, solving homogeneous linear recurrence relations with constant coefficients, generating functions – definition and properties, solving recurrence relations with generating functions).
12. Boolean reasoning in biclustering (the notion of bicluster, more than two dimensions generalization, a sample examples of binary data pattern search, based on weak and strong theorems, extrapolation to continuous data analysis)

Table classes:
Table classes are devoted to consolidate and illustrate (exercise and problem solving) the material presented during the lecture.

Laboratories:
1. Programming in logic – PROLOG programming language, implementation of exemplary and illustrative programs, combining programs written in PROLOG with object-oriented software.
2. Rough Sets – RRoughSet library – properties, methods, applications, data analysis with the use of RRoughSet library.
3. Expert Systems – an illustrative example, example of implementation in Python.
4. Practical applications of formula satisfiability checking algorithms in solving problems

Bibliography:

1. Ross K. A., Wright C.R.B.: Discrete Mathematics. Pearson 2003 (5th edition)
2. Mattson H.F.: Discrete Mathematics with Applications, John Wiley & Sons.
3. Ben-Ari M.: Mathematical Logic for Computer Science. Springer 2012.
4. Pawlak Z.: Rough Sets: Theoretical Aspects of Reasoning about Data, Kluwer Academic Publishers.
5. Knuth D. Graham R.L.: Concrete Mathematics. Addison-Wesley Professional; 2nd edition 1994.
6. Kowalski R. Logic for problem solving, Revisited. Books On Demand 2014.
7. Clocksion W.F., Mellish C.S.: Programming in Prolog. 5th Edition. Springer 2005
8. Sikora M., Sikora B.: Elements of theory of sets, logic and rough set theory, Silesian University Press, 2018 (in Polish)

Learning outcomes:

Course-specific learning outcomes: at the completion of the course, student:
- has knowledge of the basics of set theory, relational algebra, logic, and predicate calculus (written test – theoretical part, written test – practical part) K1A_W02;

- has knowledge and practical experience in logic programming (Prolog) (laboratories) K1A_W09
- is able to use publicly available documentation and literature related to the use of analytical environments used in the laboratory (laboratories) K1A_U06
- is able to correctly count combinatorial objects in finite spaces (written test – theoretical part, written test – practical part) K1A_U08
- is able to design a simple expert system (based on a skeleton system) to solve simple diagnostic and recommendation problems (laboratories) K1A_K02

Assessment methods and assessment criteria:

The course is passed on the basis of:
1. Written test - multiple true/false choice questions (theoretical part - lecture).
2. Written test - multiple true/false choice questions (practical part – table classes)
3. Laboratory reports (practical part - laboratory).

The theoretical exam is worth up to 50 points. The practical exam is worth up to 30 points. Laboratories are worth up to 20 points. The range of points [0; 100] implies the final grade as follows:
- [0; 50) - 2.0
- [50; 60) - 3.0
- [60; 70) - 3.5
- [70; 80) - 4.0
- [80; 90) - 4.5
- [90; 100] - 5.0.

However, a necessary condition for obtaining a pass is obtaining at least 25 points in the theoretical part, at least 15 points in the practical part and a product of points from laboratory reports greater than zero.

The syllabus is valid from academic year 2024/25 and its content cannot be changed during the semester.

Element of course groups in various terms:

Course group description	First term	Last term
Informatics S1 semester 3 common subjects (InfAAu>SI3-19-WSP)	2020/2021-Z	

Course credits in various terms:

<without a specific program>

Type of credits	Number	First term	Last term
European Credit Transfer System (ECTS)	4	2020/2021-Z	