Syllabus
Course Program

Algorithms and data structures

Specialty
122 – Computer Science

Institute
Institute of Computer Science and Information Technology

Educational program
Computer Science and Intelligent Systems

Department
Software Engineering and Management Intelligent Technologies (321)

Level of education
Bachelor's level

Course type
Special (professional), Mandatory

Semester
2

Language of instruction
English, Ukrainian

Lecturers and course developers

Andrii Kopp

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Doctor of Philosophy (Ph.D.), Associate Professor, Associate Professor of Software Engineering and Management Intelligent Technologies Department

Google Scholar: https://scholar.google.com/citations?user=B8fggLEAAAAJ
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Scopus: https://www2.scopus.com/authid/detail.uri?authorId=57202887287
Web of Science: https://www.webofscience.com/wos/author/record/T-4283-2018).
More about the lecturer on the department's website

Kateryna Yahup

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Doctor of Technical Sciences, Professor, published more than 90 scientific papers, basic courses " Software Architecture Basics", "Discrete Mathematics".

More about the lecturer on the department's website

General information

Summary

The course “Algorithms and Data Structures” is a course in the cycle of professional compulsory training of the specialty 122 “Computer Science”. It is taught in the second semester in the amount of 120 hours (4 ECTS credits), in particular: lectures – 28 hours, laboratory classes – 28 hours, self-study work – 64 hours. The course includes two modules and two modular tests. The study of the discipline ends with the test.

Course objectives and goals

This course objective is formation of students' knowledge of basic data structures and algorithms as well as the acquisition of practical skills in the analysis of algorithms.

Format of classes

Lectures, laboratory classes, self-study work (and individual calculation work). Final assessment – test.

Competencies

GC1. Ability to think abstractly, analyze and synthesize.
GC2. Ability to apply knowledge in practical situations.
GC3. Knowledge and understanding of the subject area and understanding of professional activities.
GC6. Ability to learn and master modern knowledge.
GC7. Ability to search, process and analyze information from various sources.
PC3. Ability to think logically, build logical conclusions, use formal languages and models of algorithmic computing, design, develop and analyze algorithms, evaluate their effectiveness and complexity, solvability and intractability of algorithmic problems for adequate modeling of subject areas and creation of software and information systems.
PC8. Ability to design and develop software using various programming paradigms: generalized, object-oriented, functional, logical, with appropriate models, methods and algorithms of computation, data structures and control mechanisms.

Learning outcomes

PLO1. To apply knowledge of the basic forms and laws of abstract and logical thinking, the basics of the methodology of scientific knowledge, forms and methods of extracting, analyzing, processing and synthesizing information in the subject area of computer science.
PLO5. Design, develop and analyze algorithms for solving computational and logical problems, evaluate the effectiveness and complexity of algorithms based on the use of formal models of algorithms and computable functions.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 28 hours, laboratory classes - 28 hours, self-study - 64 hours.

Course prerequisites

Higher mathematics
Algorithmization and programming
Fundamentals of computer science and artificial intelligence methods

Features of the course, teaching and learning methods, and technologies

Teaching and learning methods:
interactive lectures with presentations, discussions, laboratory classes, teamwork, case method, student feedback, problem-based learning.
Forms of assessment:
written individual assignments for laboratory work (CAS), assessment of knowledge in laboratory classes (CAS), express surveys (CAS), online tests (CAS), final/semester control in the form of a semester exam, according to the schedule of the educational process (FAS).

Program of the course

Topics of the lectures

Topic 1. Introduction to data structures and algorithms
Topic 2. Basic data structures
Topic 3. Sorting, merging, and search
Topic 4. Combinatorial algorithms
Topic 5. Fundamental graph algorithms
Topic 6. Geometrical algorithms
Topic 7. Cryptographic algorithms

Topic 8. Approximation algorithms
Topic 9. Mathematical foundations of algorithm analysis
Topic 10. Recursion
Topic 11. Algorithmic strategies
Topic 12. Basics of computability theory
Topic 13. Classes P and NP

Topics of the workshops

Workshops are not provided within the discipline.

Topics of the laboratory classes

Topic 1. Basic data structures (list, queue, stack)
Topic 2. Basic data structures. Hash tables
Topic 3. Basic data structures. Red-black trees
Topic 4. Sorting algorithms
Topic 5. Combinatorial algorithms
Topic 6. Fundamental algorithms on graphs and trees
Topic 7. Geometrical algorithms
Topic 8. Dynamic programming
Topic 9. Greedy algorithms

Self-study

The individual calculation work is provided in the curriculum.
Students are recommended with additional materials (videos, articles) for self-study and processing.

Course materials and recommended reading

Key literature

1. Marcello La Rocca. (2021) Advanced Algorithms and Data Structures. New York: Manning Publications Co.
2. Krenevich A.P. (2021) Algorithms and data structures. Textbook. Kyiv: VOC "Kyiv University".
3. Helmut Knebl. Algorithms and Data Structures: Foundations and Probabilistic Methods for Design and Analysis (2020) Cham: Springer Nature Switzerland AG
4. Stratienko, N.K., Godlevsky, M.D., Borodina, I.O. (2017) Algorithms and data structures: workshop: Kharkiv: NTU "KhPI"
5. Stratienko, N. K., Borodina I. O. (2017) Methodical instructions for performing laboratory work from the course "Algorithms and data structures": for students who teach. for special 121 "Software Engineering" Kharkiv Polytechnic Institute, National technical Univ. Electron. text data. Kharkiv

Additional literature

6. Donald Knuth. (2020) The Art of Computer Programming, Volume 4, Fascicle 5: Mathematical Preliminaries Redux; Introduction to Backtracking. Boston: Pearson Education (US).
7. Florian Jaton, Geoffrey C. Bowker. (2021) The Constitution of Algorithms: Ground-Truthing, Programming, Formulating. MIT Press Ltd, United States.
8. Shmuel Tommy Klein. (2021) Basic Concepts In Algorithms. / Shmuel Tomi Klein. – Singapore: World Scientific Publishing Co Pte Ltd.
9. Hemant Jain.(2019) Problem Solving in Data Structures & Algorithms Using Python. /Hemant Jain. – Independently Published.
10. Hemant Jain (2018) Problem Solving in Data Structures & Algorithms Using C. Independently Published.
11. Steven S. (2020) Skiena. The Algorithm Design Manual. 3rd ed. Cham: Springer Nature Switzerland AG.
12. Meleshko E.V., Yakymenko M.S., Polishchuk L.I. (2019) Algorithms and Data Structures: A Study Guide for Full-time and Part-time Technical Students. Kropyvnytskyi: Publisher – V.F. Lysenko.

13. Ilman V.M., Ivanov, O.P., Panik. L.O. (2019) Algorithms, data and structures. Dnipropetrovsk National Railway University. transp.im. Acad. V. Lazaryan. Dnipro
14. Priyma S.M. (2018) Theory of Algorithms: A Study Guide. Melitopol: FOP Odnorog T.V.
15. Borodkina I.L. (2018) Theory of Algorithms: A Guide for Graduate Students. Center for Educational Literature (TsUL).
16. Allen Downey., (2017) Think Data Structures O'Reilly Media, Inc, USA.
17. Marcin Jamro. (2018) C# Data Structures and Algorithms: Explore the possibilities of C# for developing a variety of efficient applications Birmingham: Packt Publishing Limited.
18. Stratienko, N.K., Shmatko O.V., Borodina O. (2016) Methodical instructions for course work on the course "Algorithms and data structures": for students who are studying in direction 6.050103 "Software engineering" special. 05010301 "System software".; Kharkiv Polytechnic Institute, National technical Univ. Electron. text data. Kharkiv. Retrieved from: http://repository.kpi.kharkov.ua/handle/KhPI-Press/24697.
19. Stratiienko N. K. Borodina I. O. (2016) Guidance for course work on "Algorithms and Data Structures" : for students of direction 6.050103 "Software Engineering", specialty .05010302 "Software Engineering" data" : for students who in direction 6.050103 "Software engineering" special. 05010302 "Software engineering" [Electronic resource] / comp. ; National Technical University "Kharkiv Polytechnic Institute". Kharkiv, Access mode: Retrieved from: http://repository.kpi.kharkov.ua/handle/KhPI-Press/24695.

Assessment and grading

Criteria for assessment of student performance, and the final score structure

100% Final assessment as a result of Final test (30%) and Continuous assessment (70%).
30% Final test
70% Continuous assessment:
- Laboratory classes (18%)
- Calculation work (22%)
- Two module tests (30%)

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.
Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Approval

Approved by 08.06.2023 Head of the department
Ihor HAMAIUN

08.06.2023 Guarantor of the educational program
Andrii KOPP