SYLLABUS
Fall semester 2024-2025 academic year
Educational program "7M06116 – Computer science and technology "

ID and name of course	**Independent work of the master student (IWMS)**	**Number of credits**			**General number of credits**	**Independent work of the master student under the guidance of a teacher (IWMST)**
		Lectures (L)	**Practical classes (PC)**	**Lab. classes (LC)**		
103543 , Algorithms	2	1.70	3.30	0	5	6

ACADEMIC INFORMATION ABOUT DISCIPLINE				
Training format	**Cycle, component**	**Lecture types**	**Types of practical classes**	**Form and platform final control**
Offline	B, EC	Introductory , explanatory, concluding	Practical classes	Standard oral, offline
Lecturer - (s)	Jair Rodrigo Louis Wuilloud			
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Assistant - (s)				
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ACADEMIC COURSE PRESENTATION		
Purpose of the course	**Expected learning outcomes (LO)** As a result of studying the discipline the undergraduate will be able to:	**Indicators of LO achievement (ID)**
Develop the ability to understand, design, analyze, and implement advanced algorithms, while applying these concepts to solve complex real-world problems efficiently.	1. Formulate and apply fundamental algorithmic techniques	1.1 Explain core algorithmic concepts such as divide and conquer, dynamic programming, and greedy strategies.
		1.2 Analyze time and space complexity of implemented algorithms for efficiency.
	2. Analyze the Complexity of Computational Problems	2.1 Explains concepts of NP-completeness and computational intractability, identifying problems that are computationally hard.
		2.2 Classifies problems as solvable, intractable, or approximable using theoretical computational models.
	3. Design and Implement Advanced Graph Algorithms	3.1 Design and implements graph algorithms, including minimum spanning trees, shortest paths, and network flow.
		3.2 Analyzes the computational complexity of graph-based algorithms in various applications.
	4. Implement and Evaluate Algorithmic Solutions Using Advanced Data Structures	4.1 Applies advanced data structures (e.g., heaps, trees, graphs) to improve algorithmic efficiency.
		4.2 Implements data structures in practical applications, using them to optimize problem-solving.
	5. Solve Real-World Problems Using Algorithm Design Techniques	5.1 Designs algorithms tailored to real-world problems, utilizing backtracking, branch-and-bound, and approximation methods.
		5.2 Applies graph algorithms to solve complex problems.
Prerequisites	Algorithms and Data Structures[21126]	
Post-requisites	Advanced Operating Systems[103529], Advanced Design and Analysis of Algorithms[102329]	
Learning Resources	**Literature:** about the main one. 1. Dasgupta, Sanjoy. Algorithms Illuminated (Part 4): Algorithms for NP-Hard Problems.	

	Soundlikeyourself Publishing, 2023. 275 pp. 2. Skiena, Steven S. The Algorithm Design Manual. 3rd ed. Springer, 2020. 793 pp. 3. Bello, Marco, and Robert Sedgewick. Algorithms and Data Structures: The Science of Computing. Addison-Wesley, 2021. 608 pp. 4. Mehlhorn, Kurt, and Peter Sanders. Algorithms and Data Structures: The Basic Toolbox. 2nd ed. Springer, 2019. 407 pp. 5. Kleinberg, Jon, and Éva Tardos. Algorithm Design and Applications. Addison-Wesley, 2020. 1065 pp. **Literature:** additional. 1. Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to Algorithms. 3rd ed. MIT Press, 2009. 1312 pp. 2. Goodrich, Michael T., and Roberto Tamassia. Algorithm Design and Applications. Wiley, 2014.736 pp. 3. Erickson, Jeff. Algorithms. Independently published, 2019. 472 pp. **Research infrastructure** 1. Personal laptops **Internet resources** 1. LeetCode - Platform for coding practice, challenges: https://leetcode.com/ 2. VisuAlgo - Visualizing data structures and algorithms through animations: https://visualgo.net/en

Academic discipline policy	The academic policy of the discipline is determined by the Academic Policy and the Academic Integrity Policy of Al-Farabi KazNU. Documents are available on the main page of the Univer IS . **Integration of science and education.** Research work of students, undergraduates and doctoral students is a deepening of the educational process. It is organized directly in departments, laboratories, scientific and design departments of the university, and in student scientific and technical associations. Independent work of students at all levels of education is aimed at developing research skills and competencies based on acquiring new knowledge using modern research and information technologies. A teacher at a research university integrates the results of scientific activity into the topics of lectures and seminar (practical) classes, laboratory classes and into the tasks of the IWST, IWS, which are reflected in the syllabus and are responsible for the relevance of the topics of training sessions and tasks. **Attendance.** The deadline for each task is indicated in the calendar (schedule) for the implementation of the discipline content. Failure to meet deadlines will result in loss of points. **Academic integrity.** Practical/laboratory classes and SRL develop the student's independence, critical thinking, and creativity. Plagiarism, forgery, use of cheat sheets, and cheating at all stages of assignments are unacceptable. In addition to the main policies, the observance of academic integrity during theoretical training and exams is regulated by the "Rules for conducting final control" , "Instructions for conducting final control of the autumn/spring semester of the current academic year" , "Regulations on checking students' text documents for the presence of borrowings". Documents are available on the main page of the Univer IS . **Basic principles of inclusive education.** The educational environment of the university is conceived as a safe place where there is always support and equal treatment on the part of the teacher towards all students and students towards each other, regardless of gender, race/ethnicity, religious beliefs, socio-economic status, physical health of the student, etc. All people need the support and friendship of peers and fellow students. For all students, making progress is more about what they can do than what they can't do. Variety enhances all aspects of life. All students, especially those with disabilities, can receive advice by phone/e- mail +77759295274 / mussina.aigerim95@gmail.com , or via video call in MS Teams https://teams.microsoft.com/l/team/19%3AEXobN2cQvJpEY0Z6XkVPfMuU_rMyQ-Pwn3fFsUhLcGo1%40thread.tacv2/conversations?groupId=776342c7-342f-453a-a5bd-332259d38eac&tenantId=b0ab71a5-75b1-4d65-81f7-f479b4978d7b.

INFORMATION ABOUT TEACHING, LEARNING AND ASSESSMENT

Score-rating letter system of assessment of accounting for educational achievements				**Assessment Methods**
Grade	**Digital equivalent points**	**points, % content**	**Assessment according to the traditional system**	**Criteria-based assessment** is the process of correlating actual learning outcomes with expected learning outcomes based on clearly defined criteria. Based on formative and summative assessment. **Formative assessment is** a type of assessment that is carried out in the course of daily learning activities. It is the current measure of progress. Provides an operational relationship between the student and the teacher. It allows you to determine the capabilities of the student, identify difficulties, help achieve the best results, timely correct the educational process for the teacher. The performance of tasks, the activity of work in the classroom during lectures, seminars, practical exercises (discussions, quizzes, debates, round tables, laboratory work, etc.) are evaluated. Acquired knowledge and competencies are assessed. **Summative assessment** - type of assessment, which is carried out upon
A	4.0 _	95-100	Great	
A-	3.67	90-94		
B+	3.33	85-89	Fine	

				completion of the study of the section in accordance with the program of the course. Conducted 3-4 times per semester when performing IWMS. This is the assessment of mastering the expected learning outcomes in relation to the descriptors. Allows you to determine and fix the level of mastering the course for a certain period. Learning outcomes are evaluated.	
B	3.0	80-84		**Formative and summative assessment**	**Points % content**
B-	2.67	75-79		Activity in lectures	5
C+	2.33	70-74		Work in practical classes	20
C	2.0	65-69	Satisfactorily	Independent work	25
C-	1.67	60-64		Project and creative activities	10
D+	1.33	55-59		Final control (exam)	40
D	1.0	50-54		TOTAL	100
FX	0,5	25-49	Unsatisfactory		
F	0	0-24			

Calendar (schedule) for the implementation of the content of the course. Methods of teaching and learning.

A week	Topic name	Number of hours	Max. points
	MODULE 1 Fundamental Algorithmic Techniques		
1	**L 1.** Introduction to algorithms, importance in computing, analysis of algorithms (time and space complexity).	1	
	PC 1. Asymptotic notations and algorithm performance measurement.	2	10
2	**L 2.** The divide-and-conquer paradigm, solving recurrence relations, and the Master Theorem.	1	
	PC 2. Case study on Merge Sort and analysis of its complexity.	2	10
3	**L 3.** Heapsort, Quicksort, and the analysis of sorting algorithms.	1	
	PC 3. Problem-solving session on sorting algorithms and comparison of their efficiencies.	2	10
	IWMST 1. Consultations on implementation of **IWS 1** "Analysis and implementation of fundamental algorithmic techniques"		
4	**L 4.** Introduction to dynamic programming, optimal substructure, and overlapping subproblems.	1	
	PC 4. Case study on the Fibonacci sequence, matrix chain multiplication, and longest common subsequence.	2	
5	**L 5.** The greedy algorithm paradigm, characteristics of greedy algorithms, and correctness proof techniques.	1	
	PC 5. Application of greedy algorithms to problems like the fractional knapsack and activity selection.	2	20
	IWMST 2. Consultations on implementation of **IWMS 1** "Analysis and implementation of fundamental algorithmic techniques"		
	MODULE 2 Advanced Data Structures and Graph Algorithms		
6	**L 6.** Graph Traversal.	1	
	PC 6. Flavors of Graphs	2	10
7	**L 7.** Data Structures for Graphs	1	0
	PC 7. Programming graph data structure. Performing basic operations	2	10
	IWMST 3. Reception and protection **of IWMS 1** . Consultations on the implementation of **IWMS 2** "Real-world problems and advanced algorithms"		30
Midterm control 1			**100**
8	**L 8.** Traversing a Graph. Breadth-First Search	1	
	PC 8. Breadth-First Search implementation	2	10
9	**L 9.** Applications of Breadth-First Search. Connected Components	1	
	PC 9. Two-Coloring Graphs implementation	2	10
	MODULE 3 Weighted Graph Algorithm		
10	**L 10.** Weighted Graph Algorithms. Minimum Spanning Trees	1	
	PC 10. Prim's Algorithm implementation	2	10
	IWST 4. Consultations on the implementation of **IWMS 2** "Real-world problems and advanced algorithms"		
11	**L 11.** Kruskal's Algorithm	1	
	PC 11. Spanning Trees analysis	2	10
12	**L12.** Shortest Paths. Dijkstra's Algorithm	1	
	PC 12. Shortest paths algorithms analysis	2	10
13	**L 13.** Network Flows and Bipartite Matching	1	
	PC 13. Computing Network Flows implementation	2	10
	IWST 5. Reception and protection **of IWMS 2.**		30
14	**L 14.** Design Graphs. Part 1	1	

	PC 14. Computing Network Flows Implementation	2	10
	IWST 6. Consultation on exam		
15	**L 15.** Design Graphs. Part 2	1	
	PC 15. Graphs in real-world problems	2	10
Midterm control 2			**100**
Final control (exam)			**100**
TOTAL for discipline			**100**

RUBRICATOR OF THE SUMMATIVE ASSESSMENT

CRITERIA EVALUATION OF LEARNING OUTCOMES

IWMS1 - "Analysis and implementation of fundamental algorithmic techniques**"** (3**0% of 100% MC**)

Criterion	**25 -30 %**	**20-24 %**	**10-19 %**	**0-9 %**
Understanding Theories and Concepts	Demonstrates a deep understanding of algorithmic theories and their practical implications.	Shows a good grasp of algorithmic concepts, with mostly accurate explanations.	Presents a basic understanding of the theories, but explanations lack depth or have noticeable inaccuracies.	Fails to demonstrate a clear understanding of the theories. Explanations are vague, incorrect, or missing.
Implementation and Code Quality	Code is well-written, efficient, and follows best practices.	Code is mostly correct and functional, with some minor inefficiencies or coding practice issues.	The implementation is partially correct, with noticeable errors or inefficiencies.	The code is incorrect or incomplete, with significant logical errors, inefficiencies, or poor structure.

IWMS2 - "Real-world problems and advanced algorithms**" (30% of 100% MC)**

Criterion	**25 -30 %**	**20-24 %**	**10-19 %**	**0-9 %**
Application of Advanced Algorithms and Data Structures	The group effectively applies advanced algorithms (e.g., graph algorithms, network flow) and data structures to solve real-world problems.	The group applies advanced algorithms and data structures correctly but need improvements in optimization or adaptation to specific problems.	Basic application of advanced algorithms is demonstrated, but the solution may have inaccuracies or lack full optimization.	The group fails to apply the appropriate algorithms or data structures correctly, resulting in an incomplete or incorrect solution.
Problem-Solving and Experimentation	The group demonstrates a strong problem-solving approach, experimenting with multiple scenarios or parameter changes.	The group explores problem-solving scenarios with some level of experimentation, though analysis may lack depth or be somewhat limited in scope.	The group provides a basic problem-solving approach with minimal experimentation or analysis, showing limited understanding of variations.	The group provides little to no experimentation or analysis, with a weak problem-solving approach.
Theoretical Justification and Analysis	The group presents comprehensive theoretical justifications, including proofs, complexity analysis, and well-founded discussions.	The group provides mostly correct theoretical analysis, with minor inaccuracies or gaps.	Theoretical analysis is present but incomplete or contains inaccuracies. The justification is simplistic and lacks detailed exploration.	The group fails to provide meaningful theoretical analysis or justification, with significant errors or omissions.
Collaboration and Presentation	The group works cohesively, dividing tasks efficiently and collaborating effectively.	The group shows good collaboration, with some unevenness in task distribution.	Collaboration within the group is basic, with some members not fully participating.	The group demonstrates poor collaboration, with little evidence of teamwork.

acting Dean _____O.N. Turar

Chair of the Academic Committee

on the Quality of Teaching and Learning_____ Adilzhanova S.A.

acting Head of Department _____M.N. Satymbekov

Lecturer _____A.B. Mussina