COURSE UNIT DESCRIPTION

Course unit title	Course unit code
PARALLEL PROGRAMMING TECHNIQUES AND ADVANCED CALCULATIONS	

Lecturer (s)	Department where course unit is delivered
dr. Mantas Vaitonis	Kaunas Faculty Institute of Social Sciences and Applied Informatics

Cycle	Level of course unit	Type of the course unit
First	1/1	Mandatory

Mode of delivery	Semester or period when the course unit is delivered	Language of instruction
Lectures, online lectures, practices	6 semester	Lithuanian/English

Requirements for the student	
Prerequisites:	**Requisites:**

Number of ECTS credits allocated	Student‘s workload	Contact work hours	Individual work hours
5	130	68	62

Aim of the subject: competencies to be developed in the study program		
The objective of the course is to acquire knowledge and skills in the application of science and technology in to high-performance and parallel computing technologies, as well as modern software and technical equipment used in various fields from artificial intelligence to data engineering.		
Learning outcomes of course unit	**Teaching and learning methods**	**Assessment methods**
Analyzation and preparation of digital data for parallel computing, determine their reliability, and normalize them. Selection of software and technical tools for an effective solution of parallel computing tasks, for scientific research, and in computer engineering. Evaluation of the need, potential applications, and effectiveness of solving tasks using parallel computing principles	Lectures, exercises, independent work active teaching / learning methods (network configuration, network modeling, simulation of possible network failures) flow monitoring, situation analysis. The use of any artificial intelligence tools and programs is prohibited for the preparation of assignments and projects in this subject.	Case study, control works, practical works, exam

Course content: breakdown of the topics	Contact work hours							Individual work hours and tasks	
	Lectures	Consultations	Seminars	Practice classes	Laboratory	Practice	**All contact work**	**Individual work**	**Tasks**
The architecture of high-performance computing computer systems. Structure and detailed explanation of the CPU. Introduction to MATLAB software.	2			4			6	4	Literature, cases study, discussions, practical tasks
Parallel computing using high-performance computers. Comparison of CPU, GPU, and FPGA technologies. Operations with vectors and matrices.	2			4			6	5	Literature, cases study, discussions, practical tasks
Algorithm and its complexity. Introduction to the concept of the algorithm and principles for evaluating its complexity. Sequential and parallel algorithms. Principles of algorithm execution using single and multiple processors. Processing of big data and multi-dimensional matrices.	2			4			6	5	Literature, cases study, discussions, practical tasks
Evaluation of parallel computing performance, analysis of computing performance. Operations with multi-dimensional matrices.	2			4			6	10	Literature, cases study, discussions, practical tasks
Shared-memory high-performance computing and algorithms. Shared-memory computing systems of computers, principles of use. Application areas of parallel computing (science, medicine, artificial intelligence, finance, electronics modeling, etc.). Parallel computing functions using MATLAB software.	2			4			6	10	Literature, cases study, discussions, practical tasks
Distributed-memory high-performance computing. Shared-memory computing systems of computers, principles of use. Parallel computing for computer/network risk assessment.	2			4			6	10	Literature, cases study, discussions, practical tasks
Distributed systems models, architecture, and applications. The complexity of distributed systems is analyzed. Processing big data using parallel computing.	2			4			6	10	Literature, cases study, discussions, practical tasks

High-performance computing and parallel computing in cyber security. Algorithmic and high-frequency risk detection.	2			4			6	12	Literature, cases study, discussions, practical tasks
Exam preparation, consultation		2					2	12	
Exam							2		
Total	16	2		32			52	78	

Assessment strategy	**Percentage**	**Date of examination**	**Assessment criteria**
Control work (C1) from theory	10 %	Scheduled time	Evaluated on a scale of 1-10 grades: 10-9: Excellent knowledge and skills. Assessment level. 90-100 % correct answers. 8-7: Good knowledge and skills, there may be minor mistakes. Level of synthesis. 70-89% correct answers. 6-5: Average knowledge and skills, there are mistakes. Analyzes level. 50-69% correct answers. 4-3: Knowledge and skills are below average, there are (essential) errors. Level of knowledge application. 20-49% correct answers. 2-1: Minimum requirements not met. 0-19% correct answers.
Practical work (P1)	20 %	Scheduled time	Evaluated on a scale of 1-10 grades: 10-9: Excellent knowledge and skills. Assessment level. 90-100 % correct answers. 8-7: Good knowledge and skills, there may be minor mistakes. Level of synthesis. 70-89% correct answers. 6-5: Average knowledge and skills, there are mistakes. Analyzes level. 50-69% correct answers. 4-3: Knowledge and skills are below average, there are (essential) errors. Level of knowledge application. 20-49% correct answers. 2-1: Minimum requirements not met. 0-19% correct answers.
Practical work (P2)	20 %	Scheduled time	Evaluated on a scale of 1-10 grades: 10-9: Excellent knowledge and skills. Assessment level. 90-100 % correct answers. 8-7: Good knowledge and skills, there may be minor mistakes. Level of synthesis. 70-89% correct answers. 6-5: Average knowledge and skills, there are mistakes. Analyzes level. 50-69% correct answers. 4-3: Knowledge and skills are below average, there are (essential) errors. Level of knowledge application. 20-49% correct answers. 2-1: Minimum requirements not met. 0-19% correct answers.

Exam (E1)	50 %	Scheduled time	Students have to prepare individual project based on course material. Only if they fail this project, they can take exam on scheduled time which would cover the whole course material. Evaluated on a scale of 1-10 grades: 10-9: Excellent knowledge and skills. Assessment level. 90-100 % correct answers. 8-7: Good knowledge and skills, there may be minor mistakes. Level of synthesis. 70-89% correct answers. 6-5: Average knowledge and skills, there are mistakes. Analyzes level. 50-69% correct answers. 4-3: Knowledge and skills are below average, there are (essential) errors. Level of knowledge application. 20-49% correct answers. 2-1: Minimum requirements not met. 0-19% correct answers.
Final grade: 0.1*C1+0.2*P1+0.2*P2+0.5*E1			

A student who, throughout the semester during seminars, consistently fails to demonstrate progress in achieving the intended learning outcomes of the course, does not have all three assessments from the interim evaluations (C1, P1, and P2), and has not uploaded the laboratory assignments by the specified deadline, will not be allowed to take the exam.

Rules for the use of AI

The use of generative AI models is not permitted in the course for conducting research, completing written assignments, tasks, or assessments.

Author	Year	Title	Number of periodical publication or publication Volume	The place of publication and publisher or online link
Required reading				
Hiroaki Kitano and James A. Hendler	1995	Massively Parallel Artificial Intelligence		MIT Press, Cambridge, MA
Nikolaos Plosk and Nikolaos Samara	2016	GPU Programming in MATLAB		Elsevier
Roman Trobec and et. al.	2018	Introduction to Parallel Computing: From Algorithms to Programming on State-of-the-Art Platforms		Springer
Antoine Savine and Leif Andersen	2018	Modern Computational Finance: AAD and Parallel Simulations		Wiley
Yurij Holovatch	2018	Order, Disorder and Criticality		World Scientific
Recommended reading				
Duane Storti, Mete Yurtoglu	2015	CUDA for Engineers: An Introduction to High-Performance Parallel Computing		Addison-Wesley Professional
The MathWork	2019	Machine Learning and Big Data in Quantitative Investing		The MathWorks

M Vaitonis	2020	High Frequency Computerized Trading Strategies Engineering in Financial Markets		Vilnius University