

Subject card

Subject name and code	Concurrent and Parallel Programming, PG_00203635						
Field of study	Informatics						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2026/2027		
Education level	Master's studies		Subject group		Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study	part-time studies		Mode of delivery		at the university		
Year of study	1		Language of instruction		Polish		
Semester of study	2		ECTS credits		5.0		
Learning profile	academic		Assessment form		credit		
Conducting unit							
Name and surname of lecturer (lecturers)	Subject supervisor		dr Piotr Arłukowicz				
	Teachers		dr Piotr Arłukowicz				
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	20.0	0.0	20.0	0.0	0.0	40
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	40		0.0		85.0	125
Subject objectives	To familiarize students with concurrent and parallel programming models, synchronization mechanisms, and techniques for designing efficient and scalable multithreaded and distributed programs using the shared-memory model (OpenMP) and the message-passing model (MPI).						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[INFMU2_W03] has in-depth knowledge of programming paradigms and architectures and advanced programming constructs; knows current trends in programming languages		Has in-depth knowledge of concurrent/parallel constructs (threads and processes, synchronization, OpenMP and MPI models), parallel-processing patterns, and current trends in languages/tools supporting concurrency.		[SW4] test/exam - oral or written [SW2] presentation/project/paper/report		
	[INFMU2_W04] knows and understands in depth the principles of designing and implementing complex software systems, the impact of system architecture on its concurrency, performance and scalability, concurrent and parallel processing models and their application in modern systems		Knows and understands concurrent and parallel processing models (shared memory and message passing), the impact of hardware/software architecture on concurrency, performance and scalability, and scalability laws (Amdahl, Gustafson).		[SW4] test/exam - oral or written [SW2] presentation/project/paper/report		

Subject contents	1. Concurrency vs parallelism — processes/threads, execution models, multicore/distributed architectures. 2. Concurrency problems — race conditions, deadlock, starvation, Coffman conditions. 3. Synchronization — critical sections, mutexes, semaphores, monitors, condition variables, barriers. 4. Classic problems — producer-consumer, readers-writers, dining philosophers. 5. Shared-memory model — multithreading, OpenMP directives (parallel loops, sections, reductions, variable scope). 6. Message-passing model — MPI (point-to-point and collective communication, communicators, process synchronization). 7. Parallel patterns — fork-join, map-reduce, thread pools, data/task parallelism. 8. Performance and scalability — speedup, efficiency, Amdahl/Gustafson laws, load balancing. 9. Parallel programming on accelerators (GPU) — introduction. 10. Correctness — testing/debugging, concurrency-error detection tools.		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	project	51.0%	60.0%
	test	51.0%	40.0%
Recommended reading	Basic literature	• M. Ben-Ari, <i>Podstawy programowania współbieżnego i rozproszonego</i>, WNT. • Z.J. Czech, <i>Wprowadzenie do obliczeń równoległych</i>, PWN. • P. Pacheco, <i>An Introduction to Parallel Programming</i>, Morgan Kaufmann.	
	Supplementary literature	• B. Wilkinson, M. Allen, <i>Parallel Programming. Techniques and Applications Using Networked Workstations and Parallel Computers</i>, Pearson. • A. Silberschatz, P.B. Galvin, G. Gagne, <i>Podstawy systemów operacyjnych</i>, WNT. • Dokumentacja standardów OpenMP (https://www.openmp.org/) oraz MPI (https://www.mpi-forum.org/).	
	eResources addresses		
Example issues/ example questions/ tasks being completed			
Work placement	Not applicable		

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