Subject card

Subject name and code	High Performance Computing Systems, PG_00054279		
Field of study	Informatics		
Date of commencement of studies	February 2023	Academic year of realisation of subject	2022/2023
Education level	second-cycle 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	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Computer Architecture -> Faculty of Electronics, Telecommunications and Informatics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Paweł Czarnul	
	Teachers	mgr inż. Robert Kałaska mgr inż. Szymon Olewniczak dr hab. inż. Paweł Czarnul Piotr Januszewski	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	15.0	0.0	0.0	30
	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	30	10.0	35.0	75

Subject objectives	learning methods and technologies for parallelization and optimization of algorithms in HPC systems

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U04] can apply knowledge of programming methods and techniques as well as select and apply appropriate programming methods and tools in computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study, making assessment and critical analysis of the prepared software as well as a synthesis and creative interpretation of information presented with it	knows how to optimize an implementation of a parallel application	[SU1] Assessment of task fulfilment
	[K7_W06] Knows and understands, to an increased extent, the basic processes taking place in the life cycle of devices, facilities and technical systems.	knows how to debug parallel applications	[SW1] Assessment of factual knowledge
	[K7_U42] can solve engineering and research problems including design, assessment and maintenance of information systems and applications, using experimental methods and management techniques	can configure a parallel environment	[SU1] Assessment of task fulfilment
	[K7_W42] Knows and understands, to an increased extent, the principles and trends in the analysis and design of local and distributed IT systems and the basics of computer modeling and computerization of complex cognitive and decision-making processes.	can design parallel algorithms	[SW1] Assessment of factual knowledge
	[K7_W08] Knows and understands, to an increased extent, the fundamental dilemmas of modern civilisation, the main development trends of scientific disciplines relevant to the field of education.	knows how to find applications for parallel computing	[SW1] Assessment of factual knowledge

Subject contents	1 Passing criteria 2 Introduction to computing in parallel environments: model of a parallel application: basic parameters of an application and a parallel system, topologies. Assignment criteria. Latency and bandwidth. Values for real systems 3 Parallel architectures: Shared Memory, Distributed Shared Memory, Distributed Memory. 4 Paradigms: master-slave, SPMD, pipelining, divide-and-conquer. Examples 5 MPI: model of an application. Basic API. basic application. 6 MPI: running, various implementations: MPICH, OpenMPI, running on clusters, supercomputers, queueing systems 7 MPI: send communication modes: classic, rsend, bsend, ssend, examples. Non-blocking communication. Blocking communication. Collective vs, point-to-point communication, creation of data types and packing. 8 MPI: communicators 9 MPI: dynamic load balancing: repartitioning, „ghost nodes". 10 Examples of applications in MPI – performance on TASK clusters (communication modes (SSend,Isend,Rsend,Send), overlapping communication and computations in MPI) 11 MPI: spawning processes dynamically, one-way communication 12 Checkpointing of parallel aplikations 13 Threads vs MPI. OpenMPI 14 Advanced techniques for algorithm parallelization: overlapping communication and communication, other techniques for hiding communication costs 15 OpenMP 16 Parallel I/O in MPI 17 Examples of HPC applications: medical etc. 18 Programming basics in CUDA 19 Programming basics using OpenMP for Xeon Phi

Prerequisites and co-requisites	znajomość języka C, znajomość podstawowych algorytmów sekwencyjnych i struktur danych

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Midterm colloquium	50.0%	50.0%
	Practical exercise	50.0%	50.0%

Recommended reading	Basic literature	
		1 Dokumentacja MPI
		2. Dokumentacja OpenMP
		3. Dokumentacja CUDA
		4. P. Czarnul. Parallel Programming for Modern High Performance Computing Systems. Taylor & Francis. 2018 ISBN 9781138305953
	Supplementary literature	No requirements

	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	