Study programme	Type of study (cycle)	Third cycle of studies – doctoral studies
	Name of the study programme	Doctoral Study in Mathematical and Computer Sciences

COURSE

Course title	**High Performance Computing**

Course code	Semester	Course status	ECTS credits	Contact hours
CS 655	II	Elective	10	30

Course objectives and learning outcomes	Introduction to the application of HPC in mathematical disciplines. Understanding current hardware architectures (CPU, GPU, clusters) and software standards. Acquiring the principles of the design and analysis of parallel algorithms. Upon passing the course, the student will be able to: classify computer architectures according to Flynn's taxonomy and network topologies, recognize and solve concurrency problems (data races, deadlock, livelock), compare shared, distributed and hybrid memory systems, calculate and analyze program speedup by applying Amdahl's and Gustafson's laws, design and optimize parallel algorithms by managing partitioning, communication and synchronization on various hardware platforms.

Course content

- The von Neumann computer architecture
- Flynn's taxonomy (SISD, SIMD, MISD, MIMD).
- Topologies of computer/processor networks.
- Concurrency and correctness (data races, atomic operations, deadlock, livelock).
- Shared memory, distributed memory, hybrid environments.
- Partitioning, communication, synchronization, data dependency, granularity.
- Limitations and costs of parallel programming.
- Speedup, Amdahl's law, Gustafson's law.
- Multi-core processors

LITERATURE

[1] J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann Publishers, 3rd edition, 2003.

[2] M. Herlihy and N. Shavit, The Art of Multiprocessor Programming, Morgan Kaufmann, 2008.

[3] T. Rauber and G. Runger, Parallel Programming: for Multicore and Cluster Systems, Springer, Berlin, 2010.

[4] Robert Robey and Yuliana Zamora, Parallel and High Performance Computing, Manning, 2021.

ASSESSMENT AND GRADING

	Criterion	Points	Requirement
1.	Homework assignments	30	
2.	Project	30	
3	Final exam	40	
	T o t a l	100	55