

Teaching Parallel and Distributed Computing at Masaryk University

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The Faculty of Informatics at Masaryk University was established in 1994 as a very first university faculty in Central and Eastern Europe specialized entirely on informatics in a broad sense. The faculty is part of a non-engineering university. From a modest beginning of twenty academic staff and less than four hundred students, the faculty has grown rapidly. Today, with more than 2,400 students, it offers a wide range of study programs at Bachelor, Master and Doctoral degree.

The three years bachelor program “Parallel and Distributed Computing” has been established in 2007 with the intention to provide students with a systematic curriculum in the topic. The goals of this program are:

- Get students acquainted with modern parallel and distributed architectures and technologies.
- Equip students with expertise in advanced methods, tools and techniques for development of parallel software.
- Enable students to efficiently exploit modern parallel computing systems in scientific and commercial application areas.

Faculty of informatics has a long tradition both in theory and in practice of parallel and distributed systems and parallel computing. Having access to university Super computing center as well as to numerous clusters of workstations and other parallel platforms, the students have already been exposed to various aspects of parallel and distributed computing before introducing the new curriculum. The new curriculum can thus be seen as a new reformulation of the program in the context of the current developments in the area.

There are several specific key aspects (in addition to the expected ones) that our PDC program is based on. The first important ingredient is a strong emphasis on a solid *mathematical background*. The reason is that due to the verification issues the role of formal methods and rigorous reasoning in software development for parallel and distributed computing is even more important than it was in the case of sequential computing. In particular, it is the inability of testing procedure to properly address concurrency issues that lead to the need of utilization of (semi) automated formal techniques and tools for verification of distributed systems. Therefore, there is a strong emphasis on teaching

verification and validation techniques and methods in our PDC program. Another ingredient is the existence of a Laboratory for Parallel and Distributed Systems (ParaDiSe) that serves as a place where the students work on team oriented projects and some of them are even directly involved in *research activities*. Many of our past undergraduate students have made significant contributions to our research and co-authored conference and journal publications. We consider this close connection of education and research activities an important part of the parallel and distributed systems curriculum. Finally, as the Faculty of Informatics is part of the university, we extensively use this opportunity to let students work on joint projects with *applications of parallel and distributed computing in chemistry, systems biology* and other areas where high-performance computing are applicable.

The PDC program is formed by courses that can be divided into two groups. The first group, so called common courses, are designed to all students and are shared by multiple bachelors programs taught at the faculty. Common courses form the core of informatics and maths knowledge on top of which the specialized courses are provided. Among the specialized courses there are several compulsory for all students of the PDC program while others are recommended and allow the students to concentrate more on either algorithmic, verification, or project staff. Specialized courses are presented both as lectures and team projects. The university supports European Credit Transfer and Accumulation System (ETCS). To graduate from a bachelor’s program, a student has to collect at least 180 ETCS credits. Out of these, 120 credits are supplied by common courses and the remaining credits by specialized courses. Rough structure of courses taught is given in the table below.

Besides specific PDC related knowledge the degree program provides students with the necessary theoretical knowledge and a solid understanding of the underlying technologies upon which software solutions are built. This foundation ensures graduates will have the knowledge needed to continually grow as technology evolves and will provide a basis for success in any computer science career the student chooses to pursue. In particular, graduates also have skills and knowledge that can be used in the following study in the Master Degree Programs at the Masaryk University or other high school in the Czech Republic and also abroad.

Selected Compulsory Courses – All programs

Foundations of Mathematics
Linear Algebra
Calculus I-II
Algebra
Principles of Programming Languages
Algorithm Design I-II
Formal Languages and Automata
Computability and Complexity
Computer-Systems Architectures
Operating Systems
Database Systems
Computer Networks
C++ Programming

Compulsory Courses – PDC program

Design and Implementation of Parallel Systems
Communication and Parallelism
Project on Programming Parallel Applications
Introduction to Validation and Verification
Supercomputer Architectures and Intensive Computations

Recommended Courses – PDC program

GP GPU Programming
Parallel Algorithms and Models of Computation
Modelling and Simulation
Advanced Computer Networks