MATH-454 **Parallel and high-performance computing**

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Cursus	Sem.	Type
Computational science and Engineering	MA2, MA4	Opt.
Computational science and engineering minor	E	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	1 weekly
TP	1 weekly
Number of positions	

Summary

This course provides insight into a broad variety of High Performance Computing (HPC) concepts and the majority of modern HPC architectures. Moreover, the student will learn to have a feeling about what architectures are suited for several types of algorithms and learn to program for them.

Content

HPC overview:

- Today's HPC: Beowulf-style clusters, massively parallel architectures, hybrid computing, accelerators
- HPC history and background
- HPC benchmarks explained
- Multicore systems
- Scaling

Writing HPC code:

- Shared memory parallelism with OpenMP
  Distributed memory parallelism with MPI
- Hybrid programming with OpenMP and MPI
- GPGPU primer
- Profiling

Keywords

HPC, Parallelization, Multi-threading, MPI, GPU

Learning Prerequisites

Required courses

- Analysis, bachelor level
- Numerical analysis for engineers
- Matrix algebra
- C/C++ programming

Important concepts to start the course

Learning Outcomes

By the end of the course, the student must be able to:

- Classify the types of HPC architecture
- Identify codes suited for parallelization
- Apply the most common parallelization techniques
- Implement algorithms in parallel
- Argue about the differences in performance between theory and practice
- Investigate the performance of parallel code
- Optimize the usage of hardware and software resources depending on the type of algorithm to parallelize

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Communicate effectively with professionals from other disciplines.
- Write a scientific or technical report.
- Access and evaluate appropriate sources of information.

Teaching methods

Lectures, exercises, project work

Expected student activities

Attendance to lectures, completing exercises, writing a project

Assessment methods

Project(s) and oral exam.

Supervision

Office hours	Yes
Assistant.e.s	Yes
Forum	Yes

Resources

Moodle Link

- https://go.epfl.ch/MATH-454