

## Tárgytematika / Course Description

### High performance computing

**GKNM\_MSTA039****Tárgyfelelős neve /****Teacher's name:** dr. Környei László**Félév / Semester:** 2024/25/2**Beszámolási forma /****Assesment:** Vizsga**Tárgy heti óraszám /****Teaching hours(week):** 2/2/0**Tárgy féléves óraszám /****Teaching hours(sem.):** 0/0/0

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### OKTATÁS CÉLJA / AIM OF THE COURSE

The aim of the course is to get hands on experience on advanced high performance computing tools, environment and development. The focus is on programming a small cluster system.

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### TANTÁRGY TARTALMA / DESCRIPTION

Programming with MPI. The MPI standard. Program structure, compiling, execution. Setting number of processes and threads. Measuring runtime. Categorizing MPI functions. Point-to-point communication. Buffered and unbuffered calls. Blocking and non-blocking communication. Collective MPI calls. Defining and using deduced data types. Communication groups and communicator. Calculating speedup and parallel efficiency. Amdahl's and Gustafson's law. Planning and measuring weak and strong scaling. Advanced topics in MPI: Communication groups and virtual topologies. 1D and 2D cartesian topologies. Solving the 2D heat equation. Visualizing results. Analysing 2D and 3D data sets. Automating postprocessing. MPI-aware numerical linear algebra packages: Installing, implementing numerical solvers, running on cluster. Advanced topics in MPI: Derived datatypes. Domain decomposition: computation and communication focus. Input and output handling. Parallel I/O

Advanced topics in OpenMP: Task directive. Work sharing with taskloops. Parallel traversing of a tree. Using SIMD. Pitfalls and Optimization problems in OpenMP

Hybrid programming: MPI+OpenMP. Compiling, running, job submission. Benchmarking, process pinning, profiling

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### SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESSMENT'S METHOD

For the signature, students must complete weekly homeworks, and a mid term exam. Minimum requirements are 33% for the homeworks, and 50% on the mid term exam.

The final note consist of some smaller tasks to work on at home as homework. A home project is to be created at home and to be presented at the end of the semester. An oral exam is required to present the learned topics. Attendance is not compulsory, but recommended. Students attending get extra credit at the final evaluation. Both home project and oral exam must have a minimum of 10% (from 30%)

Parts for the final exam weigh as follows:

30% Homework  
30% Home project  
30% Oral exam  
10% Attendance

A minimum of 50% must be reached for a successful exam.

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### **KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL**

the lecture notes of the classes, that will be available online in electronic format

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### **AJÁNLOTT IRODALOM / RECOMMENDED MATERIAL**