GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2023-2024

Parallel Computer Systems (E034140)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2023-2024

A (semester 1)	English	Gent	lecture seminar	
B (semester 1)	Dutch	Gent	seminar: coached exercises	30.0h

Lecturers in academic year 2023-2024

Eeckhout, Lieven	TW06	lecturer-in-charge

Offered in the following programmes in 2023-2024	**crdts**	**offering**
Bachelor of Science in Computer Science	6	A
Master of Science in Teaching in Science and Technology(main subject Computer Science)	6	A
Bridging Programme Master of Science in Bioinformatics(main subject Engineering)	6	A
Bridging Programme Master of Science in Computer Science Engineering	6	A
Master of Science in Electromechanical Engineering(main subject Control Engineering and Automation)	6	A
Master of Science in Electromechanical Engineering(main subject Electrical Power Engineering)	6	A
Master of Science in Bioinformatics(main subject Engineering)	6	A
Master of Science in Electromechanical Engineering(main subject Maritime Engineering)	6	A
Master of Science in Electromechanical Engineering(main subject Mechanical Construction)	6	A
Master of Science in Electromechanical Engineering(main subject Mechanical Energy Engineering)	6	A
Master of Science in Computer Science Engineering	6	B
Master of Science in Computer Science Engineering	6	A

Teaching languages

English, Dutch

Keywords

Computer architecture, instruction-level parallelism, data-level parallelism, memory-level parallelism, thread-level parallelism, superscalar processing, speculative execution, shared-memory computer systems, cache coherency, memory consistency, multi-core processors, multi-threading, data centers, supercomputers, system performance fundamentals, impact of technology on architecture, power/energy, reliability and fault-tolerant computing

Position of the course

This course continues on the courses 'Computer Architecture' and 'Operating Systems'.
This course describes:

- modern high-performance microarchitectural techniques implemented in contemporary microprocessors for exploiting instruction-level parallelism and for bridging the memory wall;
- methods for exploiting thread-level parallelism, including fundamentals of shared-memory multiprocessors, multicore and manycore processor architectures, multi-threading;
- basics of datacenter and supercomputer organization;

- impact of technology including power/energy and reliability;
- fundamentals in systems performance.

Contents

Processor architecture
- Exploiting instruction-, data- and memory-level parallelism
- Superscalar processor architectures
  - Pipelining, in-order, out-of-order, speculative execution
  - Memory hierarchy

Multiprocessor architecture
- Exploiting thread-level parallelism
- Fundamentals of shared-memory systems
  - Cache coherency, memory consistency, synchronization
- Multicore and manycore architectures
- Multi-threading (simultaneous, fine-grained, coarse-grained, GPU)
- Interconnection networks

Data center and supercomputer architecture
- Organization
- Cost analysis

Performance, power and reliability issues – impact of technology
- Iron Law of Performance, Amdahl's Law
- Dynamic and static power consumption, power- and thermal-aware design
- Fault-tolerance, soft and hard errors, redundant computation

Initial competences

It is expected that the contents of the courses 'Computer Architecture' (obligatory) and 'Operating Systems' (not obligatory, but recommended) are well understood.

Final competences

1 Understand and be able to describe the architecture and their impact on performance of superscalar processor architectures, shared-memory multiprocessors, multi-threading, datacenters, supercomputers.
2 Understand and be able to describe the impact of technology on parallel computer systems.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture

Learning materials and price

Course notes made available through Ufora

References

Computer Architecture: A Quantitative Approach, Sixth Edition, John. L. Hennessy and David A. Patterson, Morgan Kaufmann Publishers

Course content-related study coaching

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment open-book

Examination methods in case of periodic assessment during the second examination period

Written assessment open-book

Examination methods in case of permanent assessment

Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible

Extra information on the examination methods

- During examination period: written open-book exam.
- Second chance: written open-book exam.
- During semester: graded project reports (15% of total score). Second chance: possible.

Calculation of the examination mark

Evaluation throughout semester as well as during examination period. Special conditions: A combination of the exam and the project work (15% of the total score). A student only passes the course if he/she passes the exam.