

## 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
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**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.

(Approved)

**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.