UNIVERSITY OF GOTHENBURG

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DIT361 Parallel Computer Architecture, 7.5 credits

Parallell datorarkitektur, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Computer Science and Engineering on 2017-12-19 to be valid from 2018-08-19, autumn semester of 2018.

Field of education: Science 100%
Department: Department of Computer Science and Engineering

Position in the educational system

The course is offered within several programmes. It is also a single subject course at the University of Gothenburg.

The course can be part of the following programme: 1) Computer Science, Master's Programme (N2COS)

Main field of studies	*Specialization*
Computer Science	A1F, Second cycle, has second-cycle course/s as entry requirements

Entry requirements

To be eligible to the course, the student should have successfully completed 90 credits of studies in computer science or equivalent. Specifically, the course DIT051 Computer Architecture, 7.5 credits, is required, or equivalent.

Applicants must prove knowledge of English: English 6/English B or the equivalent level of an internationally recognized test, for example TOEFL, IELTS.

Learning outcomes

After completion of the course the student should be able to:

Knowledge and understanding

- describe current approaches to parallel computing
- explain the design principles of the hardware support for the shared memory and message passing programming models
- describe the implementation of different models of thread-level parallelism, such as core multithreading, chip multiprocessors, many-cores or GPGPU

Competence and skills

- implement synchronization methods for shared memory and message passing parallel computers
- design scalable parallel software and analyze their performance

Judgement and approach

- analyze the trade-offs of different approaches to parallel computing in terms of function, performance and cost

Course content

From 1975 to 2005, the computer industry accomplished a phenomenal mission: in 30 years, we put a personal computer on every desk and in every pocket. In 2005, however, mainstream computing hit a wall, and the industry undertook a new mission: to put a personal parallel supercomputer on every desk, in every home, and in every pocket. In 2011, we completed the transition to parallel computing in all mainstream form factors, with the arrival of multicore tablets and smartphones.

Power and temperature have joined performance as first-class design goals. High-performance computing platforms now strive for the highest performance/watt. This course looks at the design of current multicore systems with an eye towards how those designs are likely to evolve over the next decade.

The content is divided into several parts:

- a review of fundamental concepts in computer architecture
- basic multiprocessor designs for the message passing and shared memory programming models
- interconnection networks, an essential component in chip multiprocessors and scalable parallel computer systems
- how to correctly support parallel algorithms in shared memory hardware
- last years' recent transition towards chip multiprocessors (also known as "multicores")

A common thread running through all content parts is a discussion of cost tradeoffs with respect to performance, power, energy, verifiability, programmability, and maintainability. A second unifying theme is the memory bottleneck, and the importance

of efficient resource management.

The lectures are complemented with several exercise sessions. Via three lab assignments, participants learn how to develop software using models such as C++ threads and OpenMP, they develop and analyze synchronization algorithms, and they learn how to use performance analysis tools. The course also contains a written assignment in which the participants take the role of the computer architect who will survey and discuss solutions to a particular problem in the field of parallel computing.

Sub-courses

1. **Written examination** *(Skriftlig tentamen),* 4.5 higher education credits
   Grading scale: Pass with Distinction (VG), Pass (G) and Fail (U)
2. **Project** *(Projekt),* 1.5 higher education credits
   Grading scale: Pass with Distinction (VG), Pass (G) and Fail (U)
3. **Laboratory work** *(Laboration),* 1.5 higher education credits
   Grading scale: Pass (G) and Fail (U)

Form of teaching

The course is organized into lectures, exercises, lab assignments, and a writing project, all of which focus on the principles and practices of parallel computer design.

Language of instruction: English

Assessment

Written individual exam given in an examination hall, laboratory work, and multi-week written project conducted individually or in pairs.

If a student, who has failed the same examined component twice, wishes to change examiner before the next examination, a written application shall be sent to the department responsible for the course and shall be granted unless there are special reasons to the contrary (Chapter 6, Section 22 of Higher Education Ordinance).

In cases where a course has been discontinued or has undergone major changes, the student shall normally be guaranteed at least three examination occasions (including the ordinary examination) during a period of at least one year from the last time the course was given.

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).
A Pass grade (G) for the entire course requires at least a Pass grade for all sub-courses.

To be awarded Pass with Distinction (VG) for a full course, the student must, in addition, receive the grade VG on both the sub-courses Written examination and Project.

Course evaluation

The course is evaluated through meeting after the course between teachers and student representatives. Further, an anonymous questionnaire is used to ensure written information. The outcome of the evaluations serves to improve the course by indicating which parts could be added, improved, changed or removed.

Additional information

The course is a joint course together with Chalmers.

Course literature to be announced the latest 8 weeks prior to the start of the course.

The course replaces the course DIT360, 7.5 credits. The course cannot be included in a degree which contains DIT360. Neither can the course be included in a degree which is based on another degree in which the course DIT360 is included.