

EDA420 / DIT170- Parallella och Distribuerade Realtidssystem Parallel and Distributed Real-Time Systems

4 credit points, Quarter 3, 2005/06

This web page functions both as a course description sheet and as a medium for distribution of new information regarding the course. The information will be updated dynamically, so please visit this web page at least once per week. Information regarding course syllabus, examination results, and submission of homework assignment is available at the [course's home page at the Student Portal](#).

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News: **UPDATED** (January 15, 2007)

NEWS 070115: Updated the official home page of the course in **Parallel and Distributed Real-Time Systems** for 2006/07.

Lecturer and examiner:

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Course Outline:

Real-time systems play a vital role in many application domains including drive-by-wire automotive systems, intelligent traffic control systems, banking systems, and autonomous robots. For many real-time applications, the system must be designed with multiple processors in order to meet imposed application constraints. Such situations can occur when tasks need to be physically distributed (as in a fault-tolerant vehicle braking system) or when the inherent parallelism of the application need to be fully exploited (as in a high-performance multimedia application).

This course is intended to give a deeper understanding of the problems involved in designing real-time systems based on multiprocessor architectures. In particular, the course covers the following topics:

- Background: motivation for, and definition of, real-time computing systems.
 - Characterization of real-time systems: application constraints, design methods and performance measures.
 - Modeling of real-time tasks and evaluation of system's ability of meeting application constraints.
 - Single- and multiprocessor real-time scheduling: problem definition and terminology.
 - Task assignment and scheduling to meet application constraints.
 - Complexity theory and NP-completeness in the context of real-time scheduling.
 - Real-time communications: protocols and end-to-end delay guarantees.
 - Fault-tolerance techniques for real-time systems: models, algorithms and architectures.
 - Distributed clock synchronization.
 - Estimation of program worst-case run times.
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Organization:

Lectures and homework assignments:

The course is organized as a series of lectures where fundamental theories and concepts are presented. Lectures are given at two occasions per week (except study week 1 & 2 where there is one additional lecture per week):

Tuesdays at 13.15-15.00 in room ES51, and Thursdays at 10.00-11.45 in room ES51

As a complement to the lectures, there will be two homework assignments on the specific topics covered during the scheduled

lectures. As an aid for the students for their homework, a consultation session will be offered. The consultation sessions offer assistance regarding questions and problems related to the homework assignments (or other related issues). The intention is for the student to attempt to solve the problems and then go to the consultation session in case help is needed. Consultation sessions are offered on one occasion per week (except study week 1 & 2 where a lecture replaces the consultation session):

Fridays at 10.00-11.45 in room ES51

The course lectures and the consultation sessions are conducted in English.

Examination:

The student is evaluated through two compulsory homework assignments and a final written exam. The final grade is a weighted average of the compulsory homework assignments and the final exam. Each homework assignment tentatively counts approximately 30 % and the final exam 40 %. The score for each homework assignment and the final exam individually, must be equivalent to a grade of 3 or above. **The final exam is closed book where only dictionaries and word lists are allowed.** The grading scale is U, 3, 4, 5.

Two compulsory homework assignments are included in the course. The homework assignments can be handed in by individuals or as a group of no more than 2 (two) students. The homework assignments are graded individually for each of the two assignments (grade scale: U, 3, 4, 5). For an assignment to pass, the group member should (a) submit solutions of good enough quality in a written report and (b) orally present, and argue for, their choice of solutions in a meeting with the examiner.

The homework assignments consists of the usual problem solving and paper reading. The two assignments are handed out on *February 1* and *February 19* respectively, and must be handed in *within 18 days* from the date when the assignment was handed out. Each assignment solution must be written in Swedish or English, be computer generated (no handwritten solutions) and contain a separate front page which states the group name, the author(s) name, ID-number (personnummer), email address and specialization (linjetillhörighet).

The submission of the homework solutions is administrated via the Student Portal and is done in the following way. First, you register for a **group** ([link to group registration](#)) and will thereby be assigned a group name. Then, you **submit** the homework solutions electronically ([link to homework submission](#)). Finally, you **book** a time for presentation of the homework solutions using your group name ([link to booking of presentation times](#)). Please note that you must be logged on to the portal in order to be able to use these services.

For the final exam the following rules of thumb apply:

- The lecture notes (slides and blackboard notes) represent the level of which course material, protocols and concepts should be known and understood for the final exam. As emphasized in class, it is more important to understand concepts and principles rather than specific and complicated implementation details.
- Let the list of "suggested reading" provided below be a guide rather than a cook book for using the textbook. Use the lecture notes, the textbook and some common sense to avoid spending significant time on less relevant material. The student should become comfortable with the material such that general concepts and principles are well understood and can be applied.
- Complicated mathematical calculations and other time consuming procedures are tested in the homework assignments and will be limited (if appearing at all) on the final exam. Focus on the final exam is instead on the comfortable understanding of basic concepts and fundamental principles within the area. To facilitate evaluation of basic knowledge, the final exam is closed book.

The ordinary examination takes place on Thursday, March 15, 08.30 - 12.30 in the V building.

Re-examination will be offered on an individual basis. Notify examiner if you intend to attend a re-examination.

IMPORTANT! *As of the academic year 2005/06, there are compulsory sign-ups for final written exam. You can sign up as early as six weeks before but no later than two weeks prior to the beginning of the examination period. Cancellation of a sign-up must be made one week or more prior to the date of the exam. Examination sign-up is made via the Student Portal ([link to examination sign-up](#)).*

Literature:

- C. M. Krishna and Kang G. Shin, "[Real-Time Systems](#)", McGraw-Hill, 1997, ISBN 0-07-114243-6 (paperback), ISBN 0-07-057043-4 (cloth) (can be purchased at Cremona)

What parts of the book that is relevant are listed in the following [reading guideline](#)

- Research articles from archival journals and conference proceedings: (downloadable [here](#))

Course Documents:

- Course information sheet (downloadable [here](#))

- Lecture notes (downloadable [here](#))
- Written exams (downloadable [here](#))
- Homework assignments (downloadable [here](#))

Login name and password for downloading protected documents are available from the examiner.

The course information and lecture notes are available as both Postscript and PDF files.

Click [here](#) if to download a reader for these formats: ([Ghostview](#), [Acrobat Reader](#))

Related information:

- Links to international archival journals that cover the topic of real-time systems design:
 - [Real-Time Systems: The International Journal of Time-Critical Computing Systems](#)
 - [IEEE Transactions on Computers](#)
 - [IEEE Transactions on Parallel and Distributed Systems](#)
 - [IEEE Transactions on Software Engineering](#)
 - Books that deal with the topic of real-time systems design:
 - A. Burns and A. Wellings, *Real-Time Systems and Programming Languages*, Addison-Wesley, 2001, ISBN 0-201-72988-1.
 - H. Kopetz, *Real-Time Systems: Design Principles for Distributed Embedded Applications*, Kluwer Academic Press, 1997, ISBN 0-7923-9894-7.
 - G. Buttazzo, *Hard Real-Time Computing Systems: Predictable Scheduling Algorithms and Applications*, Kluwer Academic Press, 1997, ISBN 0-7923-9994-3.
 - Links to research activities in real-time systems design:
 - in Sweden ([ARTES](#) och [SNART](#))
 - internationally ([IEEE CS Technical Committee on Real-Time Systems](#))
 - Link to Chalmers undergraduate course in [Real-Time Systems](#)
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CHALMERS

Computer Engineering

Computer Science and Engineering – Chalmers University of Technology and Göteborg University

EDA420 / DIT170 - Parallella och Distribuerade Realtidssystem

Parallel and Distributed Real-Time Systems

Schedule:

Activity	Week	Day	Time	Room	Topic
L 1	4	Tuesday	13.15-15.00	ES51	Introduction; background and characteristics
L 2	4	Thursday	10.00-11.45	ES51	System modeling and performance evaluation
L 3	4	Friday	10.00-11.45	ES51	Complexity theory and NP-completeness
L 4	5	Tuesday	13.15-15.00	ES51	Scheduling: problem definition and terminology
L 5	5	Thursday	10.00-11.45	ES51	Schedulability analysis techniques [HWA #1 available]
L 6	5	Friday	10.00-11.45	ES51	Task assignment and scheduling algorithms
L 7	6	Tuesday	13.15-15.00	ES51	Task assignment and scheduling algorithms (cont'd)
L 8	6	Thursday	10.00-11.45	ES51	Aperiodic servers and overload management
C 1	6	Friday	10.00-11.45	ES51	<i>(Consultation session)</i>
-	7	Tuesday	13.15-15.00	--	<i>(no lecture due to 'Charm-dagarna')</i>
L 9	7	Thursday	10.00-11.45	ES51	Communication: models, terminology and protocols
C 2	7	Friday	10.00-11.45	ES51	<i>(Consultation session)</i>
L 10	8	Tuesday	13.15-15.00	ES51	Communication scheduling protocols [HWA #2 available]
-	8	Thursday	10.00-11.45	--	<i>(no lecture)</i>
C 3	8	Friday	10.00-11.45	ES51	<i>(Consultation session)</i>
L 11	9	Tuesday	13.15-15.00	ES51	Worst-case execution-time analysis
L 12	9	Thursday	10.00-11.45	ES51	Fault-tolerant scheduling: terminology and algorithms
C 4	9	Friday	10.00-11.45	ES51	<i>(Consultation session)</i>
L 13	10	Tuesday	13.15-15.00	ES51	Clock synchronization; Reading hints
C 5	10	Thursday	10.00-11.45	ES51	<i>(Consultation session)</i>
-	10	Friday	10.00-11.45	ES51	--

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Parallel and Distributed Real-Time Systems

Reading guidelines:

Krishna & Shin, "Real-Time Systems":

Chapter	Contents	Recommended reading	Complementary reading
1	Introduction	Section 1.1 - 1.5	---
2	Characterizing Real-Time Systems	Section 2.1 - 2.2.2, 2.2.5, 2.3 - 2.4	Section 2.2.3 - 2.2.4
3	Task Assignment and Scheduling	Section 3.1 - 3.2, 3.4 - 3.7	Section 3.3; Section 3.2.1 (pp. 55-64, 71-73, 74-79)
4	Programming Languages and Tools	---	---
5	Real-Time Databases	---	---
6	Real-Time Communication	Section 6.1 - 6.4	---
7	Fault-Tolerance Techniques	---	Section 7.1 - 7.11
8	Reliability Evaluation Techniques	---	Section 8.1 - 8.6
9	Clock Synchronization	Section 9.1 - 9.7	Section 9.5.2 pp. 381-384; Section 9.6.1 pp. 392-394; Section 9.6.3 pp. 399-401

Please observe that this book contains an errata sheet: [\[PS\]](#), [\[PDF\]](#)

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