

## Real-Time Embedded Systems, 4 credits

### *Realtids- och inbyggda system, 4 hp*

Course Code/Codes	50DT046
Subject Area	Computer Science (Datavetenskap)
School/equivalent	School of Science and Technology (Institutionen för naturvetenskap och teknik)
Valid from	2016-12-15
Approved	2016-12-15
Revised	,
Approved by	Head of School Peter Johansson
Translation to English, date and signature	,

## 1 Course content

The course includes theory and state-of-the-art of methods and algorithms in Real-Time Embedded Systems. Real-Time Embedded Systems are usually complex and have to be carefully analysed and verified before deploying them. The aim of the course is to show the challenges in analysis and verification of such systems. The course starts with introducing concepts and terminology of Real-Time Embedded Systems. It continues with discussion about Real-Time Operating Systems (RTOS), Scheduling Algorithms, Resource Handling and Synchronization Protocols, Real-Time Communication, Real-Time Scheduling on Multiprocessors, Resource Handling and Synchronization on Multiprocessors

## 2 Outcomes

### 2.1 The course in relation to the doctoral programme

The course shall primarily refer to the following intended learning outcomes for third-cycle courses and study programmes as described in the Higher Education Ordinance, i.e. the doctoral student shall demonstrate:

#### *Knowledge and understanding*

- broad knowledge and systematic understanding of the research field (**part of outcome 1**)
- familiarity with the methods of the specific field of research in particular (part of outcome 2)

#### *Competence and skills*

- the capacity for scholarly analysis and synthesis (part of outcome 3)
- the capacity to review and assess new and complex phenomena, issues and situations autonomously and critically (part of outcome 3)

- the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively (part of outcome 4)

The intended learning outcomes are listed in the same order as in the general syllabus for the programme.

## **2.2 Intended course learning outcomes**

To obtain a passing grade, the doctoral student shall demonstrate:

- An understanding of the basic concepts of real-time systems
- Knowledge about challenges in complex real-time systems and consequences of failures in such systems
- An understanding of scheduling algorithms and resource handling algorithms for both single processor and multiprocessor systems
- An ability to distinguish the difference between various methods and algorithms and has the knowledge about where and when to apply the methods.
- Knowledge about analysis and verification of Real-Time Systems
- Awareness of current research topics in real-time and embedded systems

## **3 Reading list and other teaching material**

The following course readings and teaching material will be used on the course:

Buttazzo, Giorgio C (latest edition)

Hard real-time computing systems : predictable scheduling algorithms and applications  
Springer.

Burns, Alan and Wellings, Andy (latest edition)

Real-Time Systems and Programming Languages: Ada, Real-Time Java and C/Real-Time POSIX  
Pearson

Slides from presentations during the course

## **4 Teaching formats**

Teaching on the course takes the following format:

The teaching formats of the course includes lectures, seminars and compulsory assignments

## **5 Examination**

The course is assessed through an examination in the format of

Assignments

**Solving handout assignments and presenting and discussing the solutions in group sessions.**

*For examinations consisting of several examination components, the following applies:* If during the course it is concluded that a doctoral student is unable to complete a certain examination component, the examiner may set a substitute assignment provided that circumstances do not

reasonably allow for the course component to be completed at a later date during the run of the course.

## **6 Grades**

Examinations on third-cycle courses and study programmes are to be assessed according to a two-grade scale with either of the grades 'fail' or 'pass' (local regulations).

The grade shall be determined by a teacher specifically nominated by the higher education institution (the examiner) (Higher Education Ordinance).

To obtain a passing grade on examinations included in the course, the doctoral student is required to demonstrate that he/she attains the intended course learning outcomes as described in section 2.2. Alternatively, if the course consists of multiple examinations generating credit, the doctoral student is required to demonstrate that he/she attains the outcomes that the examination in question refers to in accordance with section 5.

A student who has failed an examination is entitled to a retake.

If an examination consists of several examination components, and a student fails an examination component, the examiner may, as an alternative to a retake, set a make-up assignment with regard to the examination component in question.

A doctoral student who has failed an examination twice for a specific course or course element is entitled, upon his/her request, to have another examiner appointed to determine the grade.

## **7 Admission to the course**

### **7.1 Admission requirements**

To gain access to the course and complete the examinations included in the course, the applicant must be admitted to a doctoral programme at Örebro University.

### **7.2 Selection**

Selection between applicants who have been admitted to doctoral programmes at Örebro University and who otherwise meet the admission requirements as listed above is made according to the following order of precedence:

If no other selection criteria are specified in this section, priority shall be given to applicants with a lower number of course credits left before the award of their degree over applicants with a higher number of remaining course credits. Should two or more students have equal number of credits, selection will be done through the drawing of lots. This also applies within any selection groups listed unless otherwise stated.

### **7.3 Other applicants than doctoral students admitted at Örebro University**

Other applicants than doctoral students admitted at Örebro University may be given access to the course on the grounds of provisions for and/or agreements regarding contracted courses, joint degrees, national graduate schools or cooperation in other respects with other universities.

Any decisions on what such other applicants may be given access to the course are made separately and on the basis of the provisions and/or agreements that occasion the student to apply for the course.

For participation in the course in other respects, the same provisions shall apply as for doctoral students admitted to Örebro University.

## **8            Transfer of credits for courses, study programmes and other experience**

Provisions on the transfer of credits can be found in the Higher Education Ordinance and on the university's webpage.

## **9            Other information**

The course is taught in English.

### **Transitional provisions**

None.