

# Computer Engineering and Real-time Systems

Programme course

6 credits

Dator teknik och realtidssystem

TSEA81

Valid from: 2017 Spring semester

**Determined by**

Board of Studies for Electrical  
Engineering, Physics and Mathematics

**Date determined**

2017-01-25

## Main field of study

Computer Science and Engineering, Electrical Engineering

## Course level

Second cycle

## Advancement level

A1X

## Course offered for

- Industrial Engineering and Management - International, M Sc in Engineering
- Industrial Engineering and Management, M Sc in Engineering
- Mechanical Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Electronics Design Engineering, M Sc in Engineering

## Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

## Prerequisites

Computer Hardware and Architecture, Programming and Data Structures, basic knowledge of programming in the C programming language. (If you have used C in your bachelor project in Electronics this is typically enough.)

## Intended learning outcomes

To develop an understanding of hardware/software interactions in computer systems with parallel activities and time constraints, and to develop basic skills for integration of software using a real-time operating system.

After a completed course, the student shall be able to:

- give examples of hardware/software interactions for handling of parallel activities and time constraints
- explain properties of software with parallel activities
- describe the structure, and give examples from the implementation, of a real-time kernel
- summarize how the underlying computer architecture and instruction set influences the implementation of a real-time operating system
- design and implement software with parallel activities and time constraints
- use a real-time operating system
- exhibit basic skills in integration of software and a real-time operating system for a specific computer architecture

## Course content

Introduction to real-time systems, parallel activities and time constraints, parallel activities on a processor, interrupt-driven systems, foreground/background systems, processes and threads, real-time operating systems, shared resources, mutual exclusion, semaphores, condition variables, message-based systems, structure and implementation of a real-time kernel, context switch implementation, hardware support for parallel activities, interrupts and exceptions, user mode and supervisor mode in a processor, memory protection, virtual addressing, examples of real-time operating systems, examples of industrial applications

## Teaching and working methods

The course contains lectures, assignments, and laboratory exercises. The assignments and laboratory exercises constitute a coherent series, where a sequence of assignments give the student basic competence in design and implementation of real-time systems using a real-time operating system. The assignments are performed independently by the students, with support given in lessons with guidance and examination. A selected set of the assignments are also examined by a written report. The assignments are done on a PC, with Windows or Linux.

The laboratory exercises use external hardware, in the form of an embedded system. A first laboratory exercise treats integration and bring-up of a real-time operating system in an embedded system, combined with verification of an application developed in the assignments. A second, and concluding, laboratory exercise treats, using the same embedded system, a larger application, where the knowledge obtained during the course is used and put in a larger context, e.g. using Linux in an embedded system.

The course uses the programming language C.

## Examination

LAB1	Translation is not available	4 credits	U, G
TEN1	Written Examination	2 credits	U, 3, 4, 5

Grade for the course: The grade for the course is based on the grade from the written exam

## Grades

Four-grade scale, LiU, U, 3, 4, 5

## Department

Institutionen för systemteknik

## Director of Studies or equivalent

Tomas Svensson

## Examiner

Anders Nilsson

## Course website and other links

<http://www.isy.liu.se/en/edu/kurs/TSEA81/>

## Education components

Preliminary scheduled hours: 40 h

Recommended self-study hours: 120 h

## Course literature

### Additional literature

#### Books

Dahl, Ola, (2004) *Realtidsprogrammering*

Studentlitteratur

Sloss, A., Symes, D., Wright, C., (2004) *ARM System Developer's Guide: Designing and Optimizing System Software*,

Referenslitteratur

## Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at [http://stydokument.liu.se/Regelsamling/Innehall/Utbildning\\_pa\\_grund-\\_och\\_avancerad\\_niva](http://stydokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva).