UNIVERSITY OF GOTHENBURG

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DIT633 Development of Embedded and Real-Time Systems, 7.5 credits

Utveckling av inbyggda- och realtidssystem, 7,5 högskolepoäng

First Cycle

Confirmation

This course syllabus was confirmed by Department of Computer Science and Engineering on 2021-10-26 to be valid from 2023-01-16, spring semester of 2023.

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

Position in the educational system

The course is compulsory within the Software Engineering and Management Bachelor's Programme. It is also a single subject course at the University of Gothenburg.

The course can be part of the following programme: 1) Software Engineering and Management Bachelor's Programme (N1SOF)

Main field of studies	*Specialization*
Software Engineering	G1F, First cycle, has less than 60 credits in first-cycle course/s as entry requirements

Entry requirements

To be eligible to the course, the student should have successfully completed 30 credits of courses within Software Engineering, Computer Science, or equivalent, including a 7.5 credits course in programming (e.g., DIT043 Object-Oriented Programming, DIT012 Imperative Programming with Basic Object-Oriantation, 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

On successful completion of the course the student will be able to:

Knowledge and understanding

- exemplify characteristics of embedded systems and of real time systems
- explain the basic theory of exceptions, interrupts, and timers
- illustrate an overall view of a compilation process
- explain cross compilation
- clarify the differences between a desktop application and an embedded application
- define the concepts of tasks, scheduling, semaphores, message queues, synchronization and communication
- exemplify methods of abstracting the underlying hardware

Competence and skills

- implement an embedded application using a system programming language, such as C for some given hardware, using a cross compiler
- carry out a test strategy for an embedded application
- manage rudimentary real time applications
- transfer a compiled binary from the compilation environment to the target embedded system

Judgement and approach

- analyse and participate in discussions of an embedded real-time system´s basic modularity
- estimate the need for and suggest how to perform software tests for an embedded real-time system
- judge the impact of the solution (embedded system) on sustainability attributes, such as energy consumption, electronic waste, economical sustainability
- reason about the use of simulated environment vs. real hardware with respect to the balance between sustainability (in terms of resource consumption, development process) and possibilities to validate the system

The course is sustainability-related, which means that at least one of the learning outcomes clearly shows that the course content meets at least one of the University of Gothenburg's confirmed sustainability criteria.

Course content

Embedded and real-time software is often closely interacting with hardware. Typically, this software is written in a language like C on either a real-time operating system or a stripped Unix/Linux version. The course contains an introduction to embedded and real-time systems, programming for an embedded environment and tools used to

develop embedded systems, use of IDEs as well as command line programs (compilers, linkers etc.).

The course also contains an introduction to the principal of program execution and the interrupt manage process, general operating systems and real-time operating systems, concepts, mainly, used in the real-time and embedded systems.

The course introduces and discusses the concept of sustainability in terms of minimizing electronic waste, reusing components and using simulation as a means to reduce the electronics footprint.

Sub-courses

1. **Hall examination** *(Salstentamen),* 4.5 credits
   Grading scale: Pass with distinction (5), Pass with credit (4), Pass (3) and Fail (U)
2. **Assignments** *(Inlämningsuppgifter),* 3 credits
   Grading scale: Pass (G) and Fail (U)

Form of teaching

The teaching consists of lectures, exercises and examination parts, as well as supervision in connection to the exercises.

Language of instruction: English

Assessment

The course is examined by an individual written exam carried out in an examination hall and written assignments normally carried out in groups. The assignments part is examined on the basis of solutions to compulsory problems handed in during the course and on the basis of individual contribution to the group work. Students are required to complete written self- and peer-assessment forms during the course which will be part of the assessment of the student's individual contribution to the group work.

The student may also earn bonus points to the written exam through the assignments part in the course with up to 1/4 of the points needed for the grade Passed in the written exam. The bonus points are only valid for the three examinations during the course year.

Retake examinations of the assignments part consist of additional individual assignments.

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 (5), Pass with credit (4), Pass (3) and Fail (U).

To pass the course, students must receive a passing grade in both modules. The grade for the entire course will be determined by the written exam.

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

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

The course replaces the course DIT632, 7.5 credits. The course cannot be included in a degree which contains DIT632. Neither can the course be included in a degree which is based on another degree in which the course DIT632 is included.