MASTER OF SCIENCE IN ENGINEERING

Module Description, available in: EN

Embedded Real-time Software

General Information

Number of ECTS Credits

3

Module code

TSM_EmbReal

Valid for academic year

2024-25

Last modification

2022-10-21

Coordinator of the module

Simon Künzli (ZHAW, simon.kuenzli@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EIE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Knowledge in C programming language and object-oriented programming in a programming language
- Good knowledge of computer and microprocessor architectures
- Fundamentals of Operating Systems
- Basic knowledge in concurrent programming

Brief course description of module objectives and content

Embedded Systems, although they are not visible, have become integral parts of this world. Embedded Systems essentially consist of two components: hardware and software. In contrast to information systems e.g. in the banking world, hardware is more application specific. Due to this fact, the software that interacts directly with the hardware is more specific as well. Real-time and concurrency are important issues in Embedded System development, which come on top of the generally valid requirements for correctness and reliability.

The module teaches methods to develop Real-Time Embedded System Software and deals with the following complementary aspects:

- Modern C++ for microcontrollers, focusing on programming close to hardware with and without dynamic memory allocation
- Real-Time Operating Systems, Applications and Modelling
- Software concepts for asymmetric multiprocessor systems

Aims, content, methods

Learning objectives and competencies to be acquired

Based on requirements, the students will be able to apply the optimal method to develop and verify an Embedded System,

- on the boundary between hard- and software using modern C++ and RTOS features
- on application layer using modeling methods.

Module content with weighting of different components

The module provides insights at real-time embedded systems from various perspectives, consisting of three major parts.

In the first part, we focus on C++ for embedded systems with focus on the use on microcontrollers.

- Using C++: showing the huge advantages of C++ for Embedded Systems
- Point out where C++ uses dynamic memory allocation and how to deal with it on microcontrollers.

In part II, we discuss SW modelling and implementation aspects using real-time operating systems

- Introduction to RTOS
- Task Models and Real-Time Scheduling
- Concurrency
- Modeling & Code Generation
- Testing & Debugging

In the last part, the focus is on software development for asymmetric multi-core embedded systems:

- Inter-Processor communication
- Multi-core programming

Teaching and learning methods

- Ex-cathedra teaching
- Exercises
- Self-study (study of papers, case studies)
- practical exercises: programming embedded software on embedded systems

Literature

Assessment

Certification requirements

Module does not use certification requirements

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- open book, all materials including PC, laptop, tablets etc. allowed during the exam session
- any telecommunication and the respective programs/apps for communications must be turned off (incl. mobile phones)
- no active help from third parties, i.e. no active participation in web forums, discussion groups, or similar means of information exchange

Other permissible aids

No other aids permitted

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted