CS-476

# Embedded system design

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| Cursus | Sem. | Type |
|---|---|---|
| Computer science | MA2, MA4 | Opt. |
| Cybersecurity | MA2, MA4 | Opt. |
| Electrical and Electronical Engineering | MA2, MA4 | Opt. |
| Robotics | MA2, MA4 | Opt. |
| SC master EPFL | MA2, MA4 | Opt. |

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| Language of teaching | English |
| Credits | 6 |
| Session | Summer |
| Semester | Spring |
| Exam | During the semester |
| Workload | 180h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Lecture | 2 weekly |
| Labs | 2 weekly |
| **Number of positions** | |


## Summary

Hardware-software co-design is a well known concept in embedded system design.It is also a concept required in designing FPGA-accelerators in data-centers.This course teaches how to transform algorithms in smart hardware-software solutions.


## Content

High-level architectures:

- FIFO's, LIFO's, ring-buffers, and ping-pong buffers.
- FSM-D (finite state machine data-path) structures.
- Stream processing.

Acceleration methods:

- Custom instruction set extensions.
- Hardware accelerators
- Compiler optimizations.

Implementation methods:

- Hardware-software co-design.
- Timing closure.
- Virtual prototyping.
- Bare metal versus usage of an RTOS.

## Learning Prerequisites

### Required courses

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### Recommended courses

- Architecture-aware programming
- CS-200 Computer Architecture or CS-208 Computer Architecture I and CS-209 Computer Architecture II

### Important concepts to start the course

- C/C++ programming skills
- Verilog/VHDL description skills

## Learning Outcomes

By the end of the course, the student must be able to:

- Design buffers to account for different read and write behaviors
- Understand the concept of FSM-D's and use this concept to design accelerators
- Understand the concept of stream processing and be able to implement a stream processor
- Design and optimize an embedded system on FPGA given a set of prerequisites

## Teaching methods

- First 9 weeks : theory with small projects and reports
- Last 5 weeks : mini project in groups of 2 students with final demonstration and presentation

## Expected student activities

- Perform in groups of two students small projects to put the theory into practice
- Optimize a real world problem in a final project, explain the choices made, and present the results

## Assessment methods

- Lab reports : 50%
- Final mini-project : 50%

## Supervision

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| Office hours | No |
| Assistants | Yes |
| Others | Electronic forum and Moodle |

## Resources

### Moodle Link

- https://go.epfl.ch/CS-476