CS-473

Embedded systems

Beuchat René

Cursus	Sem.	Type
Computer science	MA1, MA3	Opt.
Cybersecurity	MA1, MA3	Opt.
Electrical and Electronical Engineering	MA1, MA3	Opt.
Microtechnics	MA1, MA3	Opt.
Robotics, Control and Intelligent Systems		Opt.
Robotics	MA1, MA3	Opt.
SC master EPFL	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Project	2 weekly
Number of positions	

Summary

Last year with R.Beuchat as teacher. The main topics of this course are understanding and designing embedded system on a programmable circuit (FPGA). Students will be able to design a camera or a LCD controller on an FPGA in VHDL and will use their controller through a softcore processor.

Content

- Microcontrollers and their associated programmable interfaces (GPIO, Timer, SPI, A/D, PWM, interrupts)
- Hardcore/softcore processors (ie. NIOS II, ARM)
- Memory organizations, little/big endian
- Synchronous busses, dynamic bus sizing (ie. Avalon Bus in Memory Mapped mode)
- Processor busses, busses realized in a FPGA
- Serial busses(ie. UART, SPI, i2c, ...)
- How an LCD graphical screen and a CMOS camera work
- FPGA-based conception of Embedded Systems
- Embedded systems with processors on FPGAs

Laboratories provide knowledge & practice to develop an embedded system based on an FPGA device.

Keywords

microprocessors, microcontroller, FPGA, embedded systems, SoC, programmable interface

Learning Prerequisites

Required courses

Introduction to computing systems, Logic systems, Computer architecture

Recommended courses

Electronic, Programming (C/C++), Project System On Chip

Important concepts to start the course

- Computer architecture (processor, memory, programmable interfaces)
- Processor Architecture (PC, registers, ALU, instruction decoding, instruction execution)
- Knowledge of C programming language

- Knowledge of VHDL

Learning Outcomes

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

- Design an embedded system on an FPGA
- Analyze a specific problem to be solved and propose an FPGA-based system to solve it
- Implement a solution to the given problem
- Realize and simulate the design
- Test the developed solution on an FPGA
- Use complex development tools and hardware debugging tools such as a logic analyzer and an oscilloscope

Transversal skills

- Use a work methodology appropriate to the task.
- Negotiate effectively within the group.
- Set objectives and design an action plan to reach those objectives.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Use both general and domain specific IT resources and tools
- Make an oral presentation.

Teaching methods

Ex cathedra and exercises, laboratories by specific sub-topics, final mini-project

Expected student activities

- Reading and deepening of course concepts
- Preparation of exercises performed in the laboratory
- Writing reports on different labs
- Realization of a final mini-project by group with oral presentation, report and demonstration

Assessment methods

With continuous control.
all labs 30%, mini-projet 20%, oral exam 50%

Supervision

Others	Course on Moodle with forum

Resources

Bibliography

Teaching notes and suggested reading material on moodle
Specialized datasheets (micro-controllers, FPGA) and standards(ie, SPI, i2c, Amba, Avalon, etc)
Book downloadable freely: https://www.arm.com/resources/ebook/fundamentals-of-soc
Fundamentals of System-on-Chip Design on Arm Cortex-M Microcontrollers

Notes/Handbook

Documents and slides provided on moodle

Moodle Link

- https://go.epfl.ch/CS-473

Prerequisite for

CS-476 Real-time embedded systems