Design Methodology for FPGAs (E031251)

Course Specifications
Valid as from the academic year 2019-2020

Course size (nominal values; actual values may depend on programme)

<table>
<thead>
<tr>
<th>Credits</th>
<th>Study time</th>
<th>Contact hrs</th>
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</thead>
<tbody>
<tr>
<td>6.0</td>
<td>180 h</td>
<td>60.0 h</td>
</tr>
</tbody>
</table>

Course offerings and teaching methods in academic year 2019-2020

A (semester 1) English
- lecture: 30.0 h
- seminar: practical PC room classes: 30.0 h

B (semester 1) Dutch
- guided self-study: 30.0 h
- seminar: practical PC room classes: 30.0 h

Lecturers in academic year 2019-2020

Stroobandt, Dirk TW06 lecturer-in-charge

Offered in the following programmes in 2019-2020

<table>
<thead>
<tr>
<th>Programme</th>
<th>crdts</th>
<th>offering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridging Programme Master of Science in Electrical Engineering (main subject Communication and Information Technology)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Bridging Programme Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Master of Science in Electrical Engineering (main subject Communication and Information Technology)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Master of Science in Electromechanical Engineering (main subject Control Engineering and Automation)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Master of Science in Electromechanical Engineering (main subject Electrical Power Engineering)</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)</td>
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<td>A</td>
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<tr>
<td>Master of Science in Electronics and ICT Engineering Technology (main subject Electronics Engineering)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Master of Science in Electronics and ICT Engineering Technology (main subject ICT)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Master of Science in Electromechanical Engineering (main subject Maritime Engineering)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Master of Science in Electromechanical Engineering (main subject Mechanical Construction)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering)</td>
<td>6</td>
<td>A</td>
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<tr>
<td>Master of Science in Computer Science Engineering</td>
<td>6</td>
<td>A</td>
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<td>Master of Science in Computer Science Engineering</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>Master of Science in Electrical Engineering</td>
<td>6</td>
<td>B</td>
</tr>
<tr>
<td>Exchange Programme in Computer Science (master's level)</td>
<td>6</td>
<td>A</td>
</tr>
</tbody>
</table>

Teaching languages
- Dutch, English

Keywords
- Design methodology, hardware/software, complexity

Position of the course

The goal of this course is to familiarise students with different aspects and phases in the design of complex hardware/software systems. First, we build on the competences gained from the course Digital Electronics and we elaborate on hardware design at RT and system level, architecture exploration, hardware/software partitioning and interface.
synthesis. Next, we discuss the very important aspect of data transfers and memory use and elaborate on CAD, verification and testing of digital systems. In a second course part we focus on some important aspects of complex systems design.

Contents
- SoC, embedded systems and performance measures
- Models of computation
- System specification techniques and design languages
- Hardware architectures
- Hardware design at RT and architecture level
- Computer-aided design
- Functional verification, validation and testing
- Optimisation of data transfers and memory use
- High level synthesis and system design
- Architecture exploration
- HW/SW partitioning
- HW/SW interfaces
- RTOS
- Dynamic power management in systems
- Modern complex system design trajectories

Initial competences
Obtained credits for the course Digital Electronics or prove that equal competences have been obtained.

Final competences
1. Being able to draw Pareto curves
2. Being able to analyse and use control and timing concepts in digital systems
3. Being able to design a complex digital system in a hierarchical way
4. Knowing how to use programmable components such as FPGAs to implement a digital system
5. Knowing the different sorts of interfaces and how they can be designed
6. Understanding how the design of a memory hierarchy can influence the performance of a system
7. Being able to design and simulate test benches
8. Being able to recognise the impact of performance measures on the implementation
9. Knowing how to systematically explore the design space
10. Knowing what an RTOS is and how it differs from another OS
11. Being able to perform a hardware design from specification to final realisation in reconfigurable hardware

Conditions for credit contract
Access to this course unit via a credit contract is determined after successful competences assessment.

Conditions for exam contract
This course unit cannot be taken via an exam contract.

Teaching methods
Guided self-study, lecture, project, seminar: practical PC room classes.

Extra information on the teaching methods
Classroom lectures; Computer-assisted problem solving; Lab sessions.

Learning materials and price
Partly full course text, partly annotated slides. The following book is also used as learning material:
A Practical Introduction to Hardware/Software Codesign
Author: Schaumont, Patrick R
1st Edition., 2010, XVIII, 396 p., Hardcover
ISBN: 978-1-4419-5999-7
Price: 59,95 EUR

References

Course content-related study coaching
The practical exercises are fully coached. For the practical exercises we do not foresee further follow-up with homework (preparing the exercises is beneficial though) Some practical exercises are replied by a project.

(Approved)
Evaluation methods
   end-of-term evaluation and continuous assessment
Examination methods in case of periodic evaluation during the first examination period
   Written examination, open book examination, oral examination
Examination methods in case of periodic evaluation during the second examination period
   Written examination, open book examination, oral examination
Examination methods in case of permanent evaluation
   Skills test
Possibilities of retake in case of permanent evaluation
   examination during the second examination period is possible in modified form
Extra information on the examination methods
   During examination period: oral open-book exam; written open-book exam - problems
   During semester: graded lab sessions and project. Second chance: Possible in adapted form
   Frequency: four times per semester
Calculation of the examination mark
   Special conditions: The computer laboratory work counts as 10% of the final grade, the project as 20%, the theory exam as 30% and the exercises exam as 40% of the final grade. The student has to obtain a minimum score of 8/20 for each part in order to pass, otherwise the total score "P" (/20) is recalculated as P' = min(8, P).