UNIVERSITY OF GOTHENBURG

# COMPUTER SCIENCE AND ENGINEERING

## DIT797 Digital design, 7.5 higher education credits

Digital konstruktion, 7,5 högskolepoäng

*First Cycle*

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### Confirmation

This course syllabus was confirmed by Department of Computer Science and Engineering on 2015-09-29 to be valid from 2016-08-29, autumn semester of 2016.

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

### Position in the educational system

The course is a part of the Computer Science Bachelor's Programme and a single-subject course at the University of Gothenburg.

The course can be part of the following programmes: 1) Computer Science, Master's Programme (N2COS) and 2) Computer Science, Bachelor´s Programme (N1COS)

| *Main field of studies* | *Specialization* |
|---|---|
| Computer Science | G2F, First Cycle, has at least 60 credits in first-cycle course/s as entry requirements |

### Entry requirements

To be eligible for the course students should have successfully completed courses corresponding to 60 hec in the subject of Computer Science, including the course DIT791 Fundamentals of Digital Systems and Computers (or equivalent).

### Learning outcomes

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

*Knowledge and understanding*

- describe binary arithmetic units for addition, multiplication and division.
- describe the different storage elements used in digital circuits (latches, flip-flops, different types of memories).
- recognize the function and uses of Reconfigurable and ASIC technologies.
- list the differences of various types of Finite State Machines (Mealy, Moore, synchronous Mealy).
- recognize the basics of design for testability and the basic principles behind the testing.
- identify and describe asynchronous sequential circuits.
- list the factors that affect the timing, power and area of a digital circuit.

*Skills and abilities*

- minimize a Boolean function or derive its canonical form.
- create the design specifications of a digital circuit for a given problem.
- measure the critical path delay of a digital circuit.
- use VHDL to describe combinatorial and sequential circuits.
- use modern tools to perform simulation, synthesis and implementation of a digital circuit described in VHDL.
- create test benches for VHDL designs to validate their correct functionality.
- use FPGA technology to implement a digital hardware design.
- define FSM encodings and perform state minimization.

*Judgement and approach*

- evaluate the advantages and disadvantages of different implementation technologies (ASICs, FPGAs) for digital designs, and select one for a specific design.
- compare different design for binary arithmetic (e.g. different adder designs).
- critically evaluate and judge a design choice in terms of power, delay, area, and be able to select the one that fits the particular design constraints.

**Course content**

The course is intended to give fundamental knowledge about design, implementation, and optimization of combinatorial and sequential digital circuits. It further presents the technologies used for implementing such circuits. As part of the course, the students will be introduced to modern computer-based design tools (CAD), and learn the basics of a hardware description language. More precisely, the course contents are the following:

- Boolean Algebra and logic minimization
- Arithmetic Units
- Memory

- Combinational circuits
- Sequential circuits and Finite State Machines
- Technologies of digital circuits (ASIC, FPGA)
- Asynchronous circuits
- Timing and Power consumption of digital circuits
- Testing and design for testing
- Hardware description languages (VHDL) for digital circuits
- Hardware Design, test and evaluation of a simple processor

*Sub-courses*

1. **Examination** *(Tentamen),* 4.5 higher education credits
   Grading scale: Pass with Distinction (VG), Pass (G) and Fail (U)
2. **Laboration** *(Laboratory),* 3 higher education credits
   Grading scale: Pass with Distinction (VG), Pass (G) and Fail (U)

**Form of teaching**

The course additionally includes exercise sessions complimentary to the lectures.

*Language of instruction:* English

**Assessment**

The course is examined by an individual exam given in an examination hall and laboratory assignments. The Laboratory work is carried out in groups of normally 2 students.

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 (VG), Pass (G) and Fail (U).
To obtain the grade Pass for the whole course the student must pass the laboratory assignments and pass the exam. In order to get the grade Pass with Distinction for the whole course, the student must have been awarded Pass with Distinction on the exam and at least a passing grade on the laboratory assignments.

**Course evaluation**

The course is evaluated through meetings both during and 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. The results of and possible changes to the course will be shared with students who participated in the evaluation and students who are starting the course.

**Additional information**

The course is a joint course together with Chalmers.