

Course description / SYLLABUS etc.

(Version: September 7, 2007)

Introduction

The aim of the course is to provide the participants with: (1) in depth knowledge on basic computer organization and (2) structured and systematic design of digital circuits and systems using the hardware description language VHDL. The course is based on a textbook on computer organization and design, supplemented with a VHDL-textbook, lecture notes, journal articles, manuals, and data sheets.

In parallel with the lectures, participants will be working (in teams of 2-4 students) on a project in which they design and simulate a simple pipelined 32-bit RISC processor called Mini-MIPS (As an alternative to the Mini-MIPS project a more software oriented project is also considered where students would have to optimize the execution of a program).

Practicalities

Instructors

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Teaching assistants (Mondays & Thursdays):

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Textbook

The course textbook is:

- D.A. Patterson & J.L. Hennessy, “Computer Organization and Design - The Hardware/Software Interface, 3rd edition (revised printing), 2007,” Morgan Kaufmann. ISBN: 978-0-12-370606-5 (Pol. bookstore: 629.00 DKK –10 % student discount).

The CD-ROM included with the Patterson & Hennessy course textbook contains the very useful “VHDL Tutorial” by Peter J. Ashenden, which is a short version of “The Designers Guide to VHDL”. For some students this might be enough to cover the VHDL we use in this course.

For a complete VHDL reference, we highly recommend:

- Peter Ashenden, “The Designers Guide to VHDL (2nd Ed.)”. Morgan Kaufmann, 2001. ISBN: 1558606742 (Pol. bookstore: 759.00 DKK –10 % student discount).

Alternatively you may want to consider:

- Mark Zwolinski, “Digital System Design with VHDL (2nd Ed.)”
Prentice Hall, 2003, ISBN: 013039985X.

which is practical with many examples.

We have negotiated with the publisher a very well priced bundle containing the Patterson&Hennessy and the Ashenden books. The bundle costs only 999 DKK –10 % student discount.

Location Lectures on Mondays are in building 308, auditorium 11 (generally 13:00-15:00). Lectures on Thursdays are in building 303, auditorium 41 (generally 8:00-10:00).
Labs. are in building 341, rooms 015 and 019.

Homepage On Campusnet, course 02151, you will find all information about the course. We will update the campusnet-pages on a weekly basis.

Lecture notes The textbook will be supplemented by lecture notes and misc. handouts. You can buy the the set of lecture notes in the IMM bookshop in the corridor between buildings 304 and 305. The opening hours are as follows: 1st week of the semester: each day from 9:00 to 14:00; 2nd week of the semester: each day from 12:00 to 14:00; following weeks: only Monday and Tuesday from 12:00 to 13:00. The price is 80 kr.

Homework For some lectures a set of homework problems will be posted. The solution will be discussed during the following lectures.

Lab-sessions For students who are not familiar with VHDL and the ModelSim VHDL simulator we will organize introductory lab-sessions on the 13th and 17th of September. These lab-sessions are highly recommended and we may not be prepared to offer help on VHDL later in the course if you did not complete these lab-sessions.

Design project You will be working in teams of 2-4 students. Find partners you like to work with. You must register your team no later than the fourth week in the semester. You can work at any time that suits you. Teaching assistants are available in the labs (bldg. 341 rooms 015 and 019) at the assigned hours (normally Mondays 15-17, and Thursdays 10-12). In addition to these lab hours, you are expected to spend some extra time, either in the labs or at home at any time that suits you.

You may also install the free Xilinx ISE WebPACK and ModelSim XE Starter VHDL tools on your own PC and work at home. These tools can be downloaded from the Xilinx webpage free of charge. (Go to: www.xilinx.com – Products – Design Tools – ISE WebPACK, and register for the download. Remember to also get the ModelSim MXE Simulator. For debugging and testing MIPS assembler programs (for example related to Task 1 & 2 of the Mini-MIPS project) the SPIM MIPS simulator is used, see Appendix A in the textbook. PCSpim is available for download at <http://www.cs.wisc.edu/~larus/spim.html>

Deadlines:

1. The GCD task should be completed and the report must be handed in no later than Friday, September 28, 2007, at 16h:00.
2. The behavioral specification of the Mini-MIPS (Task 1) should be completed as early as possible and the report must be handed in no later than Friday, October 26, 2007 at 16h:00.
3. The final report describing and documenting your pipelined Mini-MIPS design is due on Friday, December 7, 2007, at 16h:00.

All reports are handed in using the "02151 mailbox" located in the (west) entrance to building 322.

All teams are supposed to complete Task 2 of the Mini-MIPS design project.

Exam (E2B) Friday, December 14, 2007.

Written four-hour exam (open books open notes) (50%), a report on the final design project (35%) and two short reports during the semester (GCD Task: 5% and Mini-MIPS Task 1: 10%). The final grade is based on all results in their entirety (Danish: helhedsvurdering).

Required reading for the exam (danish: Pensumliste)

From the 2006 exam, for reference only. For 02151 fall 2007 this will be announced later.
Textbooks:

- [1] D.A. Patterson & J.L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface (Third edition, 2004)," Morgan Kaufmann. Sections: 2.1-2.9 (Briefly. Focus on basic MIPS assembly language instructions as used in chapters 5 and 6 and in Mini-MIPS), 3.1-3.4, 3.6, 4.1-4.3, 5.1-5.6, 6.1-6.6, 6.8-6.9 (pages 440-447 only briefly), 7.1-7.5, 8.1, 8.2 (pages 569-571 only), 8.4-8.5.
If you have the old second edition of the textbook the material may differ! A pretty good match to the above is: 2.1-2.3, 3.1-3.8 (Focus on basic MIPS assembly language instructions as used in chapters 5 and 6 and in Mini-MIPS), 4.1-4.4, 4.6, 4.8, 5.1-5.6, 6.1-6.8, 6.11, 7.1-7.5, and 8.1-8.6.
- [2] S.A. Ward & R.N. Halstead, "Computation Structures," MIT Press, McGraw-Hill, 1990. Sections: 7.1-7.5 and 8.1-8.4.

Lecture plan

This is a tentative lecture plan. Check campusnet regularly for updates.

Week	Date	Topic	Lec.	Reading	Lab	
36	1	3/9	Introduction	JS / OHM	[1] Ch. 1	Tutorial VHDL GCD GCD due Mini-MIPS
	2	6/9	Control Structures and Disciplines	JS	[2] Ch. 7	
37	3	10/9	Performance measures and Trade-offs	JS	[2] Ch. 8	
	4	13/9	Introduction to VHDL	OHM	[3,4,5]	
38	5	17/9	VHDL simulation and modeling	OHM	[3,4,5]	
	6	20/9	Introduction of the GCD exercises/problem	OHM	[3,4,5]	
39	7	24/9	Computer Performance	JS	[1] Ch. 1, Ch. 4	
	8	27/9	RISC concepts, MIPS ISA + Mini-MIPS project	JS	[1] Ch. 2	
40	9	1/10	The processor, single- & multiple cycle	JS	[1] Ch. 5.1-4	
	10	4/10	Implementing the Control Unit	JS	[1] Ch. 5.5, Ap.C	
41	11	8/10	Pipelining: basics and data hazards	OHM	[1] Ch. 6.1-3	
	12	11/10	Pipelining: Control hazards	OHM	[1] Ch. 6.3-7	
42		15/10	Fall vacation			
		18/10	Fall vacation			
43	13	22/10	Pipeline Interrupts & Performance	OHM	[1] Ch. 6.8-11	
	(14)	25/10	<i>No Lecture (Finish Mini-MIPS Task 1)</i>			
44	15	29/10	Integer Arithmetic (multiplication and division)	OHM	[1] Ch. 3.3-5	
	16	1/11	Floating Point Arithmetic	OHM	[1] Ch. 3.6-7	
45	17	5/11	Memory Systems: The basics of caches	OHM	[1] Ch. 7.1-2	
	18	8/11	Memory Systems: Caches (continued)	OHM	[1] Ch. 7.3,7.5	
46	19	12/11	Memory systems: Virtual Memory	JS	[1] Ch. 7.4-6	
	20	15/11	Virtual Memory (O.S. related issues)	JS	[1] Ch. 7.4-6	
47	21	19/11	Interfacing processors and peripherals	OHM	[1] Ch. 8.1-2,8.4-8	
	22	22/11	Guest lecture: SUN's multi-threaded multiproc.	NN		
48	23	26/11	Interfacing processors and peripherals	OHM	[1] Ch. 8.4-8	
	(24)	29/11	NoC and Multi-processor SoC	Ph.d.	Notes	
49	25	3/12	Old exam problems	JS/OHM	Notes	
	26	6/12	Old exam problems. Course Evaluation	JS / OHM		

Literature:

- [1] D.A. Patterson & J.L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface (Third Edition, August 2004)," Morgan Kaufmann.
- [2] S.A. Ward & R.N. Halstead, "Computation Structures," MIT Press, McGraw-Hill, 1990. (Chapters 7 and 8, included in the lecture notes.)
- [3] Peter J. Ashenden, "VHDL Tutorial" (included on the CD-ROM of [1]).
- [4] Jan Madsen & Steen Pedersen, "An Introduction to VHDL," ID-U:1993-65. (Included in the lecture notes).
- [5] Some more comprehensive textbook or other resource on VHDL (see section on textbooks).