Computer Organization II

Position
- Advanced (MSc) level course (2005 degree requir.)
- Intermediate (BSc) level course (2010 degree requir.)

Prerequisite: Computer Organization I (TiTo)
- Main hardware
- Symbolic assembly language, machine instructions
- CPU Instruction cycle
  - What happens in system during the cycle?

Related to Operating Systems
- Interrupts
- Virtual memory
- I/O Techniques
Course Material

- Course book (Make sure you have one!)
  - (7&6th ed.) possible, but MISSING a lot of material

- Lecture course home page (Autumn 2010)
  - Schedule, slides, exercises, announcements, links, etc.

- Course home page
  http://www.cs.helsinki.fi/group/nodes/kurssit/tikra/
  - Old courses, slides in Finnish and English, etc.
Schedule Autumn 2010

Lectures: 2.11. – 9.12.2010
- Tue and Thu 14-16 (D122), Teemu Kerola
- In English when needed

Practice sessions:
- Thu 14-16 (D122), Teemu Kerola
- General discussion in English
- Table discussion in Finnish (if everyone understands)

Course Exam
- Tue 14.12.2010, 9-12 (A111)
- Tue 25.1.2011, 16-20 (A111), make-up exam/final exam
- All exams also in English, if requested in advance
Comp Org I (TITO)
Lowest Presentation Level

Functionality! What happens in the system?

A := B + C;
High-level lang.

MOV AX, B
ADD AX, C
MOV A, AX
Assembler

Sta10: Fig 12.6
Implementation! How is the hardware composed of?
What makes it tick? How do ticks translate to work?

MOV AX, B
ADD AX, C
MOV A, AX

Assembler

Logical circuits
Learning goals

- **Digital logic**: Combinatorial & Sequential Circuits
- **Bus**: multiplexing, signaling
- **Memory hierarchy**: cache, TLB
- **Arithmetics**: Booth algorithm, representations
- **Instruction set**: operands, operations, memory reference
- **Processor structure and functions**: pipelining, RISC, CISC
- **Control**: micro-operations, micro-programmed control, clock pulse
- **Parallel Processing**: types, cache coherence, multicore

More detailed learning goals are available from course page
Course contents and schedule

- **Week 1**
  - Overview (Ch 1 – 8)
  - Digital logic (online Ch 20)
  - Bus (Ch 3)

- **Week 2**
  - Memory, Cache (Ch 4, 5)
  - Virtual memory (Ch 8.3-8.6)

- **Week 3**
  - Computer arithmetic (Ch 9)
  - Instruction sets (Ch 10, 11)

- **Week 4**
  - CPU struct. & func. (Ch 12)
  - RISC-architecture (Ch 13)

- **Week 5**
  - Instruction-level parallelism, Superscalar proc. (Ch 14)
  - Control Unit (Ch 15-16)

- **Week 6**
  - Parallel Processing (Ch 17)
  - Multicore (Ch 18)
  - Summary
Work during the course

- Combine the details together to form a larger picture
  - Try to continuously understand and analyse the connections
  - Stay awake!

- Make notes
  - Write down own ideas and questions immediately

- Ask questions
  - Question are never too simple.
    (If you missed the point, then somebody else missed it also)
  - Ask from teachers but also from co-students.

- Teamwork is allowed even with individual assignments
  - However, own paper must be written by you, even if you co-operated in learning the content
Summary lectures

All lectures are summary lectures
- Slides are just the “table of content” for summary lectures
- Students are expected to have studied lecture topic in advance
  - Read given chapters from the text book!

Lecture consists of
- Summary of central topics for this lecture
- Small group discussions on given topics
- General discussions, based on small group discussions and student questions
Practice Sessions

- Mark down homeworks done
  - Grade points based on marked homeworks and attendance

- Split into tables
  - Some tables in English

- Discuss all problems in each table

- Ask questions if needed
Projects

- All volunteer with extra projects

- Project 1: Make 2 new practice problems
  - Team project, 1-4 students
  - Understand some topics better

- Project 2: Study diary
  - Can work with a team
  - Each student will turn in their own diary
  - 1st part turned in already after 3 weeks
  - Understand all topics better
<table>
<thead>
<tr>
<th>Course Component</th>
<th>Available points toward grade</th>
<th>Minimum points needed to pass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice Sessions (homeworks, attendance)</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Course Exam</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Extra Projects</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42</strong></td>
<td><strong>18</strong></td>
</tr>
</tbody>
</table>
How much time do I need to invest for this course?

Simple time estimations (for planning)

- VERY OLD: 6.5 weeks * (2*(4+2) h/wk) = 78 h
- OLD: 4 cu = 2 study weeks: 2 * 40 h = 80 h
- CURRENT: 1 year / 60 cu = 1600 h / 60 cu = 26.67 h / 1 cu = **107 hours** / 4 cu

Motto:

"It is not good exercise, if you do not sweat"
("Kunto ei nouse, ellei tule hiki.")

Enjoy the course!
Credits

- Teemu Kerola 1999-2003
  - Original slides (in English), Based on 5th edition
  - Updated to 6th edition 2002

- Auvo Häkkinen 2004-2005
  - Most slides translated to Finnish, orange layout
  - Updated to 7th edition 2005

- Teemu Kerola 2006

- Liisa Marttinen 2007

- Tiina Niklander 2008-2010
  - 2009: Translation to English from the Finnish slide set
  - 2010: Updated most slides to 8th edition